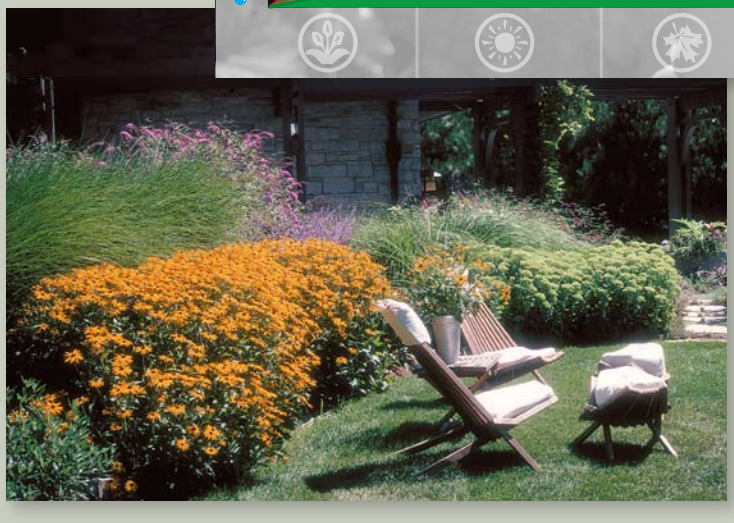
Summer **Smart** Water Use

A GUIDE TO PEAK SEASON WATER DEMAND MANAGEMENT



FOR MASSACHUSETTS COMMUNITIES

Metropolitan Area Planning Council
495/MetroWest Corridor Partnership
May 2006

MAPC

arc of innovation
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This report is one product of the *I-495/MetroWest Corridor Water Resources Strategy* being conducted by the Metropolitan Area Planning Council and the 495/MetroWest Corridor Partnership with financial assistance from the U.S. Environmental Protection Agency.

Special Thanks to U.S. Congressman James P. McGovern, who secured EPA funds for this initiative.

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SPECIAL THANKS are due to those who provided information, clarification, visuals, and feedback for this report, including: **Joanne Bissetta**, Department of Public Works, Town of Concord, MA; **Jane Ceraso**, Acton Water District, Town of Acton, MA; **Wendy Garpow**, North and South Rivers Watershed Association; **Robin Fullford**, Westford Water Department, Westford, MA; **Glenn Gibbs**, Town of Ipswich, MA; **Tim Henry**, Department of Public Works, Town of Ipswich, MA; **Paul Lauenstein**, Citizen, Town of Sharon, MA; **Duane LeVangie**, Massachusetts Department of Environmental Protection; **Emily Levin**, Ipswich River Watershed Association; **Scott MacNevin**, Energy New England; **Ted McIntire**, Department of Public Works, Town of Reading, MA; **Bart Miller**, Western Resource Advocates, Boulder, CO; **Anne Monnelly**, Massachusetts Department of Conservation and Recreation, Office of Water Resources; **Steve Pearlman** and **Ian Cooke**, Neponset River Watershed Association; **William Shaughnessy**, Water Division, Town of Wellesley, MA

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FOREWORD

"Summertime, and the livin' is easy…"

— Porgy and Bess

Summer may be a time of easy living when the fish are jumping and the cotton is high, but when well pumps are straining and the reservoirs are low, the picture is not so pretty. In many Massachusetts communities, water use rises 50% or more during summer months, taking a heavy toll on water supply infrastructure and environmental resources. Watersheds are required to provide more water during the season when water levels are lowest, while communities must pay for new wells or withdrawals that are needed for only a few months of the year.

This mismatch between supply and demand is partly due to local water policies that tend to promise abundance and promote consumption. Yet in the face of increasing scarcity, we can no longer think of water as a limitless commodity that should be sold as cheaply as possible. Water suppliers, municipal officials, and customers must move together toward greater sustainability in our water systems.

Managing peak season water demand is a component of water sustainability, and this guide—one in a series of products produced by MAPC and the 495/MetroWest Corridor Partnership on the region's water challenges—describes many strategies that communities can use to reduce discretionary water use during summer months. Public education is an important component, but voluntary conservation alone will not eliminate the problem. Conservation pricing, irrigation controls, and direct water use regulation all require more time, investment, and political commitment than a public outreach campaign does, but they are essential to success.

Dealing with peak demand also requires participation from all sectors. Property owners need to curb their demand through low-water landscaping; developers and engineers must become skilled in water efficient site design and irrigation systems; and municipal officials and water suppliers need to adopt a sustainability model, where conservation is seen as an alternative to system expansion, and full-cost water pricing accounts for environmental costs and investments in demand management. The solutions may not be easy or immediate, but together we can be smart about our summer water use.

George Preble, P.E.

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Chairman of the 495/MetroWest Corridor Partnership Water and Sewer Committee

ABOUT THIS REPORT

This report is a catalogue of strategies that communities can use to manage summer water demand. It is intended for stakeholders interested in developing and implementing a peak demand management program: water suppliers, municipal officials, regulators, citizen board members, and advocates. This report discusses strategies for public outreach, but is not itself intended for a general audience. Other public education materials are referenced within the document.

The first section of the report is an introduction to the problem of peak season demand, its implications, and its relationship to general water conservation. The next chapter provides guidance on developing a peak demand management program, with attention to program design, water system best practices, priority-setting, and program evaluation. The majority of the report comprises six chapters describing key peak demand management strategies: public education, water use regulation, conservation pricing, alternative sources, targeted outreach, and incentives.

In order to help communities prioritize their efforts, strategies are classified as basic, intermediate, and advanced. Basic measures are fundamental practices that should be adopted by all water systems, even those not currently experiencing excessive peak demand. Intermediate measures represent positive steps to reduce peak demand for communities that have covered the basics. Advanced measures are for those communities with the most pressing peak demand issues and those that have already implemented the other strategies.

Wherever possible, the report references Massachusetts communities that have implemented the peak demand management strategies recommended. In addition, three case studies of Massachusetts towns provide more comprehensive and detailed descriptions of their programs.

The last chapter of the report describes the basics of program evaluation. Six appendices are included with information about water efficient landscaping concepts (including key resources) and the text of model bylaws and of bylaws adopted in various Massachusetts communities.

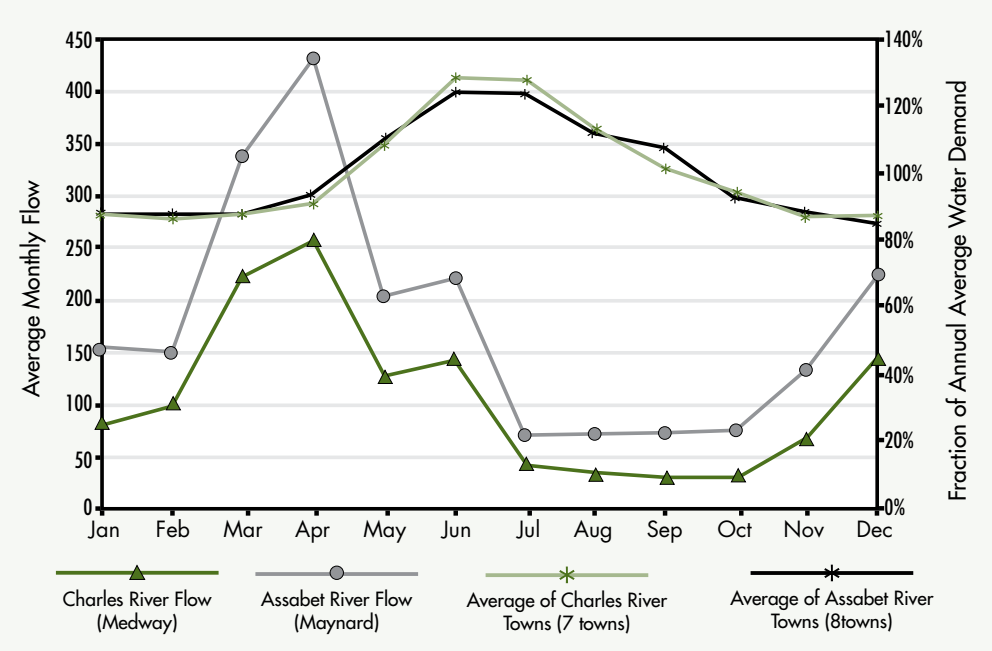
More information about peak season demand management, electronic copies of this report, references, links, and updated information can be found at our websites: www.mapc.org/peakdemand or www.arc-of-innovation.org.

INTRODUCTION

Why worry about peak season water demand?

Although Massachusetts receives an average of 44 inches of rain each year and has many valuable water resources, water is not always available where and when it is needed and wanted for human use. Issues with the distribution and seasonality of supply are becoming increasingly challenging and expensive for the state's communities, creating a growing interest in how to manage demand and supply more effectively. This report focuses on the latter problem—how to bring water demand more in line with the availability of water during the driest part of the year.

Many Massachusetts cities and towns withdraw their water from local surface water supplies or from shallow sand and gravel aquifers that tend to have less flow or storage during summer months. Meanwhile, people use the most water during dry summer months, when demand for irrigation and other outdoor uses is highest. In June, July, August and September, residential water demand generally increases by 50% due to outdoor water use.[1] This means that water supply systems are being made to withdraw more water at precisely the time of year when aquifers and surface water supplies are least able to provide that extra supply and when aquatic habitat is most stressed.



Average monthly demand in selected Massachusetts communities compared to flow in nearby rivers.

This mismatch between seasonal demand and supply can manifest itself in a variety of ways:

- **Peak season demand is a major driver of costly system expansion.** Where summer usage exceeds the engineering capacity of the local water system, it may force communities to invest large amounts of money in new wells, new treatment facilities, increased storage and pumping capacity, water permitting, or connection to the MWRA, even though this extra capacity is only needed a few months out of the year.
- **High summer demand is bad for water system infrastructure and water quality.** When demand is high but water levels are low, well pumps must work harder to pull water out of the ground, resulting in higher energy costs and more frequent maintenance, replacement, and potential system outages. During peak demand periods, an enlarged "cone of depression" in the water table near wells can affect water quality by pulling in more impurities such as iron and nitrate as well as drawing contaminants from a wider area.
- **Wasteful water use damages local rivers, streams, and wildlife habitat.** Peak season water withdrawals can lead to low-flow conditions in local rivers and streams, affecting wildlife and recreational

opportunities. A United States Geological Survey study of the Ipswich River found that peak-season water withdrawals in that basin substantially decrease flows in the river, contributing to extreme low-flow conditions or even dry riverbeds during the late summer. Since 1995, upper stretches of the Ipswich have run dry during five summers, and in some reaches observers have reported the river flowing *upstream*, in the direction of operating municipal wells. Even if rivers do not dry up, low flow conditions can reduce water quality, increase water temperature, and affect habitat, degrading the value of water resources for wildlife and recreational uses.

- **Peak season shortages are bad for business.** When communities fail to address peak demand proactively, the resulting water shortages during summer months may interrupt commercial and industrial operations, and continued shortages may cause firms to expand or relocate elsewhere.

In spite of these impacts, many communities have been slow to make the necessary investments in conservation programs and peak demand management efforts. Some municipal officials see conservation programs as an unnecessary expense that drives up water rates, and many water system managers view water as a commodity, and therefore seek to sell more of it.

Peak Season Demand Management versus General Water Conservation

Seasonal demand management is one component of a general water conservation program. Many communities already have sophisticated water conservation programs to reduce "baseline" demand on a year-round basis, through incentives or mandates for high-efficiency plumbing upgrades, technical assistance for industrial and commercial users, leak detection and repair, and public education. While reducing baseline demand will also help to reduce peak demand, it is not a primary focus of this report. Peak season demand management focuses on the reduction of discretionary water use for irrigation, car washing, pools, etc, which is highest in summer months.

In planning a program to reduce peak water demand, it is important to figure out how seasonal demand management fits in to your community's overall water conservation plan. If your community doesn't have a water conservation/water efficiency plan, start with the *Massachusetts Water Conservation Standards* to figure out what you should be aiming for, and check out the U.S. EPA *Water Conservation Guidelines* for guidance on preparing a plan. Both documents are referenced in the "Key Resources" section at the end of the next chapter.

A more comprehensive view of water system economics recognizes that current water rates often fail to account for the environmental costs of peak season withdrawals, the monetary value of maintaining regulatory compliance, or the long-term costs of system expansion. Because water is an increasingly scarce resource, water managers must shift from a "business expansion" model to one based on sustainability, in which conservation programs are recognized as an operating cost that should be incorporated into full-cost pricing. Communities with high peak season demands may expand their systems through major capital expense, long permitting processes, and high environmental costs; or they may choose to invest in demand reduction programs that provide a more cost-effective approach to balancing demand and supply.

The toolkit of strategies described in this document goes far beyond lawn watering bans, which are what most people think of when they hear about peak demand reduction. Many other techniques are also available, such as "water smart" irrigation systems, rainwater recovery systems, reuse of treated wastewater for irrigation, low-water landscaping techniques, leak detection programs, and land development standards that reduce the demand for landscaping water. Municipalities may also wish to pursue a variety of incentives and mandates, such as conservation pricing structures, seasonal water rates, rebates for water efficient fixtures, and restrictions on outdoor watering, all of which are covered in this report.

You Can Do It!

Gardener's Supply Company

For communities facing water shortages during summer months, the prospect of reducing demand enough to eliminate those shortages may seem attractive, but daunting. Will homeowners turn off the sprinkler once in a while, or do they love their lawns too much? Are builders willing to create developments that use natural landscaping instead of thirsty Kentucky Bluegrass? Will municipal officials be willing to adopt—and enforce—new regulations and conservation pricing? Certainly the challenge should not be underestimated, but through collaboration and persistence many communities throughout Massachusetts have been making progress on these very issues.

Both Danvers and Middleton have implemented *water use restriction regulations* that tie the level of restrictions to triggers based on stream flows in the Ipswich River. In Middleton, the town has also extended water conservation standards to include *private wells*. The Town of Ipswich uses *monthly billing and seasonal water rates* to send a strong signal to homeowners about the fiscal impacts of outdoor water use. North Andover established standards governing the use of *automated irrigation systems*. Many towns have full-time *water conservation coordinators*. These same standards or strategies may not be appropriate to your town, but they demonstrate that communities in Massachusetts are making progress in the field of seasonal demand management.

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PROGRAM DEVELOPMENT

Getting Started

In preparation for developing a peak demand reduction strategy, there are some steps you should take to lay the groundwork:

- **Build a network** of people in your community who have an interest in water conservation and seasonal demand management. Reach out to public works/water works officials, elected officials, developers and local engineering firms, local environmental advocacy groups, garden clubs, and civic organizations. More collaboration and participation will help generate strategies that are realistic and implementable. Your collaborators will also be important advocates for implementation once the strategies are finalized.
- **Specify your conservation goals**. Develop them with input from your collaborators and the broader community.
- **Identify funding sources** for your peak demand management program. General municipal funding is unlikely to provide sufficient or consistent funding for a long-term effort. Instead, seek to create a dedicated funding stream from water system revenues. With the increasing scarcity of water, conservation programs are part of the cost of doing business, and should be paid for through utility revenues.
- **Understand your water system.** Inventory existing facilities, service characteristics, water supply, service connections, seasonal demand, rate information, and existing water management plans. The WaterSmart Indicators developed by the Metropolitan Area Planning Council (MAPC) can help you understand your community's water use trends.
- **Look ahead.** To the extent possible, forecast future water demand and identify planned improvements to the water system over a reasonable planning horizon. The WaterSmart Indicators include water demand projections for each community to the year 2030.
- **Keep the public informed and involved** through outreach. Public education will improve customer relations, increase program effectiveness, and reduce the likelihood of backlash from the community that could slow or even kill conservation efforts. Consider creating a water conservation coordinator position to advance and implement the selected conservation strategies and to serve as the contact person for public inquiries.

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Do Your Part to Operate Efficiently

Before asking water system customers to use water more efficiently, make sure that your local water supplier and the municipality are using water as efficiently as possible themselves. This means eliminating system waste by checking for leaks, moderating system pressure as appropriate, and implementing water efficiency measures on municipal properties:

- **Conduct a system water audit** on an annual basis to quantify unaccounted-for water using the Massachusetts Department of Environmental Protection's Water Audit Guidance Document. Many Massachusetts public water systems lose 15% or more of their water to unaccounted for demand. Conduct a comprehensive audit every 5 to 10 years depending on the findings of the annual audit.
- **Conduct system-wide leak detection** frequently (every 2 years for most systems). Much unaccounted-for water is lost through leaky distribution pipes. The Metropolitan Area Planning Council has a

regional leak detection services contract that allows communities to contract for leak detection services at lower cost and with less administrative overhead through a joint services contract managed by MAPC. For information, visit www.mapc.org /services/leakdetection.html.

- **Reduce excessive pressure** in the water distribution system. Lower pressure can decrease flow through leaks and through open water fixtures. It can also alleviate stress on pipes and joints that can cause leaks, extending system life and reducing the need for repairs. Residential areas with water pressure over 80 psi may be candidates for pressure reduction. Any pressure management activities should be consistent with state and local standards, should take into account system conditions and needs, and should not compromise system integrity or service quality.[2]
- **Lead by example.** Implement water efficiency measures for municipal properties and buildings:
  - Use water-efficient landscaping for municipal properties where possible.
  - Use water-efficient irrigation systems and irrigation management practices for municipal fields, parks, and landscaped areas.
  - Ensure that all municipal cooling systems minimize water use.
  - Consider installing water-saving pool filters on municipal swimming pools.
  - Retrofit indoor plumbing fixtures with water-saving devices or new high-efficiency models. Buy water-efficient appliances when replacements are needed.

Acton Water District

Acton Water District water-wise garden, a demonstration project located in front of the District's office on 693 Massachusetts Avenue in West Acton

More guidance on these techniques can be found in the Massachusetts Water Resources Commission Water Conservation Standards.

Prioritize

Having laid a solid foundation for embarking on a peak demand reduction program, the next step is program design. Each community and water system is different, so the techniques in this handbook should be considered a set of options that can be tailored to local needs and local conditions. That said, some steps are more essential than others. The measures recommended in the following sections have been prioritized into three levels based on their importance and level of difficulty:

Basic measures are fundamental strategies that are applicable to all water systems, even those not currently experiencing summer water shortages. These include:

- Raise awareness through communication with customers about the environmental and engineering impacts of peak water demand and techniques for customers to reduce their summer use.
- Authorize municipal or water supply officials to impose water use restrictions in times of drought, shortage, or environmental damage due to excessive withdrawals.
- Implement 100% metering. Every water system should make full metering of all public water supply connections a priority in order to know where water is going and ensure that all users are paying for the water they take from the public system. Report water usage to consumers on their water bill and emphasize the link between usage and cost.
- Eliminate disincentives to conservation in the water rates:

- eliminate any flat fee or declining block rate structures in favor of inclining block and/or seasonal rate structures;
- ensure that customer rates are set high enough cover the full costs of operating the water supply system, including funding conservation programs; and
- if outdoor meters are allowed, set a significantly higher rate for outdoor water use.

Intermediate measures should be considered in any community with the capacity and/or the need to go beyond the Basic measures. They include:

- Increase public education efforts such as school programs and/or demonstration drought-tolerant gardens.
- Move from uniform water rates to inclining block rates and/or a seasonal rate structure.
- Read meters frequently (at least quarterly) and bill customers based on actual usage.
- Regulate the use of private wells for irrigation during times of water shortage.
- Regulate the use of automatic irrigation systems.
- Encourage the use of rain barrels or cisterns (where appropriate) for outdoor water use
- Provide user-specific information through residential audits and/or landscape and irrigation workshops.
- Offer financial incentives or freebies for water-efficient products.
- Establish by-laws addressing residential development patterns (such as Open Space Residential Design) and landscaping to reduce landscape water needs

Advanced measures should be pursued by water suppliers with the most pressing peak demand issues, those that already have advanced conservation programs, and those that can implement them without sacrificing other important strategies. These include:

- Tailor water rates to the individual customer through targeted, individualized or wasteful use rates.
- Explore the use of treated wastewater as an alternate source for certain non-potable uses, such as golf-course irrigation.
- Conduct audits or industry-specific workshops for commercial, industrial, and institutional users.
- Establish centralized irrigation information systems for use by large landscape managers.

You will need to tailor the mix of strategies to local conditions and local drivers of peak water demand. To better understand local needs and what measures will be more locally acceptable, consider using market research to identify barriers to conservation, the incentives that will help customers overcome those barriers, and the marketing strategy mostly likely to reach the targeted audience.

The subsequent chapters offer detailed guidance on the program elements outlined above. They are organized thematically rather than by their classification as Basic, Intermediate, or Advanced so that the reader can see all the possibilities and the stage where they may be appropriate before selecting the elements most suitable to local circumstances.

Use Money Wisely

Cost-effectiveness is a key consideration for peak season demand management. Some measures may be very expensive, yet also highly effective. Others may be quite cheap but minimally effective. Making the case for investing in conservation requires some understanding of the costs and benefits of various strategies. Where appropriate, a cost-benefit analysis should also include an assessment of system expansion strategies, to put conservation efforts in the context of the full range of options available to the water supplier, and the costs of all those options.

The information needed to assess the benefits of a particular conservation or peak demand management strategy includes:

- the reduction in water use expected per item of a particular measure (where an item may be a rebate, a set of landscaping materials, an audit, or a development held to new standards);
- the number or percent of customers that will implement or be affected by the measure; and
- the persistence of the water savings over time, and the expected water use had the measure not been implemented.

Where available, this guide provides information on the costs and potential water savings of different techniques, based on actual program data. Many of the measures described in this handbook do not lend themselves to easy calculation of expected water savings, and some program evaluations have yielded contradictory data on the same techniques. This means that peak demand management cannot rely on a standardized recipe of techniques; a successful program will require local knowledge and ongoing program evaluation. By monitoring program impacts, a water supplier can refine the peak demand reduction program in future years to make it more cost-effective. More information on measuring and evaluating program results, including cost-benefit analysis and cost-effectiveness analysis, is included in the Program Evaluation chapter.

Key Resources

The following resources offer additional guidance on water conservation planning and/or peak water demand management:

U.S. Environmental Protection Agency, *Water Conservation Plan Guidelines* (http://www.epa.gov/owm/water-efficiency/webguid.htm): offer guidance to water system planners on designing a water conservation plan appropriate to their water system with Basic, Intermediate, and Advanced guidelines

Massachusetts Water Resources Commission, *Water Conservation Standards for the Commonwealth of Massachusetts* (available from http://www.mass.gov/envir/mwrc/default.htm): provide standards and recommendations on water conservation for water supply planners

Massachusetts Water Resources Commission, *Guide to Lawn and Landscape Conservation* (available from www.mass.gov/envir): a guide for communities, property owners, managers, and Massachusetts state agencies on addressing summer water demand

Massachusetts Executive Office of Environmental Affairs and Massachusetts Emergency Management Agency, *Working Draft: Massachusetts Drought Management Plan* (www.mass.gov/envir/mwrc/pdf/Massachusetts_Drought_Plan.pdf): plan guiding state response to drought conditions, including responsibilities, lines of communications, sequence of actions, and emergency powers

Ipswich River Watershed Association, *Water Wise Communities: A Handbook for Municipal Managers in the Ipswich River Watershed* (http://www.ipswichriver.org/pdfs/water_wise_communities_full.pdf): offers a set of tools, including planning, regulatory, economic, infrastructure, and outreach tools, to manage water resources

Amy Vickers, *Handbook of Water Use and Conservation (Waterplow Press, 2001)*: offers detailed information on a variety of water conservation strategies, including indoor domestic water use; landscape water use; commercial, industrial, and institutional water use; and agricultural water use

American Water Works Association, *WaterWiser Program* (http://www.awwa.org/waterwiser): an online clearinghouse of water efficiency information

RAISE AWARENESS

Raising public awareness of the consequences of high summer water use is the first step to dealing with the problem. Customers must understand how their actions affect the water system as well as the natural environment and how conservation measures can save them money. Pricing structures, technology, outdoor use restrictions, and development standards all depend on the water user for their effectiveness. Without an educated consumer who is aware of cause, effect, and solution, efforts to change behavior will be ill-received and ineffective.

Outreach regarding peak demand management should be integrated as one part of the water system's strategic communications efforts. It is important to ensure consistent messaging, and to ensure coordination between program activities and outreach efforts. The American Water Works Association offers a number of handbooks for water supply managers on how to communicate effectively with the public. These include: *Message Management: Effective Communication* (2005); *Customer Attitudes, Behavior, and the Impact of Communications Efforts* (2004); and *Avoiding Rate Shock: Making the Case for Water Rates* (2004). All are available from the AWWA online bookstore (www.awwa.org/bookstore).

Outreach Alone is Not Enough

While public education efforts are necessary, education alone will not reduce peak demand in any significant way. Voluntary conservation programs may have other important benefits, such as improved customer relations, but without other, stronger signals to conserve, there is little inducement for users to change their behaviors or make a special effort to use water efficiently. The strongest conservation and peak demand reduction programs incorporate a full suite of measures including extensive public outreach and customer education, conservation pricing, and regulations that allow the utility or municipality to limit discretionary water use during peak periods and times of shortage.

A water conservation coordinator can help to manage the many different components of a peak demand management program while also ensuring consistent messaging to customers and the general public about the rationale for conservation, the workings of the program, and the steps that individuals can take to reduce their use.

This section describes three types of public outreach campaigns activities suited to peak demand management programs: public information campaigns, demonstration gardens, and water education in schools.

Public information campaigns

BASIC MEASURE

Level of Complexity: Low

Costs: Low

Local Example: North and South Rivers Watershed Association

Public information campaigns are designed to provide information about peak demand management and water conservation to as many people as possible. A campaign can include public displays (such as posters at town hall), educational materials distributed with water bills or local newspapers, information on the town or city website, and public service announcements on TV and/or radio. Although times of drought are often the times when water use issues get the most attention from the media and the general public, ongoing, comprehensive programs can be more effective and may help maintain water conservation gains beyond the period of the drought.

There are many resources available for public education. "Water Use it Wisely" has online resources, educational games, and links for water conservation at their website (http://www.wateruseitwisely.com/toolsLinks/index.html). For materials that can be included with utility bills, the American Water Works Association offers a number of conservation-oriented bill stuffers through their online bookstore (www.awwa.org/bookstore), including:

- Landscaping to Save Water
- How Does Your Garden Grow? – conservation techniques in the garden

- It's A Natural – landscape water-conservation techniques
- A Consumer's Guide to Water Conservation: The Outside Story – water conservation in home landscaping
- Get Your Hands Dirty – bill stuffer on soil improvement
- Good Soil for Effective Watering – watering for different soil types
- 25 Things You Can Do to Prevent Waste – preventing water waste at home
- Household Guide to Water Conservation
- 55 Facts, Figures, and Follies of Water Conservation
- 5 Basic Ways to Conserve Water
- Water Conservation at Home – conservation tips for homeowners

There are also many resources offering greater detail on water-efficient practices that can provide consumers with helpful hints on reducing their water use:


Justin Sellars

Examples of public outreach materials

- The North and South Rivers Watershed Association Greenscapes program offers tips for lawn care and gardening to conserve and protect water resources: http://www.nsrwa.org/greenscapes/
- The UMass Extension program offers tips on lawn care, gardening, landscaping, and more: http://www.umassextension.org/.
- Mass Audubon has an online Rivers Toolkit with information on the problem of summer low flow in Massachusetts rivers and what individuals and communities can do about it: http://www.massaudubon.org/rivers/action.php.
- The Massachusetts Department of Food and Agriculture has a guide to yard care with information on responsible pesticide and fertilizer use and watering practices: http://www.mass.gov/agr/waterwellbeing/
- The MWRA has online tips sheets on several topics:
  - Gardening and landscape water conservation: http://www.mwra.state.ma.us/04water/html/gardening.htm
  - Indoor water conservation: http://www.mwra.state.ma.us/04water/html/watsav.htm
  - Water efficient appliances and fixtures: http://www.mwra.state.ma.us/04water/html/lctoilet.htm
- Water Use it Wisely has online guides to lawn and plant watering, and offers a printed copy of the guide for free: http://www.wateruseitwisely.com/waterguide/index.html. They also have a list of tips for water conservation, tailored to the Northeast region, including both indoor and outdoor measures: http://www.wateruseitwisely.com/100ways/ne.shtml.
- The American Water Works Association offers a number of educational materials through their online bookstore (www.awwa.org/bookstore):
  - A Consumer's Guide to Water Conservation – on VHS or DVD
  - A Consumer's Guide to Water Conservation: Dozens of Ways to Save Water, the Environment, and a Lot of Money – booklet

Combining a number of these initiatives, and increasing the intensity of the public information campaign as the peak water use season nears can increase the likelihood that the message will be heard.

Demonstration gardens

INTERMEDIATE MEASURE

Level of Complexity: Low
Costs: Low to Medium
Local Examples: Westford, Acton, Concord

If natural or low-water landscaping is an important part of your peak demand management program, demonstration gardens will help to make citizens comfortable with otherwise unfamiliar practices. Demonstration gardens on municipal properties in prominent locations where visitors have full access to the site will increase visibility of conservation efforts and acceptance of water-conserving landscapes.

Several communities in Massachusetts have developed water-wise demonstration gardens, including Westford, Acton, and Concord. The Westford Water Department partnered with the Westford Academy community service team to transform a patch of turf into a drought-tolerant garden full of native species. The Acton garden, which is located in front of the Acton Water District office, was built by a girl scout with support from the Acton Garden Club and several Acton nurseries.[3] In Concord, two small drought-tolerant gardens have been planted by the Concord Department of Public Works.[4]

Westford Water Department

Westford water-wise demonstration garden two years after planting

Other communities have created demonstration rain gardens, a Low Impact Development technique that helps filter and infiltrate stormwater. Local examples include Cohasset (at the Water Treatment Plant); Marshfield (at Town Hall); Plymouth (Town Hall); and Scituate (Scituate High School).[5] The North and South Rivers Watershed Association offers more information and a "self-guided tour" of LID projects on their website: http://www.nsrwa.org/programs/low_impact_development.asp.

Water education in schools

INTERMEDIATE MEASURE

Level of Complexity: Medium
Costs: Depends on program design
Local Examples: MWRA Schools Program

Water conservation education programs at local public schools can disseminate conservation messages to residential users through their children. These programs can also help instill a conservation ethic early, by providing children with a deeper understanding of their environment. Several programs in Massachusetts offer resources for educators, students, and schools.

The MWRA Schools Program offers teacher resources, curriculum guides, demonstration and testing kits, student resources, and other information: http://www.mwra.state.ma.us/02org/html/sti.htm. The Massachusetts Drinking Water Education Partnership also has educational resources: http://www.newwa.org/madwep. The University of Massachusetts-Amherst Extension Program in Natural Resources and Environmental Conservation "provides curriculum materials, training, and demonstration projects to build a constituency of educators and general public who can ably teach the science and environmental civics of watershed protection and engage others, including youth, in problem solving and action to protect the environment." More information is available at the program's website: http://www.umass.edu/nrec/environmental_education/enviro_curproj.html.

A national program, Educating Young People About Water, through the Environmental Resources Center at the University of Wisconsin-Madison, offers advice on building a water education curriculum or enrichment program: http://www.uwex.edu/erc/eypaw/. The American Water Works Association also offers an educational video for kids called Conserve Everyday, available through their online bookstore: www.awwa.org/bookstore.

MASSACHUSETTS CASE STUDY:

Reading, Massachusetts

In 2003, the Town of Reading implemented a comprehensive water conservation program, funded through the town's water rates. Components of the program include:

- **Rebates** for water saving devices and appliances: low-flow toilets ($120), high-efficiency washing machines (up to $200), rain-sensor systems (up to $25), and rain barrels ($25);
- Free **residential water audits**, including educational material, comparison of the household's water use patterns, evaluation of outdoor water use, leak checking, and a report with recommendations for water savings measures, including cost and payback time;
- Free installation of **water saving devices** in residences, including low-flow showerheads, faucet aerators, garden hose nozzles, dye tablets and toilet tank volume displacement bags;
- **Retrofits of municipal buildings** with water saving devices;
- An **audit of the town's water distribution system**;
- **Leak detection** and repair; and
- An extensive **public outreach** program.

The public outreach program includes educational meetings with schools and an educational meeting for commercial and industrial users to brief them on the conservation program and provide information on measures that they can implement to reduce water demand. The town provides water conservation information on the town web site, and on water and sewer bills. The town also notifies homeowners with particularly high water bills to alert them of this fact and to encourage repair or replacement of leaking or inefficient household devices.

As of April 2006, the town had issued over 590 rebates, provided water audits to over 125 residential customers and installed over 625 water-saving devices. Although formal program evaluation is not yet complete, representatives from the Reading Department of Public Works have indicated that residential usage has dropped as a result of the audits.

The town is providing data to the U.S. EPA's Targeted Watershed project in the Ipswich River on the success of both the rebate program and the water audit/retrofit program. Compilation and analysis of water-use data will continue through March 2008. Results of this data analysis will be used to:

- Identify the most successful devices and combination of devices in reducing water demand, and
- Quantify the savings associated with each device or combination of devices.

Direct Water Use Regulation

BASIC MEASURE

Level of Complexity: Medium
Costs: Low
Local Examples: Danvers, Middleton

Until a municipality or water district establishes by-laws or other regulations authorizing officials to restrict water usage, the options available in a time of water shortage are only extremes: on one end of the spectrum, officials can request voluntary reduction of water use, and on the other, they can petition for the declaration of a state of emergency by Massachusetts Department of Environmental Protection.

A preferable, proactive approach involves multiple techniques that can be tied to local conditions and phased in as necessary to prevent a crisis and minimize environmental impact of peak season withdrawals. Generally, such an approach is built on a legal framework that involves four components: indicators, triggers, restriction measures, and enforcement. The importance of the last component—enforcement—must not be underestimated. Too many Massachusetts communities have water use restrictions on the books that are either not enforced, or not effective, due to jurisdictional uncertainty, lack of political will, or lack of significant penalties.

As a condition of their modified water withdrawal permit from the Massachusetts Department of Environmental Protection (DEP), both Danvers and Middleton have implemented a water use restriction system tied to streamflows in the Ipswich River. This set of use restrictions is included in Appendix C.

Indicators

Peak Water Demand Indicators are those measurements that quantify the mismatch between supply and demand during peak periods. The Peak Demand Indicators will include, and in most cases be synonymous with drought indicators, which the MWRC defines as follows: "Drought indicators are the elements of the water supply system and the environmental conditions that are monitored to assess the status of water supplies and the associated natural resources. The appropriate indicators for each particular water supply system will depend on the specific components and dynamics of each system."[6]

The working draft of the Massachusetts Drought Management Plan gives a series of seven indicators, based on the condition of natural resources, to be used at the state level to assess the severity of a drought:[7]

- *Precipitation* – a comparison of measured precipitation amounts to 30-year averages. Cumulative amounts for 3, 6 and 12-month periods are factored into the drought determination. This data is available from the Department of Conservation and Recreation (DCR), Office of Water Resources.
- *Ground-water levels* – a drought level determination is based on the number of consecutive months ground-water levels are below normal (lowest 25% of period of record). Ground-water conditions maps showing areas of above normal, normal and below normal are provided monthly by the U.S. Geological Survey (USGS) (http://ma.water.usgs.gov/water/).
- *Streamflows* – a drought level determination is based on the number of consecutive months streamflow levels are below normal (lowest 25% of period of record). Streamflow conditions maps showing areas of above normal, normal and below normal are provided monthly by the USGS (http://ma.water.usgs.gov/water/).
- *Reservoirs* – a drought level determination will be based on the level of small, medium and large index reservoirs across the state. The reservoir level relative to normal conditions will be considered. DCR, Office of Water Resources, as part of its monthly conditions report, will maintain a list of index water supply reservoirs and their percent full.

- *Palmer Drought Index* – an index that reflects soil moisture and weather conditions; available from the National Weather Service or National Climate Data Center.
- *Crop Moisture Index* – an index that reflects short-term soil moisture conditions as used for agriculture; available from the National Climate Data Center.
- *Fire Danger* – the fire danger level reflects how favorable conditions are for brush fires. Data factored into the index include weather conditions and available fuel. This is a short-term index, which can change daily. The duration of the index will be used to determine relative drought levels. The fire danger level is available from the DEM Bureau of Fire Control, Chief Fire Warden [now the DCR Bureau of Forest Fire Control].

If peak seasonal demand not only affects water resources, but also strains water treatment and delivery infrastructure, additional indicators based on infrastructure capacity may be necessary. For communities in high and medium stressed basins, the ratio of summer use to winter use also serves as a valuable indicator and can help communities manage water use to avoid more stringent regulations from DEP. This statistic is available for many communities as one of MAPC's WaterSmart Indicators.

Triggers

Once the indicators are established, communities can establish drought stage triggers that serve as benchmarks to identify stages of concern. Each successive stage, as identified by the indicators reaching their trigger points, should correspond to a new level of restrictions on water use, so that as conditions worsen, stronger conservation measures are required. Triggers should be established carefully and based on historical data, so that they relate to the severity of conditions in the watershed. Triggers that are set too high may be met very rarely, reducing opportunities to be proactive about water shortages. Triggers that are set too low will put the system in a constant state of water emergency, reducing their effectiveness and diminishing the credibility of the program. By implementing progressively more stringent restrictions based on a series of triggers, water system managers can take action early to limit excess and discretionary water use. Early adoption of conservation or restriction measures can alleviate the overall severity of the water shortage.[8]

Water Use Restrictions

North and South Rivers Watershed Association

In order to address water shortage or excessive demand issues identified by the indicators and triggers, a set of graduated water restrictions should be tied to the trigger points. This ensures an adequate, predictable response to excessive seasonal water use or drought conditions. The restrictions should be established through a municipal by-law or ordinance or through the water district's regulations.[9] The Massachusetts Department of Environmental Protection has developed a model water restriction by-law for Massachusetts municipalities. According to the explanation of the by-law:

> It is for communities wishing to establish enforceable limitations on the use of water during temporary periods of high water demand by controlling outdoor watering, swimming pool filling and/or non-commercial car washing. If properly enacted, the municipal by-law will enable municipal water systems to control and mitigate periods of high demand - with an associated stressed water supply - typically occurring during the summer months. The restrictions included in the by-law include odd/even day outdoor watering, hand held hose watering only, limited outdoor watering hours, outdoor watering bans, and prohibitions on filling swimming pools and the use of automatic sprinkler systems.[10]

The full text of the model by-law is included as Appendix B. A water use restriction ordinance from the Town of Middleton is also included in Appendix D (this ordinance includes private well users in the restrictions; regulating use of private wells is covered in a later section of this guide).

The DEP model ordinance offers a framework for restricting water use, but it does not structure the water restrictions into levels tied to indicators or triggers. The Massachusetts Water Resources Commission Guide to Lawn and Landscape Water Conservation offers recommendations for creating a hierarchy of restrictions (see below) in accordance with the indicators and triggers, and recommends that the by-law "should identify both water system and environmental triggers that correspond with the timing of implementing specific restrictions included in the by-law or ordinance."[11]

Massachusetts Water Resources Commission Guide to Lawn and Landscape Water Conservation Water Restriction Hierarchy

Stage I Voluntary conservation

Stage II Outside water use is limited to:
between *** hours on *** days (specify particular hours and days)
and/or
Odd/even day watering or off-peak watering only

Stage III Outdoor water usage is limited to *** hours during 1 day per week (Specify day)
and/or
Outside water use restricted to hand held hose for flower and vegetable gardens only. No lawn watering, car washing (excluding commercial car washing), or pool filling allowed.

Stage IV Mandatory ban on outside water use. All outside use of water is prohibited and subject to penalties in accordance with law for violation of this restriction.

The MWRC recommendations note that exceptions should be made for agricultural uses of water, and suggests that while water restrictions on commercial and industrial users may be necessary in emergency situations, they can be covered in a separate section of the by-law. Another exception that the MWRC suggests is for water related to plantings that have been installed for erosion control or as part of site development requirements.[12]

Experience has shown that odd/even watering schedules generally do not reduce water use, and are not encouraged unless system capacity is the only issue in meeting peak demand. When faced with this restriction, homeowners may actually water more because they assume they need to water every other day, even if they didn't before. A better strategy is to use some other method, such as an every four or five day schedule based on street addresses, or to simply restrict the hours allowed for watering. In general, restricting outdoor water use to between sunset and early morning is best for turf needs and coincides with off-peak hours for many water supply systems. Also, while hand held hoses are a relatively inefficient means of irrigation compared to other methods, the fact that it is comparatively labor intensive results in greatly reduced amounts of water that are used for lawns and landscapes.

The municipality or water district may also wish to enact by-laws or regulations prohibiting water waste through negligence, poorly directed irrigation, or failure to repair leaks. Some examples of restrictions that could be included are:

- No hosing down of sidewalks, driveways, patios, alleys, parking areas, or other "hardscapes."
- No runoff is permitted from lawns and landscapes into streets, alleys, or gutters at any time.
- Water must not be used to fill or maintain levels in decorative fountains, ponds, lakes, or displays unless a recycling system is used.
- Water leaks from exterior or interior plumbing must be repaired immediately.
- No washing of vehicles of any kind except with a hand-held bucket or a hose equipped with a shut-off nozzle.[13]

These restrictions may also be tied to the water shortage triggers and stages, or they may be in effect at all times. The appropriate measures should be selected to meet the municipalities particular needs and circumstances.

MASSACHUSETTS CASE STUDY

Acton, Massachusetts

Acton's Water Conservation Program began in 1999. So far the Acton Water District has updated its regulations and implemented new conservation-based water rates, ongoing public outreach and education efforts, water-saving device distribution, and audit programs. The new conservation-based water rate structure in Acton charges a premium for usage during the summer peak demand season.

Rates:

Acton's water rates are covered in the section on seasonal rates on page 31. They use a combination increasing block rate structure and seasonal increase in rates.

Acton Water District Regulation #28:

Any person applying for water use having a design demand in excess of 2,500 gallons per day or a larger (over 2 inch) service line, will provide to the District a Water Impact Report acceptable to the District. This report will contain the following:

1. estimated impact of the project on the District's water demand;
2. impact of the project on the District's existing supply system, including maintenance of adequate fire flow;
3. impact of the project on the District's Water Management Act withdrawal permit compliance, and
4. conditions and water conservation measures that will mitigate the effect of the project's impact (applicants should request from the District a list of possible mitigation measures).

Regulations

Acton Water District regulations were updated in 2004 in order to require new uses with high water demand to submit a report estimating impacts on the water system and to mitigate those impacts through conservation (see sidebar). Water reports are reviewed and approved by the Water Commissioners. Costs associated with generating the report are the responsibility of the applicant.

In addition, the district has implemented regulations on automatic irrigation systems, requiring registration of all automatic systems, and requiring them to have certain devices to improve efficiency and prevent contamination of drinking water. The regulation is below.

Acton Water District *"Rules and Regulations for Underground Lawn Watering Systems"*

1. All automatic lawn watering systems, connected to the public water supply, must be equipped with a timing device that can be set to make the system conform to the local odd/even outdoor watering restrictions.
2. All automatic lawn watering systems must be equipped with some type of moisture sensing device that will prevent the system from starting automatically when not needed.
3. All automatic lawn watering systems must be installed with an approved backflow prevention device. Said device will be inspected initially by the plumbing inspector, and may be inspected periodically thereafter by water district employees.
4. Any person who now has, or who intends to install an automatic lawn watering system in the future, must notify the department of the existence of said system, or of their intention to install a new system prior to the actual installation. All systems, those currently in existence as well as any installed in the future must comply with all Rules and Regulations adopted on this date.
5. Any system not in conformance with the above criteria may be disconnected from the public water supply system.

Public Education:

Acton has implemented significant public outreach efforts, including the creation of water-wise demonstration gardens, on-going water conservation education programs in schools, provision of water conservation materials at local nurseries, provision of information to developers and community groups on low-water landscaping, provision of information on rain barrels and promotion of horizontal axis washing machines and other water saving household devices. Public outreach and education efforts have also included development of an Acton Water District web site and most recently, the publication of 'Using Water Wisely' a brochure and information package for new residents. On the website is information about:

Acton Water District

Acton Water District water-wise garden.

- The school education program (which includes classroom visits; field trips; drinking water related lessons and activities; consultation on integrating drinking water topics into science curriculum; lending library of educational videos, books, and other resources; special activities each spring during 'Drinking Water Week'; sponsorship of summer internships and special projects);
- The water rates, including a water bill calculator that estimates: summer bill, winter bill, gallons used, and gallons/person/day based on the customer's water usage for 6 months and the number of people living in the house;
- The importance of water conservation and background on the issue of peak demand;
- Conservation tips for customers for indoor and outdoor water use; and
- The Water Wise Garden, including rainfall data recorded there.

The Acton Water District 'Water Wise Garden' was completed at a local residence with the assistance of the Acton Garden Club and local nurseries. The garden includes drought-resistant plants, organic mulches, and water-wise design principles.

The Acton Water Conservation Program also includes irrigation audits for residential customers with high water usage. **An analysis of water use in the audited households indicated an average 23.3% reduction in water use after receiving the audits.**

Indirect Water Use Regulation

In addition to regulations directly addressing the use of water, excessive water demand can be addressed indirectly through regulations on residential development, landscape design and maintenance, and irrigation system design. This type of regulation can influence the amount of water needed for landscape and turf irrigation.

Irrigation System Requirements

INTERMEDIATE MEASURE

Level of Complexity: Medium
Costs: Low
Local Examples: Wayland, North Andover, Concord, Acton, and others

The intensity of peak demands has grown in recent years due in part to the proliferation of automatic irrigation systems. These systems generally involve a series of sprinkler heads connected by piping or hoses, controlled by a central automatic timing device so that they operate on a regular schedule without requiring any human intervention. Recent improvements in technology have made it possible to adjust irrigation schedules to local real-time or daily evapotranspiration rates – the amount of water (in inches) required to replace water lost through evaporation and transpiration (plants' use of water for photosynthesis).

Photo by K.C. Becker, provided by Western Resource Advocates

Wasteful lawn watering

Although these systems can be designed to apply water precisely and efficiently, in practice they often irrigate more frequently and more heavily than necessary because of their automated nature. As they have spread from professionally managed and carefully monitored applications at golf courses and agricultural operations, to residential and commercial developments where they receive less oversight, they have become more and more wasteful of water. While the most sophisticated irrigation systems can distribute water where and when it is needed based on plant types, site and soil conditions, and recent weather patterns, the more basic systems have the potential to waste enormous quantities of water, running longer than necessary, spraying water onto paved areas, and even running during rainstorms. The Franklin Water Department estimated that homes with automatic systems consumed an average of five times the water than the typical household. The excessive irrigation, ironically, makes outdoor watering bans more likely by draining supplies, and also weakens plants through overwatering.[14]

There are many devices that can improve sprinkler system efficiency, ranging from the most basic (rain sensors) to the most advanced (elaborate systems using real-time climate data). Rain sensors or rain shut-off devices simply collect rainwater and are wired to interrupt automatic irrigation schedules when a certain threshold of rainfall has occurred. Soil moisture sensors monitor the level of moisture in the soil and can be set up to prevent automatic systems from running until soil moisture drops to a level where irrigation is necessary. Drip irrigation systems deliver water to the base of the plant, through either a perforate hose or pipe or a drip emitter, such as the one pictured here. This

Gardener's Supply Company

Drip irrigation systems put water right where it is needed — at the roots.

method of application reduces evaporation and targets water where it is needed. The advanced irrigation control technologies are covered in the section on "Smart" Irrigation Systems. Many systems also require backflow prevention devices, which prevent water from flowing backwards into the distribution system and contaminating the drinking water.

Restrictions on Automatic Irrigation

In response to the growing awareness of the impacts of automatic irrigation systems, many Massachusetts communities have taken steps to restrict their use. The Town of Wayland adopted a measure in 2003 stating that: "No person shall install or expand a system which is connected to the public water supply if said system, after installation or expansion covers, an area greater than 15,000 square feet or more."[15] The by-law also requires an application and a $50 application fee for the installation or expansion an automatic sprinkler system of any size, and requires as a condition of approval a rain gauge, a moisture detector, a programmable automatic timer, a shut-off valve, and a backflow prevention device. The full text of this by-law is included in Appendix E.

Other towns have enacted other regulations or by-laws on automatic sprinkler systems:

- The Town of North Andover enacted an automatic lawn irrigation by-law that requires registration, a registration fee, and use of rain sensors.
- Concord requires all existing irrigation systems to have a moisture sensor and a timing device that complies with the town's time-of-use outdoor watering restrictions.
- The Acton Water District also requires moisture sensors, programmable timing devices, and backflow prevention devices. The text of the regulations is included in the Acton Case Study on page 18.

At a minimum, communities should require relatively inexpensive rain sensors for all systems to prevent some of the most wasteful operation of automatic systems.

Sudbury, Bridgewater, Norton, Northborough, Westborough, Norfolk, Walpole, Mashpee and Holliston all prohibit new irrigation systems from connecting to the public water supply.[16] However, property owners are still permitted to use private wells, which can contribute to summer water shortages if they draw from the same aquifer as the public water supply does, or if they draw groundwater levels down enough to impact streamflow. Consequently, it may be more effective in terms of overall watershed management to allow irrigation systems on the public water supply, but to control their use. The alternative is to extend regulations on outdoor water use to private well users in addition to those on the public water supply. Regulation of private wells is covered in the chapter on Alternative Sources.

"Smart" Irrigation Systems

Another response to wasteful irrigation systems is to promote or require the use of advanced irrigation system control technology. This technology is becoming increasingly more sophisticated. Individual sprinkler heads communicate with a centralized control computer and weather station that measures rainfall, wind speed, and sunlight to accurately determine whether and when irrigation is needed. The devices can work with a traditional irrigation system controller, or in some cases can replace the controller altogether. Using real-time weather and evapotranspiration data or historical reference evapotranspiration data, these devices schedule and adjust irrigation based on local conditions. In some cases, the controllers also factor in plant types, slope, soil conditions, or other features of the landscape.

Massachusetts Department of Conservation and Recreation

Weather-based irrigation control system

Though it can be expensive, this technology can be implemented with smaller-scale irrigation systems, such as outdoor areas of schools, businesses, and residences. Weather-based irrigation control products

can cost anywhere from $100 to over $3,000, and may require set up or on-going service fees. Some are highly complex to set up and may require a trained technician or landscape manager.

As this technology advances, municipal bylaws regarding irrigation systems should be regularly updated so that they are constantly requiring developers and engineers to use the best available technology.

Evaluating Weather Sensors in the Ispwich Basin [17]

Through a Targeted Watershed Grant from the U.S. EPA, the MA Department of Conservation and Recreation has worked with the Ipswich River Watershed Association and the towns of Hamilton, Middleton, Peabody, North Reading, and Reading to install a total of 25 weather-based irrigation controller switches on both residential properties and municipal athletic fields in those five communities. Water use data for each irrigation system is recorded from water meters dedicated to the irrigation system, and will be compared to water use at control sites using conventional irrigation technologies, as well as records on water use at the test sites before installation of the weather-based controllers. This project will attempt to quantify the water savings that can be achieved with innovative irrigation controller switches.

Residential Development Patterns & Techniques

INTERMEDIATE MEASURE

Level of Complexity: Medium to High
Costs: Low
Local Examples: Sharon, Falmouth, Cape Cod Commission

The form of development in a community has significant impacts on the volume and timing of water demand. Most suburban and rural communities in Massachusetts require lot sizes of one acre or more for most new residential development. In addition to consuming open space and driving up the cost of housing (as illustrated by a growing body of research), larger lots are correlated with higher per capita water use and higher seasonal water demand. (See the recent EPA reports *Growing Toward More Efficient Water Use: Linking Development, Infrastructure, and Drinking Water Policies*, available from http://www.epa.gov/livability/water_efficiency.htm, and *Protecting Water Resources with Higher-Density Development*, available from http://www.epa.gov/livability/water_density.htm.) There are several reasons for this:

- Large lots generally have larger lawns, and more builders are installing automated irrigation systems as an amenity that helps to justify very high home prices.
- Low-density subdivisions require a more extensive water distribution system, increasing the potential for leakage.
- Conventional landscaping practices that are applied at large scales in new subdivision developments generally involve the removal of topsoil and the use of non-native species, yielding lawns with shallow roots, less moisture retention, and high water needs.
- Conventional subdivision design also increases runoff and decreases stormwater infiltration, which has negative impacts on groundwater recharge and water quality, exacerbating problems during summer months.

Tim Reardon

Conventional subdivision designs create large lawns with large appetites for water.

There are numerous tools that municipalities can use to promote residential development patterns that preserve water supplies and community character. Compact development designs that use a mix of housing styles (including multifamily structures), smaller lot sizes, and traditional neighborhood layouts will generally result in lower per-capita water demand and more accessible housing opportunities as compared to the same

In contrast to conventional approaches, a clustered subdivision with smaller setbacks and preserved natural areas has smaller lawn areas and less demand for water

number of houses built in a conventional subdivision on one-acre lots. This approach will help communities meet their housing needs with lower peak season demand, while also preserving community character and (if built near commercial districts and transit stops) minimizing transportation impacts.

For development in outlying areas, the use of Open Space Residential Design (OSRD—also known as Conservation Subdivision Design) and Low Impact Site Design will minimize site alteration and reduce the demand for water in new development. Because individual house lots in an OSRD development have smaller lawn areas than conventional subdivisions, peak water demands will be lower.

Low Impact Site Design seeks to minimize site alteration, especially watershed alteration, so development sites retain more native soils and natural vegetation, which requires little or no irrigation. Low Impact Development strategies also utilize stormwater management techniques such as bioretention cells, also known as rain gardens. These landscaped areas store and infiltrate stormwater runoff into the ground and are usually planted with native species that can tolerate frequent inundation as well as dry periods. As a result, they function as stormwater management structures as well as landscaping features that require no irrigation.

Open Space Residential Development uses a four step process of site design very different from conventional subdivision development:

1. Identify critical resources and conservation areas (50% or more of the site)
2. Locate house sites to minimize environmental impacts
3. Align roads and pathways
4. Draw lot lines

In the state of Massachusetts, more than 30 communities have passed Open Space Residential Design, conservation subdivision, or similar by-laws, including Sharon, Swansea, Lexington, Wilmington, and Ipswich.[18] Green Neighborhoods and the Cape Code Commission both offer model by-laws for Open Space Residential Design, which are available on their websites (www.greenneighborhoods.org and www.capecodcommission.org, respectively). Other communities, such as Franklin, Hanover, Hamilton, Littleton, Southborough, and Weston, include in their by-laws a provision encouraging the use of Low Impact Development techniques.

Regardless of the type of development, land clearing and grading practices can impact the soil's ability to retain water and the landscaping's demand for water. The Cape Cod Commission has a Model Land Clearing, Grading, and Protection of Specimen Trees By-law that offers a combination of Site Plan Review Standards and Special Permit requirements to "minimize the loss of natural vegetation and topography and to protect specimen trees, significant forest types, and the most valuable wildlife habitat when developing a site."[19] The model by-law is available on the Commission's website: www.capecodcommission.org. Minimizing the loss of natural vegetation and quality soils can not only reduce the water consumption of the site, but can also aid in controlling erosion and flooding, and managing stormwater runoff.

Landscaping By-Laws

Another way to limit the water demand of new development is through landscaping by-laws. Since irrigation demand is directly correlated with lawn size, local bylaws limiting the extent of turf (either in terms of square footage or as a percentage of the total lot)

ADVANCED MEASURE

Level of Complexity: Medium to High

Costs: Low

Local Examples: Sharon, Falmouth

have had considerable success in reducing irrigation demand in development subject to the limitations. By-laws may also encourage the use of native plants, require the preservation of existing plant communities, and/or require a certain type or depth of soil. The North and South Rivers Watershed Association is in the process of developing a model landscaping by-law for Massachusetts designed to reduce landscape water needs as well as fertilizer and pesticide needs (both of which impact water quality).

Photo by Paul Fusco, USDA Natural Resources Conservation Service

Natural landscaping in a restored habitat in Connecticut

Locally, there are a few examples of landscape requirements. The Town of Falmouth enacted by-laws requiring Xeriscape ("a landscape designed with native, drought-tolerant species which require little fertilizer") for all applicable projects ("all development projects other than single- or two-family dwellings that require a special permit or review"), unless a drip/mist irrigation system or a private well irrigation source is used.[20] Excerpts from Falmouth's Landscape Requirement by-law are included in Appendix F. The Town of Sharon also has a provision requiring development in "Rural and Suburban 2" districts to retain at least 50% of the lot in natural vegetation,[21] and requiring building lots in Conservation Subdivision Design developments to have at least 15% of the lot in natural vegetation.[22] Experience in Sharon has demonstrated that the definition of "natural areas" is key to enforcement. Some observers have reported that developers simply leave "natural areas" bare, and homeowners seed them with lawn grass after purchase.

Concord DPW, Water/Sewer Division

Concord, MA native landscaping.

While Sharon and Falmouth created new by-laws, other communities may instead opt to include similar provisions in zoning by-laws, subdivision rules and regulations, or site plan review standard.

Both California and Colorado have model water-efficient landscaping ordinances. The California model by-law requires "all new and rehabilitated landscaping for public agency projects and private development projects that require a permit; and developer-installed landscaping in single-family and multi-family projects"[23] to submit a landscape documentation package including landscape and irrigation design plans, water use estimations, and soil analysis. The Colorado model by-law requires "new or renovated landscapes that require development review permits"[24] to abide by water-efficient landscape design principles, including:

- Well-planned planting schemes;
- Appropriate turf selection to minimize the use of bluegrass;
- Use of mulch to maintain soil moisture and reduce evaporation;
- Zoning of plant materials according to their microclimatic needs and water requirements;
- Improvement of the soil with organic matter if needed;

- Efficient irrigation systems; and
- Proper maintenance and irrigation schedules.

The by-law allows the use of plants of any water need, so long as the overall landscape is designed to meet an annual water budget.[25]

Thomas G. Barnes @ University of Kentucky

The City of Albuquerque, New Mexico, enacted a landscape ordinance in the mid-1990s requiring new developments to limit high-water-use landscaped areas (including turf grass) to 20% of the total landscaped area, or to develop an appropriate water budget to limit landscape irrigation. The ordinance also established planting requirements and watering limitations on city-owned properties. The city reported that after enacting the ordinance, single-family residential customers used 28% less water. [26]

Water-efficient landscape by-laws and modified weed laws to allow natural landscaping can reduce the amount of water that landscapes need, but landscape by-laws alone can't reduce the amount of water landscapes actually receive. As the saying goes, "plants don't waste water; people do." Effective landscape by-laws require education efforts on proper irrigation for homeowners and landscape maintenance workers so that water-efficient landscapes are watered less. Water rate structures that penalize wasteful use and charge higher rates for discretionary outdoor use can also help in this regard.

"Weed Laws" and Natural Landscaping [27]

If municipal by-laws include weed laws, these may need to be amended to allow natural landscaping that requires less water (as well as less pesticide and fertilizer, and less mowing). An article on natural landscaping and weed laws in the John Marshall Law Review offers some guidelines for communities looking to revise weed laws to allow for natural landscaping, which are summarized below:

- The ordinance should protect residents' right to choose their own landscaping;
- The ordinance should apply to all residents as well as government-owned properties;
- Any restrictions should be based on a legitimate public health, safety or welfare concern;
- The ordinance should not legislate aesthetics or allow residents to control their neighbors' landscapes;
- The ordinance should not require an application or review process for residents who want to use natural landscaping;
- Those charged with enforcement of the ordinance should be trained to distinguish natural landscaping from prohibited growth;
- Enforcement should allow for appeals;
- The ordinance should address the environmental impact of high-maintenance landscaping.

MASSACHUSETTS CASE STUDY

Town of Concord, Massachusetts

Concord's water conservation efforts began in 1997 and have included a tiered rate system, water-saving device distribution, residential water audits, and numerous public outreach and education programs.

Concord DPW, Water/Sewer Division

Concord, MA low-water demonstration garden

Rates:

Concord's rate structure incorporates both seasonal rates and an increasing block rate structure. Concord also charges higher rates for outdoor water use. The full structure is described as an example of seasonal rates in the chapter on Pricing.

Regulations:

Since 2002, all automatic in-ground irrigation systems that are permanently connected to the public water supply in Concord are required to be registered with Concord Public Works and are required to be equipped with a controller, a rain sensor, and a backflow prevention device (to protect quality of drinking water).

Public Education:

Public education and outreach for water conservation in Concord has included:

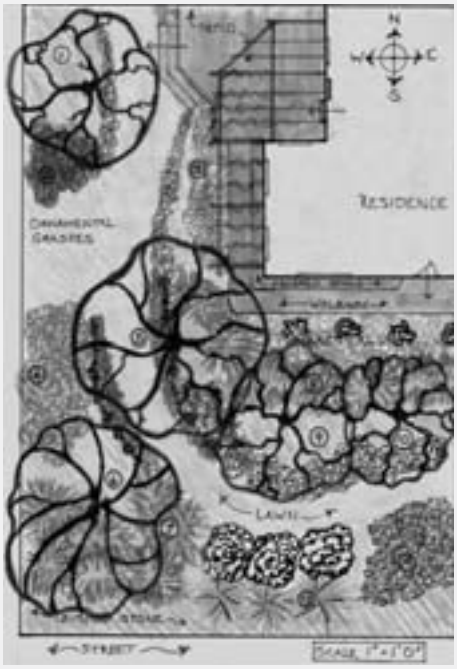
- free water use audits for residents,
- design templates for water efficient landscaping,
- targeted mailings to high-water customers,
- discounts on rain barrels,
- free water conservation devices for residences,
- rebates for replacement of inefficient toilets,
- presentations to local groups by Concord Public Works staff,
- integration of water conservation into the fourth grade science curriculum,
- a bi-annual newsletter published by Concord Public Works entitled 'Water Connection Newsletter,'
- a conservation insert in the Annual Water Quality Report, and
- on-line information.

The most recent public outreach strategy was piloted in 2005 for properties in a neighborhood with high summertime water use. Funded by a grant from DEP, the project included several components:

1. Conducted a focus group of high water users to determine what messages and strategies they might be receptive to;
2. A series of three one-page, double-sided newsletters containing tips on irrigation system control and landscaping that could save water was sent to all households in the neighborhood;
3. Customized letters sent to the ten households with highest summer water usage, informing them that they use more water than their neighbors and encourage them to get a free irrigation system audit; and

4. Follow up phone calls made to these ten households to urge them to take specific actions to reduce their water use.

The 2005 DEP grant also funded four landscape design templates and a "Water-Smart" demonstration garden to encourage property owners to replace some of their lawns for alternative plantings that are easy to maintain and require minimal water. Each of the landscape templates is tailored to a particular landscape setting or goal: 'Garden for Hot Spots' is tailored for full-sun locations; 'Wildlife Attracting Landscape' aims to attract local and migrating animals; 'Woodland Garden' is intended for properties adjacent to wooded areas; and 'Rain-Catching Garden' focuses on retaining water and allowing it to recharge groundwater. The diagram of the "Hot Spot" template is shown at right. The templates include design goals and descriptions, plant lists, and planting diagrams. They are available for free download from the town's website: http://www.concordnet.org/dpw/w&s/html/watersmartmain.htm.



Dori Smith of Gardens for Life, courtesy of Concord DPW, Water/Sewer Division

The "Hot Spot" design template is one of many that homeowners can use to help create low-water landscaping.

In addition to the landscape templates, two demonstration gardens with drought tolerant and low maintenance plants have been created by the Concord Public Works, as discussed in the section on demonstration gardens in the chapter on raising awareness.

Larger water users were targeted for the free water use audits, with a focus on correct operation of in-ground irrigation systems. The Town is also currently testing new "smart" irrigation controllers at 10 residences and several Town owned properties, including the Town House. The new irrigation technology, called 'Smart Water Application Technology' (SWAT), uses weather information to regulate when and how much water is applied to landscaping.

The following water conservation devices are provided to households for free:

- Rain Gauges
- Leak Detection Kit for toilets
- Bathroom Flip Aerators
- Dual Setting Flip Aerator with Swivel for the Kitchen
- Low-flow Showerheads
- Shower Timers

On-line information provided by Concord Public Works Department includes:

- Information on water-efficient landscaping
- Registration forms for in-ground irrigation systems
- Irrigation system design data sheet
- Order form for indoor water conservation devices
- Information on rain barrels
- 'Healthy Lawns for Healthy Families' initiative (a cooperative effort including neighboring towns that is aimed at reducing the use of non-organic pesticides on lawns).

GET THE PRICE RIGHT: PRICING, RATE STRUCTURES, AND BILLING

Water is both a necessity and a scarce commodity. This makes it important that water pricing discourages unnecessary and wasteful use while maintaining affordability for essential uses. Because a significant portion of water use is non-essential, there is some elasticity in demand with respect to price, meaning that if the price of a given quantity of water increases, consumers are encouraged to reduce their costs through reduced discretionary use and more efficient technology. In the short term, a 10% increase in the cost of water for single family residential customers can result in roughly a 1% to 2% decrease in summer water consumption. In the long run, the same price increase can reduce summer water use by approximately 2% to 5%.[28]

Adjusting the rate structure does not require raising rates overall, but rather shifting the rate burden onto those who use the most or who use the most wastefully, so that overall revenue remains steady. Rates should be set so that the utility's revenue covers the full costs of operating the water supply system. These costs include:

- treatment costs
- staff costs
- distribution system operation and maintenance
- land acquisition or protection for well sites, aquifers, and watersheds
- debt service
- conservation measures including water-efficient devices and public education
- leak detection and repair[29]

Because many communities require the water utility to be revenue-neutral, ensuring that the full costs of providing safe, clean drinking water are understood and accounted for is critical.

Many water systems in Massachusetts use a uniform rate structure in which customers pay the same rate for each gallon of water. This type of rate does not distinguish between essential and non-essential uses, between efficient and wasteful use, or between usage when supplies are high and usage when supplies are low. By structuring rates so that the price increases above certain usage levels or during certain time periods, customers will be encouraged to reduce water consumption, and/or to reduce peak use.

Most rate structures contain both an upfront fixed charge and per unit commodity charges covering the water used. There are a number of different ways to structure the commodity rates to discourage wasteful use. These include:

- Seasonal rates, which charge more for each gallon of water in the summer when demand is greater and supplies are lower;
- Increasing block pricing, in which the price per gallon of water increases with the amount of water consumed;
- Other strategies to quantify the discretionary use of each customer and to charge higher rates for the water used for discretionary purposes. These strategies include targeted use rates based on projected essential household demand; separate outdoor meters; and fees or discounts based on the use of water efficient technologies.

Regardless of the rate structure, universal metering is a prerequisite for the success of conservation-oriented rates. Also, meters should be read and customers should be billed frequently to give feedback in time to influence customer behavior.

A number of communities in Massachusetts have implemented one or more of the conservation-oriented rate and billing strategies mentioned above. The 2004 Tighe & Bond survey of Massachusetts water and sewer rates offers the follow statistics from survey respondents:

- Rate structures:
  - **48% of Massachusetts communities use an increasing block rate structure**
  - 46% use a flat rate structure
  - 5% use a flat fee
  - less than 2% use descending rates
  - **6% have separate seasonal rates**
- Billing frequency:
  - **47% use a quarterly billing cycle**
  - **5% use a monthly billing cycle**
  - 45% use a biannual billing cycle
  - the rest bill annually, bimonthly, or tri-annually
- Discounts:
  - 16% offer elderly discounts
  - 7% have early payment discount
  - 7% have low-income rates

Designing a rate structure that will encourage conservation, provide a steady stream of revenue to the water supplier, and maintain affordability for low- or fixed-income residents is not a simple task and may require more detailed guidance than what can be provided here. For additional guidance, there are a number of handbooks on rate structure design for water utilities published by the American Water Works Association (AWWA), including *Water Conservation-Oriented Rates* (2005), *Developing Rates for Small Systems* (2004), *Principles of Water Rates, Fees, and Charges* (2000), *Water Rates, Fees, and the Legal Environment* (2004), and *Thinking Outside the Bill: A Utility Manager's Guide to Assisting Low-Income Water Customers* (2005), all of which are available from the AWWA online bookstore (www.awwa.org/bookstore).

Metering and Billing to Support Conservation Pricing

In order for customers to receive the price signals embedded in a conservation-oriented rate structure, they must have a water meter, and their use must be measured and billed frequently enough to influence behavior. Full metering of water users is one of the most basic steps in a conservation program of any kind. The Massachusetts Water Resources Commission (MWRC) Water Conservation Standards include "100% metering of all public sector and private users with meters of proper size and accuracy to ensure full registering of water flow."[30] Regular maintenance, testing, and calibration of meters is also important to maintain accuracy.

BASIC AND INTERMEDIATE MEASURES

100% Metering: Basic Measure
Frequent Billing: Intermediate Measure
Level of Complexity:
- **Meter installation / Quarterly Billing:** Low
- **Meter calibration / Automatic Meter Reading:** Medium

Costs:
- **Metering:** Medium
- **Quarterly Billing:** Low to Medium (staff costs)
- **Automatic Meter Reading:** Medium to High

Local Examples:
- **Frequent billing:** Ipswich, Wellesley, Norwood, Cambridge
- **Automatic Meter Reading:** Cambridge, Malden, Topsfield

Frequent billing is another key element of conservation programs, and especially for efforts to reduce peak demand. A household that waters heavily all summer long but does not receive a bill showing the cost of the high water use until September will have missed an opportunity to recognize and then reduce excessive water consumption. Billing must occur at least quarterly (the MWRC Water Conservation Standards set quarterly billing as a standard), and preferably monthly or bi-monthly. Roughly five percent of communities in

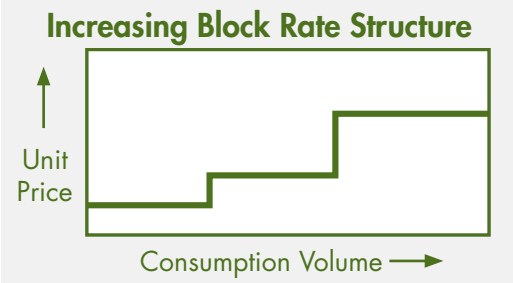
Massachusetts use monthly billing, including the towns of Ipswich, Salisbury, Wellesley and Norwood, and the cities of Boston, Cambridge and Chelsea.[31] The bill should also offer customers a sense of where their water usage stands in relation to "ideal" water usage. This could be done by listing the household usage in terms of gallons per day, referencing the Massachusetts Water Conservation Standards on water use in gallons per capita day, and then comparing them (for example, 'if you have two people in your household, you are above the conservation standard').

In order for frequent billing to be an improvement, however, billing must be based on actual use, not estimated use. Billing based on estimated use can disguise problems requiring attention and can make distinguishing summer use from winter use more difficult. Customers should be billed as often as meters can reliably be read in order to more accurately communicate water consumption information. Frequent meter reading can be time-intensive unless meters are connected to an automated meter reading system. With radio-transmitting devices attached to the meters so that they can be read while driving by in a truck, meter readers can work more quickly and efficiently, reducing the cost associated with meter reading and eliminating the need for estimated use billing.

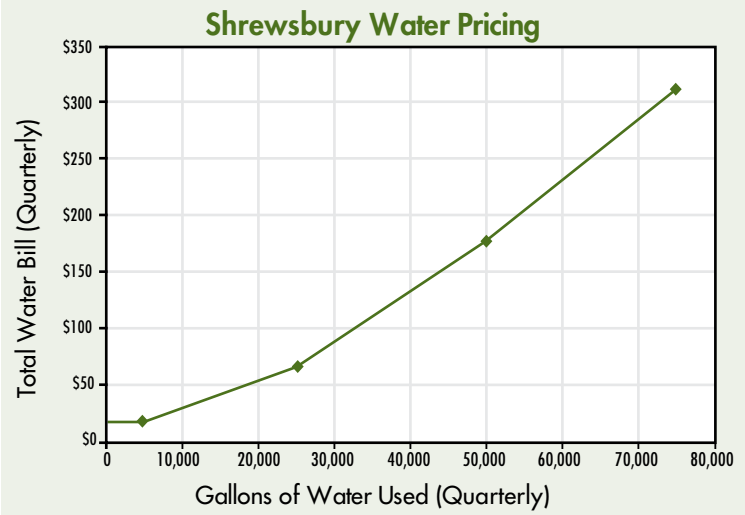
The cities of Cambridge and Malden have both converted to Automatic Meter Reading in the last few years,[32] and the town of Topsfield has recently installed and begun using radio-read meters for 500 customers as part of the EPA Targeted Watershed grant for the Ipswich River watershed. The selected Topsfield customers will be billed monthly, while all other Topsfield customers will continue being billed semi-annually. Data will be collected for the 500 participating customers and 500 others who will serve as a "control" group. The project will be used to evaluate the effectiveness of increased billing frequency in promoting conservation.[33]

Increasing Block Rates

Increasing block rates are a simple water conservation strategy based in the recognition that, as consumers use more water, they have a larger impact on overall demand, water system operations, and environmental resources. Increasing block rates reflect this fact by charging consumers more for each incremental unit of water as consumption increases. Consumers are charged a certain amount for the first "block" of water, and then higher rates for each subsequent block, as shown in the figure below.



Of the 60 communities in the MWRA system, 36 have an ascending block rate for residential users. Statewide, roughly half of local water districts have increasing block rates.[34] As an example, the town of Shrewsbury's rate structure for residential accounts is as follows (billing occurs quarterly):[35]



This rate structure is illustrated in the graph above, which shows the water bill total versus the total water used. The increasing block rates are reflected in the increasing steepness of the curve.

Town of Shrewsbury Water Rate Structure

Minimum charge (up to5,000 gallons)	$ 15.00
5,001 to 25,000 gallons	$ 2.50/1000 gallons
25,001 to 50,000 gallons	$ 4.50/1000 gallons
In excess of 50,000	$ 5.50/1000 gallons

Increasing block rate structures vary in the number of blocks, and in the "steepness" of the incline. Some communities have only two or three block rates, others may have eight or more. Steeper inclining rates send a stronger conservation signal to customers. An increasing block rate structure must be developed based on a good understanding of the basic water needs of the residents and businesses in the community. The rate structure should maintain affordability for large families and people with low or fixed incomes. The town of Ashland combines an ascending block rate with low-income and elderly discounts to ensure affordability.[36]

Seasonal rates

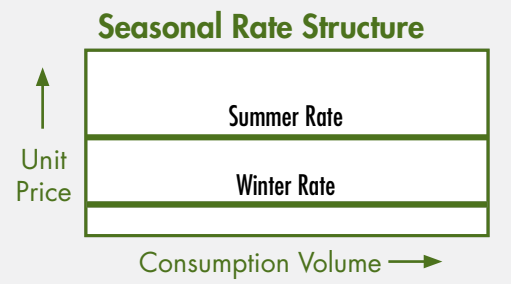
INTERMEDIATE MEASURE

Level of Complexity: Medium
Costs: Low (costs for rate structure development)
Local Examples: Ipswich

A seasonal rate structure charges different prices for water based on the season, usually, a higher rate in the summer. This is illustrated in the figure below.

This type of rate structure is explicitly targeted at reducing peak use in summer months to reflect constraints on supply and higher treatment, distribution, and environmental costs. The level of the seasonal rate should be appropriate to local costs, characteristics and circumstances.

The town of Ipswich uses a seasonal rate structure. The summer rate is set to be 1.5 times higher than the "base rate" (which is currently $4.60 per cubic foot). The town selectmen must vote to accept the rate increase for each summer at two consecutive meetings. This spring (2006), the selectmen voted to set the rate at $6.90 per cubic foot for the 2006 summer period, from May 1st until October 31st. The off-peak rate is set to a level that will make the water utility revenue-neutral for the year; that is, at the end of the summer, the utility determines how much additional revenue it needs for the year and projects usage, and sets the rates accordingly. From October 31st, 2005 to May 1st, 2006, that rate was $3.42 per cubic foot. Since implementing higher summer rates in 2003, the town's overall water consumption has decreased from around 424 million gallons in 2001 to around 400 million gallons in each of the last three years, despite the fact that the utility is serving about 600 additional customers. The "height" of the seasonal peak has remained roughly the same for total water use (because of the additional customers served), but the per capita summer peak is now lower.[37]

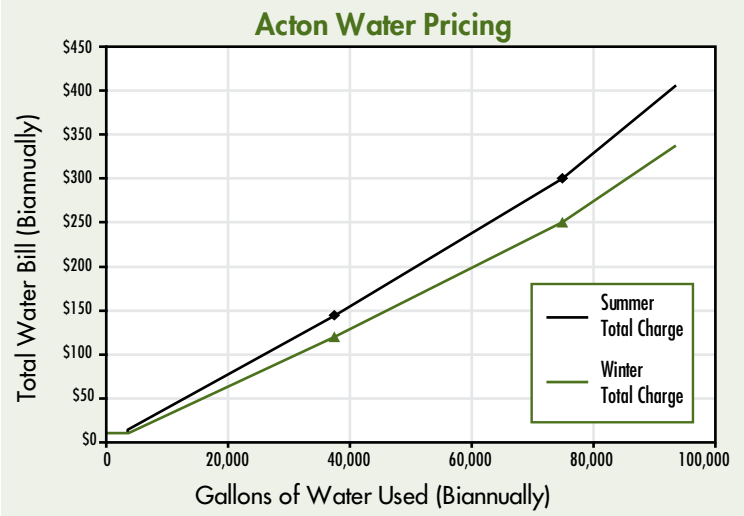


Seasonal rates can also be combined with increasing block rates. This can mean a flat rate in winter and an increasing block rate in summer, or increasing block rates in both seasons but higher unit prices in summer months. Acton, Concord, and Wellesley all use a combination block and seasonal rate structure. In the town of Acton, the blocks and rates are as follows:[38]

Town of Acton Water Rate Structure

BLOCKS	SUMMER RATE	WINTER RATE
Up to 500 cubic feet	$10.00	$10.00
All usage between 1 and 5000 cubic feet when 500 cubic feet has been exceeded	2.9¢ per cubic foot (0.39¢ per gallon)	2.4¢ per cubic foot (0.32¢ per gallon)
5001 – 10,000 per cubic foot	3.1¢ per cubic foot (0.41¢ per gallon)	2.6¢ per cubic foot (0.35¢ per gallon)
Over 10,000 cubic feet	4.2¢ per cubic foot (0.56¢ per gallon)	3.5¢ per cubic foot (0.47¢ per gallon)

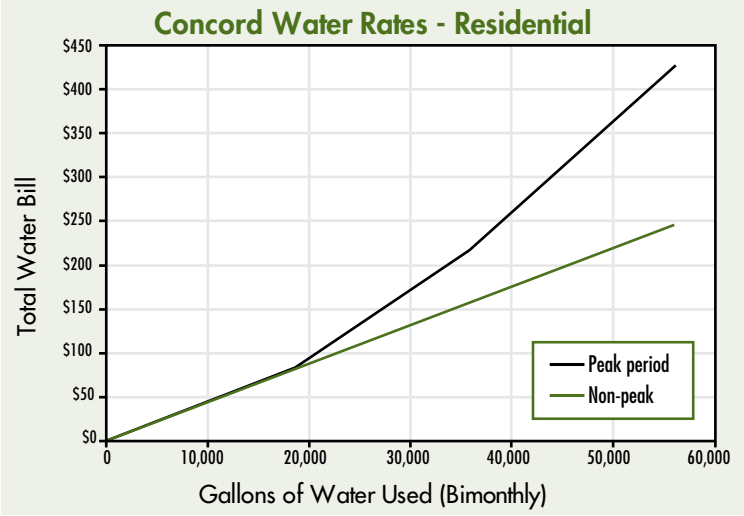
The increases with peak season and increased usage are illustrated in the graph to the right, which shows the water bill total versus the total water used.



The town of Concord uses a different approach to seasonal/increasing block rates. Concord's residential water rates are uniform except from May 1 through October 31, when an increasing block rate is applied. (Non-residential service has a two-step block structure year-round.) Concord also uses a second meter system to charge higher rates for outdoor discretionary use (outdoor water meters are covered in a subsequent section). The full rate structure follows:[39]

Residential Service		General Service		Second Meter Service	
Water charge per unit (1 unit = 100 cubic feet = 748 gallons):		**Water charge per unit** (1 unit = 100 cubic feet = 748 gallons):		**Water charge per unit** (all year)	
Step 1: (all year)	**$3.27**	**Step 1: first 50 units bimonthly** (all year)	**$3.27**	**Irrigation/Pool use**	**$5.89**
May 1 through October 31 only: **Step 2: 25 to 48 units bimonthly**	**$5.89**	**Step 2: over 50 units bimonthly** (all year)	**$3.98**	**Process use** (non-sewered, non-irrigation)	**$3.98**
Step 3: over 48 units bimonthly	**$7.69**				

The effect of the increasing rates on the water bill is illustrated in the graph to the right.



Another way to approach seasonal rates is through the percentage of Average Winter Consumption (AWC), establishing an indoor use rate for each account by using consumption patterns when outdoor use is negligible. The non-essential outdoor use can then be approximately identified without the use of a second meter. The AWC can be applied to an increasing block structure as well so that if a customer uses an average of 100 units of water per month in winter, and 200 units per month in summer, the customer will be charged the price for that block of use.[40] The disadvantage of this strategy is that it rewards customers with high indoor use, and penalizes those who are more efficient with water inside their homes. If combined with a fee and discount system to reward those who install water-efficient fixtures, as discussed in the chapter on incentives, this type of rate structure could be set up to reward those who are water-wise both inside and outside of their homes.

Targeted use or wasteful use rates

ADVANCED MEASURE

Level of Complexity: High

Costs: Medium (costs for rate structure development)

One way to improve equity for consumers that have naturally higher baseline water demands (such as large families) is to use individualized goal billing, or targeted use rates. This type of rate structure establishes an estimate of what a household's use should be based on factors like household size, yard size, and/or historical use. This strategy can be used to establish the thresholds at which different water unit prices apply in an ascending rate structure. Alternatively, customers can be given a discount for meeting the goal, or charged a penalty for exceeding it (as with wasteful use rates). The discount/penalty system can be used with any rate structure, including a flat unit rate structure or even a flat fee structure, to make the cost of water more tuned to conservation goals.

One potential problem that can arise in setting the target use level is that reliance on historical consumption data can penalize those who were already conserving and reward those who have been wasteful in the past. Adjusting for yard size or some other measure of potential outdoor demand is likely to run contrary to peak demand reduction strategies, as those with larger yards and more landscaping will be encouraged to use more water. Establishing the target use rate for each household may be a challenging and time-consuming task, but if done properly could result in the most equitable pricing structure.

The city of Boulder, Colorado is in the process of implementing a targeted use rate structure. According to the Western Resource Advocates, a group that has encouraged such measures:

> By the end of 2006, Boulder utility staff will calculate an individual 'budget' for each residential and commercial customer. Each budget will be based on typical annual indoor use as well as a monthly determination of actual needs for outdoor irrigation. Accompanying educational materials will explain, for example, that outdoor watering needs are significantly lower in the months of May and September than in the heat of the summer.

This change represents the combined efforts of the City Council, a volunteer Water Resources Advisory Board, and the Western Resource Advocates.[41]

Outdoor water meters

ADVANCED MEASURE

Level of Complexity: Low to Medium

Costs: Low

Local Examples: Concord, MA

Another way to quantify each consumer's outdoor water use is to install a second meter for the outside fixtures. This allows the water system to determine exactly what water is used for irrigation and other outdoor uses during the peak season, and to charge rates for that water that reflect the costs to infrastructure and environmental resources from the high peak demand associated with outdoor water use. Outdoor meters are common in Massachusetts, but not for purposes of seasonal demand reduction. Rather, where the sewer charges are based on water consumption, consumers request outdoor meters in order to reduce their sewer charges. As a result, outdoor meters in these circumstances may actually increase water consumption, because the perceived cost of that water is lower than if it was metered together with the indoor uses.

To eliminate this incentive for outdoor use, communities that allow outdoor meters should enact higher water rates for outdoor meters to send an appropriate conservation signal to consumers. As mentioned in the section on seasonal rates, town of Concord, MA, uses a higher rate for the second meter, charging $5.89 per unit (a unit is a hundred cubic feet or 748 gallons) for all "Irrigation/Pool use."[42] This, combined with the summer higher rates for higher use, helps the town discourage excessive outdoor use and keep peak water demand under control.

Once the rate for outdoor water use exceeds the combined water and sewer charges that would have applied without a second meter, it is unlikely that users will request second meters. In order to make the high outdoor

rates effective, it may be necessary to combine them with a regulation requiring automatic irrigation systems to be separately metered.

Charging more for outdoor water use based on a second meter does not penalize low-income or elderly customers or those already conserving, and focuses attention on the discretionary use most responsible for high peak seasonal water demand. In communities where rates must be set according to system costs, a higher outdoor rate can be justified based on the fact that the treatment and distribution systems must be substantially larger in order to meet peak demand than they would need to be if winter use levels were maintained.

ADDRESS ALTERNATIVE SOURCES

If the conservation measures described above are insufficient to eliminate the effect of peak season water demand on water infrastructure and water resources, municipal officials and water suppliers may consider allowing or encouraging alternative water sources to be used for non-potable needs. The most common alternatives are private irrigation wells, harvested rainwater, and highly treated wastewater. Increasing reliance on alternative sources must be done in a thoughtful and balanced way so that wasteful water use does not simply draw from other sources that have the same net impact on the watershed. All of these options can reduce the demand on the public water supply system, but they may still have direct or indirect impacts on the quality and quantity of the water available to the public water supplier and to local water bodies.

Since most of the water used for landscape irrigation is lost to the atmosphere through evapotranspiration, water from alternative sources that is used for irrigation is lost to the watershed. According to a report from the Neponset River Watershed Association and consultant Alexandra Dawson, "A properly irrigated law will take up and evapotranspire 100% of the supplemental water which it receives."[43] Using an alternative source for irrigation water may not prove to be a real solution for many communities, and is not a substitute for a thorough peak demand management program.

Communities in stressed basins where groundwater recharge is a priority should conduct careful evaluation in order to determine the optimal use of water from alternative sources. In some cases, demand for essential and potable uses might be shifted onto private wells with smaller, more distributed watershed impacts. In other cases, treated wastewater or harvested rainwater might be used for non-potable applications such as commercial toilet flushing, or be recharged to groundwater. Communities should seek ways for alternative sources to minimize the watershed impacts of essential uses before they promote the use of alternative sources for discretionary uses. Amy Vickers quotes from *Lawn Care for Dummies* in a recent article in the Journal of the American Water Works Association: "'Face it, you have more important things to do with water than put it on a lawn.'"[44] After all, non-essential water use is still non-essential even if it is supplied by alternative sources. Reducing outdoor water demand should still be the priority, and the availability of alternative sources should not in any way reduce conservation efforts.

Private Irrigation Wells

INTERMEDIATE MEASURE

Level of Complexity: High

Costs: Low

Local Examples: Middleton, Falmouth, Neponset River Watershed Association

As mentioned previously, several communities prohibit the connection of automatic irrigation systems to public water supplies, creating an incentive for homeowners and businesses to install private irrigation wells. Although increased use of private wells may relieve pressure on the public treatment and distribution system, it may still contribute to overall stress on the watershed, with associated impacts on recreation, water quality, and aquatic ecosystems.[45] In some cases, when wells are located near public wells or near water bodies, the impact may be a direct reduction in the water available to the public system as private wells draw down the water table in the vicinity of public water sources.

The Neponset River Watershed Association recommends a prohibition on installation of new irrigation wells near sensitive resources, establishing consistent design and performance standards for efficient use of irrigation systems regardless of the water source, and extending outdoor water use restrictions to private well users during periods of hydrologic stress.[46]

The communities of Falmouth and Middleton have both implemented by-laws extending water use regulations, which originally applied only to public water customers, to cover private well users. Both by-laws have been upheld by the Attorney General of Massachusetts. The Falmouth by-law extends any ban on water use instituted when the selectmen declare a groundwater emergency to private well users on the basis of protection of public health and safety.[47]

Middleton has enacted two by-laws that cover private well users (in addition to public water customers). The preambles to both by-laws state: "All Middleton residents that are either customers of the public water supply system or private well users shall be subject to this by-law in order to preserve and maintain the Ipswich Watershed Basin."[48] One by-law extends any water use restrictions enacted when the town Selectmen make a determination of a State of Water Supply Conservation or a State of Water Supply Emergency to private well users in addition to those on the public supply.[49] The other stipulates that the regulations on irrigation and outdoor water usage that are in effect each year between May 1st and September 30th apply equally to all water users, whether on private wells or public supply.[50] The text of both by-laws is included in Appendix D of this handbook.

Harvested Rainwater

INTERMEDIATE MEASURE

Level of Complexity: Low

Costs: Low (unless rebates are included)

Cisterns and rain barrels are simple techniques to store rooftop runoff for reuse for landscaping and other nonpotable uses. They are based on the Low-Impact Development (LID) approach that treats rooftop runoff as a resource that should be reused or infiltrated. In contrast, conventional stormwater management strategies take rooftop runoff, which is often relatively free of pollutants, and send it into the stormwater treatment system along with runoff from paved areas, where it leaves the site, and may even leave the watershed.

Rainwater Recovery Systems, LLC

Construction of a large underground distern at a commercial site; this vault consists of a weight-bearing skeleton wrapped in a water-proof membrane.

Rain barrels and cisterns are set up so that a portion of the roof runoff is captured and stored for later use, and the remainder infiltrates into the ground. The most common approach to roof runoff storage involves directing each downspout to a 55-gallon rain barrel. A hose is attached to a faucet at the bottom of the barrel and water is distributed by gravity pressure. A more sophisticated and effective technique is to route multiple downspouts to a partially or fully buried cistern with an electric pump for distribution. Where site designs permit, cisterns may be quite large, and shared by multiple households, achieving economies of scale. Stored rain water can be used for, vegetable and flower gardens, houseplants, lawn irrigation, car washing, and cleaning windows.

When rain barrels or cisterns are full, rooftop runoff should be directed to drywells, stormwater planters, or bioretention areas where it will be infiltrated. Some cisterns are designed to continuously discharge water at a very slow rate into the infiltration mechanism, so that the tank slowly empties after a storm event, providing more storage for the next event. Combining a rainwater harvesting system with other LID techniques to infiltrate stormwater can both increase groundwater recharge and decrease peak water demand compared with traditional subdivision stormwater management.

Cisterns and rain barrels are applicable to most commercial and residential properties where there is a gutter and downspout system to direct roof runoff to the storage tank. They take up very little room and so can be used in very dense urban areas.

More information on rain barrels, cisterns, dry wells, infiltration trenches, bioretention areas, and other LID techniques is available in the Massachusetts Low Impact Development Toolkit developed by MAPC. The Toolkit is available online at www.mapc.org/LID.

Several communities and watershed organizations in Massachusetts offer discounts on rain barrels. A grant from

the Massachusetts Department of Environmental Protection allowed 24 cities and towns, including Franklin, Shrewsbury, and Newton, to offer rain barrels to residents at a 40-50% discount on the retail price.[51] The Charles River Watershed Association also has a program to distribute and install rain barrels. For more information, see their website: www.crwa.org. Through a Targeted Watershed Grant from the U.S. EPA received by the Massachusetts Department of Conservation and Recreation, Rainwater Recovery, Inc., installed 39 small- and medium-capacity tanks on residential properties in the town of Wilmington in fall 2005. Additional large-capacity systems are planned, and sites are being determined. Data will be collected from spring 2006 through fall 2008.[52]

Gardener's Supply Company

Reclaimed Water

ADVANCED MEASURE

Level of Complexity: High

Costs: High

Local Examples: Kingston, Wrentham Outlet Mall, Foxborough Stadium, Intel

Treated wastewater, also known as reclaimed water or recycled water, can be used for a variety of purposes, including offsetting demand on potable water supplies through non-potable reuse, and recharging aquifers through large-scale soil absorption systems (leach fields). The reuse of treated wastewater can provide a significant increment of supply for use in non-potable applications, including industrial uses, power plant cooling water, toilet flushing, irrigation, and many other uses.

As with the use of harvested rainwater, the watershed impact of water reuse will depend on where the treated wastewater would otherwise have gone. If it would have provided virtually the only flow in a low-flow waterway, diverting treated effluent to irrigation uses could further damage the aquatic environment. If, on the other hand, it would have been piped out of the watershed, been discharged into the ocean, or overburdened the wastewater treatment plant, recycling the treated effluent can make better use of it.

Using reclaimed water for golf course irrigation and landscape watering to establish new plantings can be particularly useful in reducing peak demand. Using reclaimed water instead of potable water for irrigation can also reduce the need to fertilize, because of the higher levels of nutrients in reclaimed water.

Even reclaimed water should be used efficiently, and developing a reclaimed water system should not reduce the urgency of water conservation efforts. It should be noted also that as indoor conservation efforts reduce water use, wastewater flows will go down as well, potentially reducing the availability of reclaimed water. Wastewater reuse should be part of a comprehensive water conservation plan that has been established to create a balanced hydrologic cycle, so that reducing wastewater flows will improve the natural environment rather than harm it.

Photo courtesy of Camp, Dresser, McKee

Bayberry Hills golf course, in Yarmouth, MA uses reclaimed water for irrigation.

More information on reclaimed water is available in *Once is Not Enough: A Guide to Water Reuse in Massachusetts*, produced by the Metropolitan Area Planning Council and the 495/MetroWest Corridor Partnership (www.mapc.org/waterreuse).

GET PERSONAL: GIVE CONSUMERS THE INFORMATION THEY NEED

Conservation efforts can often benefit from going a step further in public education to providing specific information to various groups. Strategies of this kind include water audits, landscaping workshops, and provision of detailed real-time hydrological and meteorological information to large landscape irrigators.

Water Audits

Water audits offer detailed information to targeted classes of users. An audit includes a customer-specific on-site survey of water usage patterns and specific recommendations for increasing water efficiency. It may also involved distributing and/or installing water-saving devices. Audits can be conducted for both indoor and outdoor use for residential and nonresidential customers.

Generally, water use audit programs require promotion and advertising to promote participation and personnel time to carry out the audits. In some cases, summer interns, students, or others not part of the utility's regular staff can be trained to carry out the audits, often resulting in lower labor costs. Well-trained auditors are important to properly educate customers, so thorough preparation of auditors is critical. Another option is to offer a discount to users on the services of a private auditor.

Several factors identified by the California Urban Water Conservation Council can make audits more effective: [53]

- Devote sufficient resources to selecting and training auditors
- Offer audits at times that are convenient for participants
- Encourage customers to accompany the auditor so that the auditor can educate the participant on water conservation
- Present the results in oral and written form
- Look for opportunities to cooperate with other water agencies. For certain types of audits it may be most cost-effective to have one program that provides services to many districts
- Consider collaborating with the local energy utility to offer joint energy and water audits
- Perform a pre-audit site survey for commercial and industrial customers to gather base information prior to the actual audit.
- Include a follow-up visit to ensure proper installation of recommended measures and to evaluate persistence of savings
- Provide customers with information on implementation and costs of recommended measures
- In calculating payback period of conservation measures, include energy savings and avoided wastewater costs, if appropriate
- Utilize residential energy audit experience

Residential Audits

Some utilities offer audits to all residential customers; others target a subset of residences based on water use or on housing type (for example, age of housing stock, or single family houses only). Residential audits can include indoor, outdoor, or both.

INTERMEDIATE MEASURE

Level of Complexity: Medium to High
Costs: High
Local Examples: Reading, Middleton

Indoor water use audits for residential customers are generally aimed at reducing overall water use, rather than peak water use. They may include any or all of the following components:

- Test for leaks and repair if possible
- Identify opportunities to replace fixtures and appliances with higher efficiency models
- Assess behaviors impacting daily indoor water use and identify opportunities for improved efficiency
- Distribute efficiency kits and retrofit fixtures or devices
- Report on overall indoor water use efficiency, and calculate water savings (and monetary savings) if all recommended measures are implemented[54]

Outdoor water audits are described in the text box at right.

Several communities in Massachusetts have offered residential audits to water supply customers. The town of Middleton has partnered with Energy New England to offer free residential audits for a limited time in the summer of 2006.[56] The town of Reading is implementing a comprehensive water conservation program including residential audits. This program is discussed in more detail in the Reading case study on page 14.

A 1994 report for the California Urban Water Conservation Council estimated the cost of residential audits at $25 to $40 for a one-hour indoor-only audit, or $45 to $75 when an outdoor audit is included.[57] Other reports estimated costs of $40-$200 per audit, depending on the scale of the program and whether it was targeted to specific users,[58] and an average cost to the utility of $116 per participant.[59] The quantity of water savings attributed to audit programs has been estimated at 32.2 gallons per day (gpd) when high water-use households were targeted, and 21 gpd when participants were not targeted.[60] Other reports found an average of 8690 gallons saved per household over the course of a year,[61] and a range from 25 to 40 gpd for households receiving both indoor and outdoor audits (plus free devices, device installation, and educational materials).[62]

Outdoor Water Audit Checklist [55]

Outdoor or landscape/irrigation audits can include any or all of the following measures:

- Provide basic information about soil, water, and plant relationships
- Gather information on:
  - Landscape size
  - Irrigation equipment
  - Plant mixes
  - Environmental factors (e.g. sun/shade, slope)
  - Soil type
  - Pool or other water features
- Perform soil tests
- Assess existing vegetation types, estimate water needs
- Turn on irrigation system; identify leaks, overspray, and runoff
- Evaluate irrigation / sprinkler system
  - Check controller settings
  - Check sprinkler heads for damage or misalignment
  - Check that homeowner or landscape manager knows how to program the controller
  - Conduct precipitation test of the system
- Develop an efficient irrigation schedule, assist in reprogramming the controller
- Check for outdoor faucet leaks
- Evaluate outdoor water use behaviors and recommend ways to improve efficiency
- Suggest other water-saving opportunities where appropriate (e.g. pool coverings, irrigation equipment upgrade)
- Distribute information on water-efficient landscaping options
- Distribute irrigation retrofit devices (e.g. rain sensors)
- Summary report on outdoor water use efficiency
- Calculate potential water savings (and monetary savings) if various efficiency measures are implemented

Non-residential audits

ADVANCED MEASURE

Level of Complexity: High

Costs: High

Non-residential audits may also include both indoor and outdoor evaluations. Some commercial and institutional customers with large landscapes may be good targets for outdoor water use audits, similar to those described in the residential outdoor audits section.

Few large landscape audit programs have been formally evaluated, programs in California projected savings of 7% to 16% of expected water use; and 300 acre-feet of water over the course of a year, at a cost of $176,614. Another California program reported that while landscape audits at homeowners associations represented 44.5% of the sites audited and 58.7% of potential water savings, commercial/industrial sites represented just 7% of the sites audited but 25% of all potential water savings. The potential water savings from schools and parks was lower – schools represented 14% of sites but just 4% of potential water savings, and parks made up 30% of the sites, and 12% of the savings.[63]

Indoor water use audits for large commercial, industrial, and/or institutional users can be highly site-specific and require specialized knowledge of the systems and processes involved. Industrial users may be hesitant to allow auditors access to systems for confidentiality reasons, and may be unwilling to commit the time required for a complex audit.[64] The cost of industrial audits can vary widely, depending on the type of facility, what services are provided, and who performs the audit. Several cities in the west estimated costs from $1000 to $15,000 for industrial audit programs. Water savings were even harder to quantify, with reported savings ranging from 15% to 50%.[65] In communities where industrial users are a large source of year-round water demand, improving process water efficiency with these users may substantially reduce baseline water use, but in most cases this is not a strategy to reduce peak season demand. More information on industrial, commercial, and institutional water efficiency is available from the MWRA: http://www.mwra.state.ma.us/04water/html/indust.htm.

The water savings reported in all cases were the potential water savings identified during the audit, not the actual water savings, which was not measured in any of the programs. In order to improve the likelihood that the recommended measures will be implemented and the potential water savings will be realized, some programs require participants to implement some of the measures recommended by the audit (e.g. those with no more than a specified payback period) or be charged the price of the audit.[66]

Landscape and Irrigation Workshops

INTERMEDIATE MEASURE

Level of Complexity: Medium to High

Costs: High

Local Examples: North and South Rivers Watershed Association Greenscapes Program, Milton, Acton

Landscape design workshops are usually targeted at landscape architects and consultants, but may include homeowners as well. The focus of these workshops is to teach the designers to develop practical and attractive landscapes that use little water. In order for water-efficient landscape design and irrigation equipment to be effective, it requires those maintaining the landscaping and operating the irrigation system to understand and practice water-conserving irrigation techniques, soil amendments, mowing practices, etc. Workshops teaching low-water-use irrigation methods are most relevant for sites with large turf areas, such as parks, golf courses, schools, and office parks. Workshop topics may include efficient irrigation techniques, evapotranspiration rates, controller programming, soil moisture or rain sensors, and best practices for soil preparation, seeding and mowing.

Some agencies offer workshops at no charge, while others require some payment from participants. Offering free training may increase the likelihood that field staff, who have the most direct opportunity to influence the water expended in irrigation, will attend. On the other hand, some people may believe that they get what they pay for, and will assume a free workshop will not be worth their time.[67]

Several community groups in Massachusetts offer this type of workshop. The North and South Rivers Watershed

Association, through their Greenscapes program, offers periodic workshops on natural landscaping and water-wise irrigation open to landscape and irrigation professionals and interested homeowners. The UMass Extension program in Landscape, Nursery, and Urban Forestry also has periodic landscaping workshops, although they are not specific to water-efficient landscaping. Individual communities have offered natural landscaping workshops as well, such as the town of Milton, where the Department of Public Works hosted several workshops on natural landscaping techniques,[68] and the Acton Water District, which has partnered with Acton/Boxborough Community Education and the Acton Garden Club to offer natural landscape workshops.

It is extremely difficult to quantify the actual water savings resulting from workshops and other training programs. There are, however, a number of other benefits from workshops, including improved community relations and public education. Workshops offer an opportunity to discuss landscaping and irrigation topics in greater depth than is possible in brochures or mailings. They can also allow the water supplier to build relationships with local professionals in those fields. For workshops to reach beyond "the choir" it may help to do extensive outreach to the target population, hold workshops at convenient times and locations, and offer perks to those who attend. For example, high users may be sent an invitation with their water bill, and offered free landscape or irrigation audits. Holding workshops locally and offering refreshments can also help reduce barriers to participation.

Irrigation information

ADVANCED MEASURE

Level of Complexity: High
Costs: High

In areas where large-scale irrigators, such as golf courses, playing fields, and agricultural uses, represent an important portion of peak water demand, communities may want to consider implementing a centralized irrigation information system to help those responsible for irrigation water as efficiently as possible. The best example of this is the California Irrigation Management Information System (CIMIS), which consists of roughly 100 computerized weather stations throughout California that measure solar radiation, soil and air temperature, wind speed and direction, humidity, and precipitation. The information is uploaded to a central computer where it is used to calculate a reference evapotranspiration rate. Landscape managers can then use this value to estimate the water needed by their turf, landscaping, or crops. CIMIS is run by state and local governing bodies and is applicable to agricultural operations and large landscape or turf irrigation systems.[69]

Users of the system reported an average 13 percent reduction in the amount of water applied to their landscapes. Managers of golf course, municipal parks, and school athletic fields also reported significant reductions in water use with CIMIS information. Costs of the CIMIS system include roughly $5000 to set up each monitoring station and roughly $850,000 for operation and maintenance of the monitoring stations and computer system. In California, costs are split between the California Department of Water Resources and local agencies.[70]

There are also simple ways to improve homeowners' and landscape managers' ability to fine-tune their watering for the day. Evapotranspiration rates, along explanations of what they mean and tips for lawn watering and landscape irrigation, can be broadcast on the local cable channel, incorporated into daily weather forecasts, or posted on the water supplier's website.

Online tools can also help homeowners and landscape managers estimate the watering needs of their landscaping. BeWaterWise.com, a website run by a "Family of Southern California Water Agencies," offers a watering calculator, designed to give users a schedule for the maximum amount of water their plants may need each week of the year, based on the location, the type of plants, the type of soil, and the watering system (http://www.bewaterwise.com/calculator.html). The same group also calculates and provides online a watering index, estimating landscape watering needs as a percentage based on the maximum amount of water that should be applied to the landscape (http://www.bewaterwise.com/wat_index.html). These tools offer value and potential savings to engaged users, but must be developed based on local conditions and require a high level of effort from the user.

OFFER INCENTIVES FOR INSTALLING WATER-EFFICIENT PRODUCTS

INTERMEDIATE MEASURE

Level of Complexity: Low to Medium
Costs: Low to Medium (depending on program design)
Local Examples: Reading, MWRA

Even if water users understand the issue of peak demand and know that they should be using more efficient technology inside and more water-conserving landscaping and irrigation systems outside, the cost and/or the effort associated with obtaining replacements for their existing materials may be enough to prevent or delay them from doing so. To reduce the burden on the consumer, municipalities or water utilities can offer rebates, vouchers, or can provide the materials themselves. This reduces the customer's investment by paying all or some of the costs of the products, and can make the products easier to acquire, either by providing them directly or by increasing the demand and giving vendors more cause to sell those products. Because these programs require active participation by customers, advertising and public education are critical to their success.

Rebates and vouchers

Rebate programs or voucher/coupon programs help individuals buying water efficient materials recover their costs quickly. Both types of programs can be set up to cover all or a portion of the costs associated with purchasing the designated materials. The main difference between rebates and vouchers is that rebates are paid after the customer has purchased the product, while vouchers are paid at time of purchase. Rebate programs may be easier to administer but customers may prefer voucher programs because they eliminate the waiting period for reimbursement, which can be weeks or months.

Rebates can be offered on a number of conservation measures, including landscape conversion, installation of more efficient irrigation equipment, and ultra-low-flush toilets (ULFT). While ULFT rebate programs are the most common, for the purposes of reducing peak demand, landscape conversion and irrigation system rebates are the most directly relevant. (For more information on ULFT programs, see *A Guide to Customer Incentives for Water Conservation* from the California Urban Water Conservation Council, 1994, available from www.cuwcc.org/publications.)

Some examples of existing rebate programs from around the country include:

- $1.00 per square foot of landscape converted from turfgrass to Xeriscape
- $50 rain sensor rebate
- $200 soil moisture sensor rebate
- $50 multi-setting irrigation clock rebate
- 50% reimbursement for cost of drip irrigation materials and installation
- $200 for individual irrigation audits
- $100-200 ULFT rebate
- $100-230 high-efficiency washing machine rebate[71]

Landscape conversion rebates pay customers (usually residential customers) to install low-water-use landscaping or to convert all or part of their lawn to non-turf, more water-conserving plantings. Landscape rebates may be based on the total area of land converted or the percent of the landscapable area converted, and may be limited to a maximum amount. Some programs include consultation or review of landscape plans prior to construction, and many also include follow-up visits or field audits to verify compliance. Including consultation with a staff person or landscape professional as part of the process may help distinguish between appropriate and inappropriate uses of turf.

Landscape conversion programs in California and the Southwest have proven popular with water utility

customers and seem to have been effective. One California county reported saving an estimated 24 gallons per day (gpd) in summer per 100 square feet of turf removed.[72] The Environmental and Conservation Services Department in Austin, Texas reported an average of 214 gpd of savings in summer for participants of its "Xeriscape It!" rebate program compared with conventional landscapes.[73] A study of landscape conversion programs in Albuquerque, New Mexico; Tempe, Arizona; and Chandler, Arizona found average water savings of 11.6% per participant, but at a high cost to the utility per participant ($650) and per acre-foot of water saved ($1,099).[74] Differences in climate between the Southwest and the Northeast could reduce the potential water savings, as the supplemental water needed to maintain conventional landscapes is much greater in the Southwest than in New England. Still, landscape water use in New England is increasing rapidly, and the conversion to natural, native landscapes can drastically cut landscape water demand.

Rebates for products to improve the efficiency of irrigation systems can also help reduce peak demand by encouraging owners of automatic irrigation systems to run them less wastefully. The town of Reading, for example, offers a $25 rebate on moisture sensors for irrigation systems (see the Reading case study on page __ for more information). Reading and a number of other communities in Massachusetts offer rebates on other water-efficient appliances, such as clothes-washing machines and toilets, which are useful for general conservation efforts.

To make rebates effective and appealing, it is important to reimburse customers quickly. Public education efforts, both to advertise the program and to explain new technologies and their potential savings, are also key. Even with rebate programs, installation costs or difficulties can still pose a barrier to effective implementation of water conservation measures. Training or direct installation programs may be combined with rebate programs to address this issue (see the section on product distribution and retrofits). Other ways to improve the success of a rebate program include:[75]

- Provide a pre-approved list of technologies or materials that qualify for the rebate
- Notify distributors and manufacturers of the approved items about the program so that they can stock the approved products
- Estimate the likely demand for the program and allocate sufficient funds to pay out rebates in order to avoid waiting lists
- Maintain flexibility in the program to respond to changing circumstances

Most rebate programs can also be administered through vouchers, which may be preferable both for the consumer and for the utility. In a voucher program, the utility decides up front how many vouchers it will offer based on the amount of funding available. This eliminates the possibility of running out of funding unexpectedly. For large items, customers can call to receive a voucher, and the utility can pre-screen to ensure that the customers are within the specified service area. Then when the customer purchases the item, the store submits a bill with supporting documentation, and the utility or contractor can verify the customer information. For smaller items, vouchers can be offered in the form of coupons, and can be distributed as bill stuffers. This allows the utility to offer discounts of a few dollars in a way that is useful to the customer.[76]

Fees & discounts

A set of fees and discounts can be used as an alternative way to reward those who install water-saving technologies and/or penalize those who do not. In place of or in addition to offering discounts on the purchase price of water-conserving appliances or fixtures, those who purchase a given water-efficient technology can be rewarded through a one-time or on-going discount on their water bill.

The city of Santa Monica, California implemented a "Bay Saver Incentive Fee" in 1989 in conjunction with a retrofit program for ultra-low flow toilets and shower heads. All households not participating in the retrofit program were charged a fee of $2.00/month for single-family households and $1.30/month for multi-family households. Those who did install the efficient fixtures avoided the fee, and were also given a $75 rebate. The

fees paid by non-participants were used to fund the retrofit program.[77] As mentioned previously, combining a fee/discount system for the installation of water-saving technology indoors with a seasonal rate structure based on percentage of average winter consumption can result in a program that rewards both indoor and outdoor efficiency.

Another way to use water bill fees and discounts to create incentives for reducing peak demand is exemplified by a program implemented in North Marin Water District in California. There, developers who install water-efficient landscapes (according to the Water District's criteria) are given a discount on the connection fee. In the program's first 8 years, total participation included 25 single-family homes, 412 townhouse/condominium units, and 387 apartment building units.[78]

Product distribution & retrofits

Even with a financial incentive to purchase water-conserving appliances and landscaping materials may not be able to overcome the barrier of the effort and/or skill required to acquire and install those items. To address this, utilities can use direct distribution or retrofit programs. Device distribution is common for smaller water conserving fixtures such as faucet aerators, low-flow shower heads, toilet tank displacement bags, and leak detection dye tablets. Rain sensors for irrigation systems may also be included. Frequently water conservation kits including some or all of the items mentioned are made available to all residential customers in the service area free of charge. Occasionally, showerheads, sprinkler heads, or other water-conserving items are made available to commercial and institutional customers as well.

The MWRC Water Conservation Standards specify that water suppliers should make water conservation devices and educational literature available to residential customers.[79] A number of Massachusetts municipalities including Concord, Acton, and Shrewsbury, offer water-saving devices for outdoor water conservation free to some or all of their customers. The town of Concord offers water conservation devices including a rain gauge as well as indoor conservation devices. The kits can be picked up or delivered, and customers requesting the kits must sign a pledge to install the devices. The town of Acton offers free water saving devices including soil moisture sensors, rain gauges, and mechanical hose faucet timers. Shrewsbury is offering rain sensors free to residents using automatic sprinkler systems, which can be picked up at the town hall.

Conservation kits may be distributed door-to-door, mailed, or made available for pick up at designated locations. They can also be given out as part of an indoor water audit. Most programs rely on the participant to install the devices, but some offer free or reduced-cost installation to elderly and handicapped customers, or to all customers. The value of assisting customers with installation depends on the difficulty of installing the product. Retrofit programs, which include installation, are often focused on ULFTs or high efficiency washing machines. Irrigation system modifications may require professional assistance for proper installation as well.

The devices are generally quite inexpensive, but unless they are installed by users, they achieve no water savings at all. The method of distribution, the public outreach accompanying the effort, and the level of follow-up can all affect how many households receive the kits, how many install them, and how many leave them in place. Methods requiring more motivation from the customer are likely to result in lower numbers distributed but higher rates of installation and retention. The quality and effectiveness of the items themselves are also very important factors in determining customer satisfaction (and hence retention) and the magnitude of the water savings. It may be worth conducting a customer preference study to determine which model of showerhead, for example, will be most well-received (the Seattle Water Department did this and felt that the high-quality product offered was the strongest factor encouraging customers to participate).[80] Follow-up to ensure that devices have been installed properly can also improve effectiveness.

BASICS OF PROGRAM EVALUATION

Water conservation program managers need ways to select between conservation measures and ways to evaluate the effectiveness of the programs that are selected in order to tailor initiatives to community needs, identify the most successful programs, and ensure that investments in peak demand reduction measures are used wisely. Evaluations can include process evaluation (assessing operational efficiency), impact evaluation (assessing changes in water use attributable to the program), and cost-benefit or cost-effectiveness analysis.

Types of Evaluation

Process evaluation measures how well the program is run, and looks for ways to improve program management. Process evaluation will require assembling information on the program procedures, participants, activities, and costs. A survey of participants can offer valuable insights for process evaluation.[81]

Impact evaluation is intended to measure water conservation savings, and will require detailed information on water use. Data collected to evaluate water savings can include surveys, billing histories of individual customers, and billing summaries by customer class. Data from before and after program implementation for participants and non-participants will be needed in order compare the differences. Impact evaluation does not consider program costs, only the outcomes.

Assessing program impacts is very important, but measuring impacts against costs is also key in order to ensure that money is spent wisely on conservation programs. The simplest way to do this is with cost-effectiveness analysis, which measures cost per unit of benefit – in this case, cost per unit of water conserved. A cost-benefit analysis, which translates water savings and other benefits into dollar values and compares them against the dollar values of the costs, is another valuable tool, but it requires assigning monetary value to water savings and environmental benefits. This can be a challenge, and the value assigned to these benefits can determine the outcome of the analysis. For this reason it may be easier to focus on cost-effectiveness analysis, so that only costs and water savings must be quantified.

Data and Measurement

The challenge of program evaluation of any kind is in estimating ahead of time and quantifying afterwards the program costs and conservation benefits. The best way to estimate program costs and water savings is with data from other similar programs. This data may not be directly applicable to program evaluation in another situation, but it can still provide a valuable reference on the scale of impacts and the methods used to evaluate them. Unfortunately, since few water conservation programs have quantified their achievements and even comprehensive accounting of costs is not universal, there is little to draw from. This makes collecting data and evaluating program success during the program even more important. Program analysis can be costly and time-consuming, but there are relatively simple methods that can provide valuable feedback.

Collecting Water User Data

While collecting data from all participants in a given program may not be feasible, collecting data from a few may be enough. With a group of 30 to 50 participants, program managers can measure water savings relatively cheaply. More participants included means stronger results, but some is better than none.

To ensure that the observed water savings are a result of the program and not of other factors, matching the group of participants with a group of non-participants that is as similar as possible can help isolate program impacts. Each participating customer should ideally be matched with one or more non-participating customers who share as many characteristics as it is feasible to evaluate. For residential programs, selecting a "control" household from the same neighborhood may be good enough if additional information is not

available.[82] Assembling a control group so that the two groups' aggregate characteristics roughly match is another way to deal with this.

Once the study groups have been identified, individual data must be collected, such as water use information extracted from billing histories and impressions and behavioral information drawn from surveys.

Assessing program costs

Program cost estimates must come from one of three perspectives: the water supplier perspective, the customer perspective, or the societal perspective. For example, a rebate represents a cost to the water supplier but a benefit to the customer, resulting in a net zero transfer from the societal perspective.

After selecting an appropriate costing perspective (and checking for cost analyses of conservation programs at other water agencies), the next step is to identify the program costs that will drive the analysis and have the greatest impact on the overall cost. This allows the analyst to focus on those costs that matter most.

The analysis must account for both in-house and contracted costs. In house costs may include administration cost, field labor, publicity, rebates or financial incentives, unit costs for goods provided, and follow-up. Some tips for collecting cost information:

- In-house staff costs may be difficult to quantify if the amount of staff time dedicated to the project is not closely tracked, but an educated guess will do if better information is not available.
- Contracted costs are easier to arrive at since they are typically specified in the contract.
- Material costs are also straightforward as the unit cost of the items is available from manufacturers or distributors.
- Publicity costs can be easily estimated based on the cost of any media advertising, and the costs of designing and printing any original flyers, brochures, or similar.[83]

Once cost information has been collected, the next step is to note when the costs will be incurred. A dollar spent today is not comparable to a dollar spent ten years from now, so the future costs must be discounted to make them equivalent.[84] (Future dollars are discounted because if you spend the dollar later, you can earn interest on it in the years before you have to spend it, and if you receive the dollar later, you can't earn interest on it in the years before you receive it.) The discounted costs can then be summed to arrive at the total present cost of the program. For cost-effectiveness analysis, this will be compared against the total water savings attributed to the program. For cost-benefit analysis, this will be compared against the assessed dollar value of those water savings.

Further Information

Additional explanation of discounting, cost-benefit analysis, cost-effectiveness analysis, and other evaluation methods is beyond the scope of this document. For more information, please see:

> David M. Pekelney, et. al, "Cost-Effective Cost-Effectiveness: Quantifying Conservation on the Cheap," presented June 26, 1996 at the AWWA national conference in Toronto, Canada; or
>
> Planning and Management Consultants, Ltd., *Evaluation of Urban Water Conservation Programs: A Procedures Manual*, Prepared for California Urban Water Agencies, February 1992;

both available from the California Urban Water Conservation Council at www.cuwcc.org/publications.

APPENDIX A: RECOMMENDED ELEMENTS OF WATER-EFFICIENT LANDSCAPING

The following set of recommendations for water-efficient landscaping design, construction, and maintenance comes from the Massachusetts Water Resources Commission's *Guide to Lawn and Landscape Water Conservation* (p. 19-23). Additional resources offering best practices for landscaping and irrigation are listed in the next section.

ELEMENTS OF WATER EFFICIENT LANDSCAPING: DESIGN, CONSTRUCTION, AND MAINTENANCE

The following elements of landscaping are provided to help water suppliers and municipalities educate their residential and commercial water users on how they can develop and maintain an aesthetically pleasing landscape that uses little or no water. These guidelines can be used by all types of property owners to ensure that work to build new or restore existing landscapes is done in a manner to minimize water use.

Landscape Design: The Most Important Step – Reduce Lawn Area

When planning a landscape, consider how it will be used, what space and site attributes are necessary, and how much work and resources will be required for maintenance. These recommendations are appropriate for a relatively low maintenance, residential landscape.

- Minimize lawn size and maintain existing native vegetation when designing landscapes. Consider alternatives to grass, especially for steep slopes, shady areas, and near streams and ponds, where grass is difficult to maintain.
- Use drought resistant and native species of grasses. Generally, an insect resistant mixture of grasses that includes a high percentage of fine fescues will ensure a drought tolerant lawn. For more information regarding the appropriate grasses for site-specific conditions contact the Massachusetts Horticultural Society Master Gardener Hotline at (781) 235-2116.
- Some native species of shrubs, trees, and wildflowers are drought tolerant. Planting these species will create wildlife habitat and build a more drought resistant landscape. For information regarding the appropriate native species for site specific conditions contact the Massachusetts Horticultural Society Master Gardener Hotline at (781) 235-2116. Additionally, shrubs and trees create shade that helps to keep lawns green during hot, dry weather.
- Be aware of the various zones in your yard (hot/sunny, cool/shady, moist, or dry) and choose plants according to the conditions. Sloping grass areas (i.e., areas with a 6% slope or greater) tend to be difficult to maintain due to water runoff and mowing difficulty and might best be planted with a drought resistant ground cover.
- Cluster plants that require extra care together to save time and water by watering just one area.
- Design contours or "grades" in the landscape to prevent water from draining to areas off the site.

Landscape Construction: Please Don't Call It "Dirt"

A key factor in constructing a low water use landscape is to have proper soil conditions for the landscape. Landscapes on poor and shallow soils can be extremely water intensive because root systems remain shallow and require increased water to survive during summer months. Also, poor soils are unable to absorb and hold water, resulting in high water run-off that does not benefit the landscape. Finally, adequate organic material in the soil not only helps to hold water, but provides a source of nutrients for the plants.

Soil is a complex mixture of minerals, organic matter, microorganisms, water, and air. As the foundation of the landscape, the type and quality of the soil directly influences water use. It is important to know the composition of the soil in order to improve it. There are 3 broad categories of soil:

- A clay soil consists of small particles, is slow to absorb water, has good water retention, and has poor drainage capacity.
- A sand soil consists of large particles, absorbs water quickly, retains water poorly, and drains well.
- A silt soil consists of medium particles, absorbs water quickly, has moderate retention and drainage capacity, and is ideal for most gardens.

For more information on the composition of the soils on residential properties, the University of Massachusetts'

Extension Service offers a wide variety of soil test options that range in cost from $3.00 to $30.00. Call the UMass Extension Soil Testing Lab (413) 545-2311 or through their web site at www.umass.edu/plsoils/soiltest.

- Add compost or an organic material as necessary, preferably adding it to soil to a depth of 6”- 8” inches for grass areas and 12” to 18” inches for shrub and tree areas to improve soil conditions and water retention. Organic soils can hold water significantly longer than sandy soils.
- Use mulch in flower beds and around shrubs and trees to minimize evaporation, reduce weed growth, and decrease erosion.

Landscape Maintenance: Don’t Be A Slave To Your Lawn

Watering

Lawn watering accounts for the majority of landscape water use. Maintaining adequate water supplies during summer months has become a critical problem for many Massachusetts communities causing some towns to impose annual restrictions on outdoor water use. Citizens should be aware of the situation and should strive to conserve water at every opportunity.

- Abide by water restrictions and other conservation measures put into effect by the municipality or water supplier.
- Lawns should only be watered when necessary, generally no more than once per week. The rule of thumb is to apply an inch of water (from all sources, both natural and watering) to the lawn. An easy way to measure this by putting out one or more shallow containers and then measuring the depth of the water collected. To determine when to water, walk across the lawn and look for footprints. If the grass springs up after being walked on, it does not need to be watered.
- If watering is necessary, watering techniques (especially the length of time spent watering) should be matched to soil needs. Watering slowly and deeply during the spring and fall months will allow the water to be absorbed and will train grass roots to grow deeply (grass is generally not growing in the summer, so deep water does not promote root growth at this time); frequent shallow watering results in root systems that stay near the surface making the lawn drought intolerant. Ideally, root zone areas of a lawn should be thoroughly moistened during watering.
- Water between sunset and early morning to reduce evaporation. Avoid watering at night if disease is present and actively damaging the lawn or during periods of very hot humid weather.
- In newly seeded lawns, keep soil moist, but beware of overwatering.
- Install shutoff nozzles on hoses to prevent water loss from unattended hoses. Hoses without a nozzle can spout 10 gallons or more per minute.
- Use drip irrigation systems to deliver water more efficiently to flower beds, shrubs, vegetable gardens, and newly planted trees.
- Use cisterns or rain barrels to capture and recycle rain water from downspouts to use for flower beds, shrubs, and newly planted trees. Use a lid, mesh fabric or several drops of baby oil on the surface of the water to prevent mosquitoes from breeding.

Recommendations for Automatic Irrigation Systems:

The growing proliferation of automatic irrigation systems is part of the cause of increasing summertime water demands. While communities with severe water shortages should consider a moratorium on the installation of these systems, other communities should work to ensure that their use promotes efficient water use. For property managers and owners in these communities:

- Determine the best irrigation system to fit lawn size and configuration. Install matched precipitation sprinkler heads and keep them in good repair. Matched precipitation sprinkler heads are designed and installed to apply irrigation water to a particular region in site specific quantities according to landscape needs. These systems ensure that one area of the landscape is not overwatered while another is underwatered. Check the sprinkler heads frequently for proper direction and even spray pattern. Use the controller to adjust the system according to seasonal and climate changes and reschedule the controller if runoff occurs. An irrigation system’s efficiency is measured by what is called the coefficient of uniformity (CU). A highly efficient CU ranges from .75-.85.
- Consider installing a controller with the following features:
  - At least two independent programs to allow watering different parts of the yard on different days;
  - Station run times from one to 99 minutes;
  - Two start times per program;
  - Odd, even, weekly, and interval program capability up to 30 days; and

    - Rain shutoff device capability.
- Install a rain shutoff device on the irrigation system. Ensure that the shutoff device is adjusted to shut off the system after only a small amount of rain, generally 1/8 of an inch.
- Install a master valve that is connected directly to the system control timer that prevents any water from entering the system when it is not running. This can prevent water loss from leaks in the system. Check valves on sprinkler heads can also prevent water from draining from low sections of the system.
- Install flow-sensing devices that detect excess flow that may be the result of a broken sprinkler head or pipe.
- Use drip irrigation systems to deliver water more efficiently to flower beds, shrubs, vegetable gardens, and newly planted trees.
- Locate irrigation heads at least eight inches from paved areas and ensure they are directed only to landscape areas. Locating heads too close to pavement or misdirected sprinkler heads result in wasted water.
- Repair broken sprinkler heads (which can waste up to twelve gallons per minute).
- Turn off the irrigation system if runoff occurs and allow the soil to absorb the water.
- Set controllers to water between sunset and early morning and adjust them bi-monthly to correct run times. Controllers need to be rescheduled to account for current weather conditions and for seasonal changes.
- Undertake a irrigation system audit every one to two years to ensure the system is working properly.

Recommendations for Property Owners and Managers Using Private Wells or Water Sources:

The use of private wells for lawn and landscape watering can reduce demands on public systems and therefore help water suppliers avoid the impacts that large peak demands can cause. However, property owners and managers who use water from private wells or other private sources should follow the same practices as those on public systems in order to minimize water use for lawn and landscape watering purposes. In addition, property owners and managers should closely monitor whether their water withdrawals are having negative environmental impacts and reduce use accordingly. In particular, users of private water sources should:

- Abide by water restrictions and other conservation measures put into effect by the municipality or water supplier. This is particularly true if the private well is located in the zone of contribution to the municipal groundwater supply, is within the watershed of a surface water supply and if the local restrictions are caused by dry conditions rather than a water shortage caused by a system problem.
- Users of private water sources should not hook up pumps to withdraw water directly from any small ponds/lakes, streams, or rivers. These withdrawals can have negative environmental impacts, including impacts to fisheries and wildlife resources, particularly if multiple properties are drawing water from these surface water bodies.

Mowing

Mow lawns at the highest recommended height and do not mow when grass is under drought stress. A lawn's ideal length will vary with the type of grass, but many turf grass species are healthiest when kept to a height of at least 2-1/2 to 3 inches. Longer grass has more leaf surface to take in sunlight allowing it to grow thicker and develop a deeper root system, which in turn helps the grass survive drought, tolerate insect damage, and fend off diseases. Longer grass also shades the soil surface keeping it cooler, helping it retain moisture, and making it difficult for weeds to germinate and grow.

- Mow often enough that you never cut more than one-third of the height of the grass blades.
- Keep lawnmower blades sharp. Dull mower blades tear the grass blade and create a brownish appearance of the turf and may make it more susceptible to pests and diseases.

Soil Maintenance

- Aerate compacted soils to improve lawn rooting and moisture absorption. Compacted soil inhibits lawn rooting and water absorption. Options to improve rooting and counteract compaction include the use of mechanical core aerators: create holes by pulling out plugs of soil to improve rooting and water absorption. Aerators can be rented or used by a lawn care professional.
- Leaving grass clippings to decompose into the soil can both add organic matter and nutrients to the soil.

Additional Resources on Landscaping and Irrigation Best Practices

The following set of resources provide additional guidance on best practices for landscaping and irrigation.

North and South Rivers Watershed Association, ***Greenscapes Reference Guidebook*** (www.greenscapes.org/guidebook): offers tips on mowing, watering, automatic irrigation systems, low maintenance plants, managing stormwater, rain gardens, fertilizer and pesticide alternatives, and composting.

U.S. Environmental Protection Agency, Greenacres ***Sourcebook on Natural Landscaping for Public Officials*** (http://epa.gov/greenacres/toolkit/): describes the benefits of natural landscaping, the role of local officials, and offers a "how-to" guide for natural landscaping.

Massachusetts Water Resources Authority, ***Garden and Landscaping Water Conservation Tips*** (http://www.mwra.state.ma.us/04water/html/gardening.htm): offers tips on lawn watering, irrigation systems, and soil preparation.

Massachusetts Department of Environmental Protection, ***Lawns and Landscapes in Your Watershed*** (www.mass.gov/dep/images/lawn.pdf): describes the impact of lawn care on watershed health, and offers guidance on lawn and landscape design and maintenance for low water and fertilizer needs.

U.S. Environmental Protection Agency, ***Water Efficient Landscaping Guide*** (www.epa.gov/owm/water-efficiency/final_final.pdf): describes principles of water-efficient landscaping, offers guidance on water-efficient landscaping and irrigation, and provides examples of successful projects.

Irrigation Association – Water Management Committee ***Turf and Landscape Irrigation Best Management Practices*** (available from www.irrigation.org): describe best practices for design, installation, maintenance, and management of irrigation systems; also offer implementation recommendations

UMass Extension – Landscape, Nursery, and Urban Forestry Program: offers a variety of fact sheets on landscaping and watering techniques and drought-resistant plant lists - http://www.umassgreeninfo.org/fact_sheets/plantculture.html

APPENDIX B: DEP MODEL WATER USE RESTRICTION BY-LAW

Prepared by the Massachusetts Department of Environmental Protection

This is a model provided by the Department of Environmental Protection for use by municipalities in developing their own by-laws to regulate the use of water supplied by a municipal water system. It is for communities wishing to establish enforceable limitations on the use of water during temporary periods of high water demand by controlling outdoor watering, swimming pool filling and/or non-commercial car washing. If properly enacted, the municipal by-law will enable municipal water systems to control and mitigate periods of high demand - with an associated stressed water supply - typically occurring during the summer months. The restrictions included in the by-law include odd/even day outdoor watering, hand held hose watering only, limited outdoor watering hours, outdoor watering bans, and prohibitions on filling swimming pools and the use of automatic sprinkler systems. Persons violating the by-law's restrictions are subject to civil fines. The Department believes it is important for municipalities to consider exemption procedures for the restrictions included within their by-law. These, or other exemptions may be appropriate due to the economic or public health impact of water use restrictions on specific industry sectors when such restrictions may result in crop or animal loss or when they would prevent use of indoor or outdoor pools at medical or rehabilitation facilities. Municipalities should give careful consideration to the type of uses granted exemptions and should consider conditioning those exemptions to ensure that those granted exemptions are operating in a water efficient manner.

If a municipality is experiencing complex system problems affecting its ability to consistently provide an adequate supply of water, implementing the model by-law may not address the problem. In that case, a declaration of water supply emergency under M.G.L. c.21G, §15-17 should be requested from the Department. After implementation of any state of water supply conservation, the Department by regulation (310 CMR 22.15(8)(a) must be notified in writing within 14 days of the implementation of restrictions.

Local requirements for adopting by-laws may vary according to the terms of individual municipal charters. Consultation with town counsel is strongly advised before adopting any by-law. The Department makes no representation concerning the legal effect or validity of this model.

CONSULT WITH YOUR TOWN COUNSEL TO INSURE ADOPTION OF AN APPROPRIATE, ENFORCEABLE AND LEGALLY VALID BY-LAW THAT WILL MEET YOUR MUNICIPAL NEEDS.

Section 1 Authority
This By-law is adopted by the Town under its police powers pursuant to the \ Home Rule Amendment of the Massachusetts Constitution, Article LXXXIX, to protect public health and welfare and its powers pursuant to M.G.L. c.40, §§21 et seq. and implements the Town's authority to regulate water use pursuant to M.G.L. c. 41, §69B. This by-law also implements the Town's authority under M.G.L. c. 40, §41A, conditioned upon a declaration of water supply emergency issued by the Department of Environmental Protection.

Section 2 Purpose
The purpose of this by-law is to protect, preserve and maintain the public health, safety and welfare whenever there is in force a State of Water Supply Conservation or State of Water Supply Emergency by providing for enforcement of any duly imposed restrictions, requirements, provisions or conditions imposed by the Town or by the Department of Environmental Protection.

Section 3 Definitions
Agriculture shall mean farming in all its branches and agriculture, as defined at M.G.L. c. 128, § 1A.

Outdoor watering shall mean any residential, municipal, industrial, or commercial watering of decorative lawns, trees or shrubbery.

Person shall mean any individual, corporation trust, partnership, association, agency or authority, or other entity and any officer, employee, group or agent of such persons.

State of Water Supply Emergency shall mean a State of Water Supply Emergency declared by the Department of Environmental Protection under M.G.L. c.21G, §15-17.

State of Water Supply Conservation shall mean a State of Water Supply Conservation declared by the Town pursuant to section 4 of this by-law.

Water Users or Water Consumers shall mean all persons using water from the Town's public water source irrespective of that person's responsibility for billing purposes for use of the water.

Section 4 Declaration of a State of Water Supply Conservation
The Town, through its Board of Water Commissioners or selectmen authorized to act as such, may declare a State of Water Supply Conservation upon a determination by a majority vote of the Board that a shortage of water exists of such a degree that conservation measures are appropriate to ensure an adequate supply of water to all water consumers. Public notice of a State of Water Conservation shall be given under section 6 of this by-law before it may be enforced.

Section 5 Restricted Water Uses
A declaration of a State of Water Supply Conservation shall include one or more of the following restrictions, conditions, or requirements limiting the use of water as necessary to protect the water supply except as provided in Section 11. The applicable restrictions, conditions or requirements shall be included in the public notice required under section 6.

a) Odd/Even Day Outdoor Watering: Outdoor watering on property having an odd numbered address is restricted to odd numbered days. Outdoor watering on property having an even numbered address is restricted to even numbered days.

(*Odd/even day watering and off peak watering generally does not reduce overall water demand (and may actually increase overall demand), but can reduce peak demands.*

Such a restriction is only useful when the system generally has sufficient water quantity, but has system limitations in meeting peak demands)., or

Off-Peak Outdoor Watering: Outdoor watering is limited to between *** hours on *** days (specify particular hours and days). (*In general, restricting outdoor water use to between sunset and early morning is best for turf needs and coincides with off peak hours for many water supply systems. Systems may choose to restrict water use to one or two days per week during specified hours.)*

b) Outdoor Watering Method Restriction: Outdoor watering is restricted to bucket, can or hand held hose watering with automatic shutoff nozzle.

c) Outdoor Watering Ban: Outdoor watering is prohibited.

d) Outdoor Watering Hours: Outdoor watering is permitted only during daily periods of low demand, to be specified in the declaration of a State of Water Supply Conservation and public notice thereof.

e) Swimming Pools: Filling and topping off of swimming pools is prohibited.

f) Automatic Sprinkler Use: The use of automatic sprinkler systems is prohibited.

g) Car washing: Car or vehicle washing is prohibited.

Section 6 Public Notification of a State of Water Supply Conservation and State of Water Supply Emergency; Notification of DEP
Notification of any provision, including any restriction, requirement or condition imposed by the Town as part of a State of Water Supply Conservation shall be published in a newspaper of general circulation within the Town, or by such other means reasonably calculated to reach and inform all users of water of the State of Water Supply Conservation. Notification of a State of Water Supply Emergency declared by the Department shall be provided by furnishing a copy of the Notice to radio and television stations serving the area served by the public water system as soon as possible, but no later than 48 hours after the public water system receives notice of the Department's declaration. Any restriction imposed under section 5 or in the Department declaration of emergency or Order shall not be effective until such notification is provided. Notification of the State of Water Supply Conservation shall also be provided to the Massachusetts Department of Environmental Protection at the same time that notification is given.

Section 7 Termination of a State of Water Supply Conservation; Notice
A State of Water Supply Conservation may be terminated by a majority vote of the Board of Water Commissioners upon a determination that the water supply shortage no longer exists. Public notification of the termination of a State of Water Supply Conservation shall be given in the same manner as is required for notice of the Town's declaration of its State of Water Supply Conservation.

Section 8 State of Water Supply Emergency; Compliance with DEP Orders
Upon notification to the public that a declaration of a State of Water Supply Emergency has been issued by the Department of Environmental Protection, no person shall violate any provision, restriction, requirement, condition of any order approved or issued by the Department for the purpose of bringing about an end to the State of Water Supply Emergency. The notice prescribed by this section shall be in writing and shall be published once in a newspaper of general circulation within the town where it is to be effective. Such notice shall summarize the provisions of the Declaration of Water Supply Emergency and the requirements and conditions thereof. Notice as prescribed by this section shall be sufficient for enforcement of the requirements of such Declaration on and after the date following newspaper publication.

Section 9 Penalties
The Town, through its Water Commissioner, water superintendent, building inspector or local police may enforce this by-law(ordinance) Any person violating this bylaw(ordinance) shall be liable to the Town in the amount of $ ___.__for the first violation and $ ___.__for each subsequent. Fines shall be recovered by indictment, or on complaint before the District Court, or by non-criminal disposition in accordance with section 21D of chapter 40 of the general laws.

Section 10 Severability
The invalidity of any portion or provision of this by-law shall not invalidate any other portion or provision thereof.

Section 11 Exemptions
The water use restrictions adopted under this by-law shall not apply to the specific uses outlined below provided the user meets any applicable eligibility criteria. The Department suggests that municipalities develop a specific procedure for granting those exemptions.
(The Department suggests that exemptions may be appropriate for the following uses:)

a. Commercial agriculture;

b. Water to sustain animal life;

c. Swimming pools used as a primary means of exercise, therapy or rehabilitation located at a medical or rehabilitation facility;

d. Commercial car or vehicle washing facilities;

(In granting exemptions, municipalities should assess whether the user being granted the exemption is using the water efficiently. The municipality may want to condition exemptions to include specific conservation measures. For example, the municipality may want to consult with the United States Department of Agriculture's Natural Resource Conservation Service, to confirm that agricultural users seeking exemptions are using the best management practices available or will commit to adopting such practices as soon as feasible.)

1 The terms "town" and "by-law" used throughout this document are intended to also refer to cities and ordinances, respectively.

2 References to Boards of Water Commissioners throughout this by-law should be edited by particular Cities and Towns to accurately describe the municipal department or board having responsibility for the operation and maintenance of the water supply system.

APPENDIX C: DANVERS & MIDDLETON WATER USE RESTRICTIONS

Massachusetts Department of Environmental Protection, Modified Water Withdrawal Permit, Permitees: Town of Danvers & Town of Middleton, PERMIT NUMBER: 9P-3-17-071.01, MODIFICATION DATE: March 23, 2006

Level 1 - Normal Winter Conditions (Oct. 1st to April 30th)

Level 2 - Seasonal Conditions (May 1st to September 30th)

Measures	Triggers to Implement
No Outdoor Watering between the hours of: 8:00 AM and 7:00 PM	In effect May 1st to September 30th each year.

Level 3 - Drought Condition

Measures	Triggers to Implement
Increased Public Education Outdoor watering allowed 3 days a week ONLY **No** Outdoor Watering between the hours of: 8:00 AM and 7:00 PM	Drought Management Plan (DMP)*- Mild Drought Stage or River Flow Level Below 0.67 cfsm.

Level 4 - Drought Condition

Measures	Triggers to Implement
Shut Off Well 1 & Well 2 Outdoor watering allowed 2 days a week Outdoor watering between the hours of: 7:00 PM and 10:00 PM ONLY	River Flow Below 0.42 cfsm and DMP* Mild Stage or Normal Stage

Level 5 - Drought Condition

Measures	Triggers to Implement
Increased Public Education Outdoor watering by hand held hoses & cans ONLY Hand Held Watering ONLY from 7:00PM to 8:00AM No filling of Swimming Pools No washing of cars.	DMP* Moderate Drought Stage & River Flow Below 0.42 cfsm or DMP* Mild Stage & River Flow Below 0.34cfsm

Level 6 - Drought Condition

Measures	Triggers to Implement
No Outside Water Use	DMP* Severe Drought Stage & River Flow Below 0.34 cfs.

Emergency Drought Conditions

Measures	Triggers to Implement
Purchase Water from outside sources (if available) and No Outside Water Use. (Purchased water to meet demand only, no replenishment of sources allowed.)	DMP* Emergency Drought Stage

APPENDIX D: MIDDLETON WATER USE RESTRICTION BY-LAWS

Code of the Town of Middleton, Massachusetts

Article 23:

Part Two – Prudential Affairs and Internal Police

Chapter V - Water Conservation

Section 1: Water Use Restriction
Preamble: The Middleton Board of Selectmen proposes the following By-law to create a balance between the needs of the environment, the citizens of Middleton and the drinking water supply. The Town is aware of the concerns about lower ground water levels in the Ipswich River Watershed Basin and the potential demand on its water resources during the dry summer months. The Town also recognizes the therapeutic, esthetic, and environmental benefits that gardening, landscaping and greenery brings to the community. It is the intent of this By-law to permit residents to maintain their properties, while not overburdening Town water supplies, the water distribution system and to make a positive contribution to the environment. All Middleton residents that are either customers of the public water supply system or private well users shall be subject to this by-law in order to preserve and maintain the Ipswich Watershed Basin.

Subsection (a): Authority
This By-law is adopted by the Town of Middleton under its police powers to protect public health and welfare and its powers under M.G.L c.40. Sec.21 et seq. and implements the Town's authority to regulate water use pursuant to M.G.L. c.41, Sec.69B. This By-law also implements the Town's authority under M.G.L. c.40, Sec.41A, conditioned upon a declaration of water supply emergency issued by the Department of Environmental Protection.

Subsection (b): Purpose
The purpose of this By-law is to protect, preserve and maintain the public health, safety and welfare whenever there is in force a State of Water Supply Conservation or State of Water Supply Emergency by providing for enforcement of any duly imposed restrictions, requirements, provisions or conditions imposed by the Town or the Department of Environmental Protection.

Subsection (c): Definitions
Person shall mean any individual, corporation trust, partnership or association, or other entity.

State of Water Supply Emergency shall mean a State of Water Supply Emergency declared by the Department of Environmental Protection under M.G.L. c.21G, Sec.15-17.

State of Water Supply Conservation shall mean a State of Water Supply Conservation declared by the Middleton Board of Selectmen pursuant to subsection (d) of this By-law.

Water Users or Water Consumers shall mean all public and private users of the Town's public water system and Ipswich River Watershed, irrespective of any person's responsibility for billing purposes for water used at any particular facility.

Subsection (d): Declaration of State of Water Supply Conservation
The Town of Middleton, through its Board of Selectmen, may declare a State of Water Supply Conservation upon a determination by a majority vote of the Board that a shortage of water exists and conservation measures are appropriate to ensure an adequate supply of water to all water consumers. Public notice of a State of Water Supply Conservation shall be given under section (f) of this By-law before it may be enforced.

Subsection (e): Restricted Water Uses
A declaration of a State of Water Supply Conservation shall include one or more of the following restrictions, conditions, or requirements limiting the use of water as necessary to protect the water supply. The applicable restrictions shall be included in the public notice required under section (f).

a). Restricted Days and Times for Outdoor Watering: Outdoor watering by water users is restricted to days and times as determined by the Town of Middleton's Board of Selectmen, except those business and commercial agricultural users exempted by the Selectmen.
b). Outdoor Watering Ban: Outdoors watering is prohibited.
c). Filling of Swimming Pools: Filling of swimming pools is prohibited except by commercial tankers.
d). Washing of Cars: Washing of cars is prohibited.
e). Automatic Sprinkler Use: The use of automatic sprinklers is prohibited.

Subsection (f): Public Notification of a State of Water Supply Conservation; Notification of DEP
Notification of any provision, restriction, requirement or condition imposed by the Town as part of a State of Water Supply Conservation shall be published in a newspaper of general circulation within the Town, or by such other means reasonably calculated to reach and inform all users of water of the State of Water Supply Conservation. Any restriction imposed under section (e) shall not be effective until such notification is provided. Notification of a State of Water Supply Conservation shall also be simultaneously provided to the Massachusetts Department of Environmental Protection.

Subsection (g): Termination of a State of Water Supply Conservation; Notice
A State of Water Supply Conservation may be terminated by a majority vote of the Board of Selectmen, upon a determination that the water supply shortage no longer exists. Public notification of the termination of a State of Water Supply Conservation shall be given in the same manner required by section (f).

Subsection (h): State of Water Supply Emergency; Compliance with DEP Orders
Upon notification to the public that a declaration of a State of Water Supply Emergency has been issued by the Department of Environmental Protection, no person shall violate any provision, restriction, condition of any order approved or issued by the Department intended to bring about an end to the State of Emergency.

Exemptions: Exemptions from this By-law will be permitted if watering is done through drip irrigation hoses or other devices that use subsurface applications and prevent the water from being evaporated through direct contact with the atmosphere, through the use of water from cisterns and rain barrels, that derive their water directly from precipitation, recycled water, storm water run off, gray water or water not directly from ground or surface water supplies or the public water system.

Subsection (i): Penalties
Any person violating this By-law shall be liable to the Town of Middleton in the amount of $50.00 for the first violation and $100.00 for each subsequent violation. Fines shall be recovered by indictment, or on complaint before the Salem District Court, or by noncriminal disposition in accordance with Section 21D of Chapter 40 of the Massachusetts General Laws. Each day of violation shall constitute a separate offense.

Subsection (j): Severability
The invalidity of any portion or provision of this By-law shall not invalidate any other portion or provision thereof.

Article 22:

Part Two - Prudential Affairs and Internal Police

Chapter V - Water Conservation

Section 2: Irrigation/Outside Watering
Preamble: The Middleton Board of Selectmen proposes the following By-law in an effort to promote water conservation, reduce seasonal water usage and attain the benchmark water consumption standard of 65 gallons of water per capita as required under the Modified Water Withdrawal Permit Number 9P-3-17-071.01, et. al, pursuant to the Water Management Act under Massachusetts General Laws Chapter 21G and governed by the Massachusetts Department of Environmental Protection. All Middleton residents that are either customers of the public water supply system or private well users shall be subject to this By-law in order to preserve and maintain the Ipswich Watershed Basin. All land within the Middleton municipal boundaries drain to the Ipswich Watershed Basin and are thus part of said basin.

Subsection (a): Irrigation/ Outside Water Usage
This By-law is in effect from May 1st to September 30th of each year. This time period may be extended or decreased by majority vote of the Board of Selectmen, as they deem necessary, taking various conditions into consideration, including but not limited to weather, protection of both the Town's water supply and the Ipswich Watershed Basin and compliance with Commonwealth regulations.

This By-law is automatically superseded in the event of a declaration of a State of Water Supply Conservation or a State of Water Supply Emergency, described in the Water Use Restriction By-Law.

It is unlawful to undertake outside watering of vegetation between the hours of 8:00 AM to 7:00 PM using town water or private well water through a sprinkler or lawn irrigation system.

All water hoses shall be controlled by a nozzle or other device used to regulate the flow of water leaving the hose. No use of an open-ended hose will be permitted with the exception of filling or topping off of swimming pools.

All outside spigots, especially those used for filling pools or applying chemicals through hose attachments shall be retrofitted with an anti-siphon device to prevent backsiphonage onto the public water supply or the household water supply within 6 (six) months from the date of enacting this By-law.

All new automatic underground irrigation systems shall have moisture sensors installed as part of the system to prevent unnecessary watering. All existing automatic underground irrigation systems shall have moisture sensors installed as part of the system within 3 (three) years from the date of enactment of this By-law.

Subsection (b): Penalties
First Violation: The Department of Public Works will deliver a copy of the By-law to the offending water user and record such violation for both future reference and/or violations.

Second Violation: Any person violating this By-law for a second time in a calendar year shall be liable to the Town of Middleton in the amount of $50.00.

Third and Subsequent Violations: Any person violating this By-law for the third or subsequent time in a calendar year shall be liable to the Town of Middleton in the amount of $100.00 for each violation.

Fines shall be recovered by indictment, or on complaint before the Salem District Court, or by non-criminal disposition in accordance with Section 21D of Chapter 40 of the Massachusetts General Laws. Each day of violation shall constitute a separate offense

APPENDIX E: TOWN OF WAYLAND IRRIGATION SYSTEM REQUIREMENTS

Code of the Town of Wayland, Massachusetts, Division I, Part II, Article 191.

[HISTORY: Adopted by the Annual Town Meeting of the Town of Wayland 4-3-2003 by Art. 24. Amendments noted where applicable.]

GENERAL REFERENCES

Water -- See Ch. 190.

Water Department Regulations -- See Division 4.

§ 191-1. Statutory authority.
This bylaw is adopted by the Town of Wayland under its common law police powers to protect public health and welfare, MGL c. 40, § 21, and under the Town of Wayland's authority to regulate water use through its Board of Water Commissioners pursuant to Chapter 80 of the Acts of 1878.

§ 191-2. Purpose.
The purpose of this bylaw is to protect, preserve and maintain the public water supply, health, safety and welfare of the citizens of the Town of Wayland.

§ 191-3. Definitions.
As used in this bylaw, the following terms shall have the meanings indicated:

OUTDOOR UNDERGROUND WATER SPRINKLER SYSTEM -- Any underground sprinkler device, together with all pipes appurtenant thereto, used to water outside areas, and hereafter referred to as "system" or "systems." Aboveground sprinklers attached to hoses and existing systems, so long as they are not expanded, are specifically exempt from the provisions of this article.

PERSON -- Any individual, corporation, trust, partnership or association or other entity.

PUBLIC WATER SUPPLY -- Any water which is fully or partially drawn from a well operated by the Town of Wayland.

THIS BYLAW -- Chapter 191 of the Code of the Town of Wayland.

WATER CUSTOMER -- Any individual, corporation, trust, partnership or association or other entity that owns property which is receiving water from the public water supply.

§ 191-4. Certain outdoor underground water sprinkler systems prohibited.
No person shall install or expand a system which is connected to the public water supply if said system, after installation or expansion covers, an area greater than 15,000 square feet or more.

§ 191-5. Application for installation or expansion of certain systems.
No person shall install or expand a system connected to the public water supply, which covers an area of 15,000 square feet or less unless an application has been made to pursuant to this bylaw and approval of said installation or expansion has been approved pursuant to this bylaw.

§ 191-6. Types of applications.

A. Any application for the installation or expansion of a system which covers an area of 5,000 square feet or less shall be made by completing the short-form application.

B. Applications for the installation or expansion of a system which covers an area of more than 5,000 square feet and less than or equal to 15,000 square feet shall be made by completing the long-form application.

§ 191-7. System requirements.

A. All systems installed or expanded under this bylaw shall be installed or expanded pursuant to all local and state laws and regulations and shall include a backflow device (approved by the Wayland Water Department), a rain gauge, a moisture detector, a programmable automatic timer and a shut-off valve.

B. All systems installed or expanded under this bylaw shall obtain an appropriate plumbing permit from the Gas and Plumbing Inspector of the Town of Wayland.

C. All systems installed or expanded under this bylaw shall be maintained pursuant to the regulations of the Wayland Water Department.

D. All systems installed or expanded under this bylaw shall be installed outside of any road easements, which run in the favor of the Town of Wayland, and any roads owned by the Town of Wayland.

E. No portion of a system shall be installed or expanded within 50 feet of bordering vegetated wetlands.

F. No portion of a system shall be installed or expanded within 25 feet of the leaching area or a tank of a sanitary septage system

§ 191-8. Approval process.

A. Fees. All applications to install or expand a system shall include an application fee of $50.

B. The application shall include the name and address of the property owner and the installer, acknowledgement of the requirements of this bylaw, a drawing and calculation of the area covered by the system and any additional information the Board of Water Commissioners requires to reasonably identify and evaluate the compliance of the proposed system.

C. The Water Superintendent or designee shall approve the short-form application if the Water Superintendent or designee determines that said system covers a land area of 5,000 square feet or less and complies with the provisions of this bylaw.

D. The long-form application shall be approved by the Board of Water Commissioners or designee if the Board of Water Commissioners or designee determines that said system covers a land area of 15,000 square feet or less and complies with the provisions of this bylaw.

§ 191-9. Rules and regulations.

The Wayland Board of Water Commissioners shall have the authority and duty to adopt, issue and administer any additional rules and regulations necessary for the administration, operation and enforcement of outdoor underground water sprinkler systems connected to the public water supply. Any such rules and regulations shall be consistent with the provision of this bylaw.

§ 191-10. Violations and penalties.

Any person violating this bylaw shall be subject to the following:

A. Written notification of a violation by the Water Superintendent or the Board of Water Commissioners. Said notification shall include a demand that said system comply with the bylaw within 30 days receipt of the notification or that said system be removed.

B. A fine of $250 per day for each day after the initial 30 days that the system is in violation of this bylaw.

C. After the initial 30 days, a notice of termination of water services in no less than seven days may be served upon the water customer by a duly appointed Constable of the Town of Wayland. The notice shall be served to the water customer in hand or left at the address given for billing purposes and mailed to that address. Notice shall include a statement that the water customer may appeal a decision to terminate water services by requesting a hearing before the Board of Water Commissioners. Water service may be terminated seven days after receipt of the notice to terminate or after a majority vote of the Board of Water Commissioners, if the water customer has requested a hearing. Receipt of the notice shall be presumed to be three days after the notice is mailed or the day of in-hand service. After water service has been terminated, a reconnection fee of $275 during normal business hours, or reconnection fee of $200 after normal working hours, will be charged prior to renewing water service. Payment of said fees must be made before reconnection. In lieu of terminating water services, the Board of Water Commissioners, by a majority vote, may assess a fine in the amount of $250 per day for each day after the initial 30 days that the system is in violation of this bylaw.

D. Fines shall be recovered by indictment or on complaint before the District Court or by noncriminal disposition in accordance with MGL c. 40, § 21D. After disposition favorable to the Town of Wayland, any outstanding unpaid civil fines shall be placed on the water customer's water bill. The enforcing person shall be the Water Superintendent or designee.

§ 191-11. Severability.

The invalidity of any portion or provision of this bylaw shall not invalidate any other portion or provision thereof.

APPENDIX F: FALMOUTH LANDSCAPE REQUIREMENTS

The landscaping requirements reprinted below are one article of the Falmouth Zoning Bylaw. This article requires submittal of a landscape plan for all development projects that require a special permit or review, other than single- or two-family dwellings. The bylaw requires the use of drought resistant vegetation unless irrigation will be provided by a private well or through drip or mist irrigation. The bylaw also establishes requirements for street trees and parking lot vegetation islands.

ARTICLE XXIV Landscape Requirements

[Amended ATM 4-4-1979, Art. 102, ASTM 4-6-1992, Art. 22]

Section 240-114. Purpose and intent.

A. The purpose of landscape regulation is to protect the general health, safety and welfare of the residents of Falmouth; to assist in reducing incompatibility between abutting uses; to provide barriers and relief from traffic, noise, heat, glare, fumes, dust and debris; to preserve and enhance the character of the community, to prevent soil erosion and silting of drainage structures and water bodies; to retain existing significant trees, and protect rare and endangered plant species and wildlife; and to provide shade and windbreaks.

B. To this purpose, it is the intent of the town that streets, sidewalks and parking spaces be shaded by trees; that parking, service and outdoor storage areas be screened from view of the street and neighboring properties; that residences be buffered from commercial activities; and that impervious surfaces and ground without vegetative cover be minimized.

Section 240-115. Landscape plan required.

All development projects other than single- or two-family dwellings that require a special permit or review under Articles XXXVIII and XXXIX shall submit a landscape plan as part of the required application.

Section 240-118. Definitions.

ANNUAL - A plant with soft and fleshy stems which lives for only one (1) or two (2) years.

BERM - A mound of earth covered with plants and used as a screen.

BUFFER OR SCREEN - Any landscape object or structure (such as a fence, berm or hedge) used to hide something from view or as a barrier for privacy, security or from noise, wind or dust.

DECIDUOUS - Any woody perennial which drops its leaves in autumn or winter.

EVERGREEN - Any woody perennial which retains its leaves throughout the year.

FORMAL - A landscape designed primarily on classical geometric lines, usually requiring high maintenance.

GROUND COVER - Low shrubs, herbaceous perennials or reseeding annuals which are planted to cover the ground completely at maturity to stabilize slopes or substitute for a lawn.

HEDGE - Shrubs planted close together in a solid line to delineate a space, form a border or create a screen for privacy.

HERBACEOUS PERENNIAL - A perennial plant with soft and fleshy stems which dies back to the ground in winter.

LANDSCAPE - i. the spatial relationship of the topography, structures and vegetation; ii. to modify or ornament nature by altering topography, structures or vegetation.

LANDSCAPE OBJECT - Any fixed feature in the landscape which does not require a building permit.

MULCH - Organic material used to temporarily cover the ground until plants can reach maturity and cover it.

NATURALIZED - A landscape designed primarily on curved lines to mimic nature which usually requires little maintenance.

PERENNIAL - A plant which lives for more than two (2) years.

SERVICE AREA - Any area which contains a loading dock, dumpster or outdoor storage of merchandise. vehicles or equipment.

SHRUB - A woody perennial plant growing to a height of fifteen (15) feet or less at maturity.

SIGHT TRIANGLE - An area free of obstructions which might interfere with a driver's ability to see other vehicles approaching an intersection.

STREET TREE - A tree with characteristics (such as sturdy limbs, deep root system or lack of low branches) which make it desirable for planting near pavement or underground utilities.

TREE - A woody perennial plant growing to a height of fifteen (15) feet or more at maturity.

UNDISTURBED - A landscape design which primarily utilizes existing plants in a natural state and requires no maintenance.

VEGETATED ISLAND - An area inside a paved parking area covered with vegetation instead of pavement.

XERISCAPE - A landscape designed with native, drought-tolerant species which require little fertilizer.

Section 240-119. Performance standards.
For the purposes stated above, the following standards are required to be met. Alternative methods to those described below may be substituted if the applicant demonstrates to the satisfaction of the reviewing agency or special permit granting authority that the intent of this Article is upheld.

A. Xeriscape. To aid in conserving the Town of Falmouth's drinking water supply, xeriscape is required for all applicable development projects unless any of the following criteria are met:

(1) The applicant provides water for the landscape from a private well.

(2) The applicant installs an irrigation system (which may use town water) but only those which drip or mist. Spray or sprinkle irrigation using town water is prohibited.

B. Planting medium. To reduce the need for watering and fertilizing and to help maintain healthy plants, in formal and naturalized landscapes, soil shall be no more than twenty-five percent (25%) sand, no more than ten percent (10%) clay and no less than sixty-five percent (65%) silt, and decayed organic matter in an amount equal to twenty-five percent (25%) of the soil by volume shall be added. This is required to the following depths:

(1) Where trees are planted, to a minimum of four (4) feet within a four-foot radius of the trunk.

(2) Where shrubs are planted, to a minimum of two (2) feet within a two-foot radius of the trunk(s).

(3) Where ground covers, herbaceous perennials, annuals or bulbs are planted, to a minimum of one (1) foot within the planting area.

C. Mulch. To prevent soil erosion, weed growth and to help retain moisture and insulate young plants, mulch is required in formal and naturalized landscapes wherever soil is not covered by vegetation.

(1) Mulch shall be applied on the soil surface in a layer two (2) to four (4) inches deep.

(2) Mulch shall be used as a temporary cover during the first three (3) growing seasons until vegetation grows to completely cover the ground. Mulch shall not be used as a substitute for ground covers.

(3) Ground or shredded bark, peat moss, pine needles, tree leaves, straw or hay may be used as a mulch.

(4) Gravel or stone chips may be used in areas of high pedestrian traffic, but shall not exceed ten percent (10%) of the landscaped area.

D. Street trees. To reduce heat and glare on streets and sidewalks, street trees from the approved list are required to the following specifications:

(1) Except in B1 Districts, street trees shall be planted no greater than thirty (30) feet apart on a line five (5) feet behind the street frontage. Where an access driveway interrupts this pattern, street trees shall be planted on either side of the driveway, five (5) feet from the edge of pavement and behind the sight triangle at the intersection. Existing vegetation meeting the intent of this Article may be substituted for these requirements.

(2) When planted, street trees shall have a trunk diameter of at least two (2) inches at a height of four (4) feet six (6) inches, and shall be free of limbs below seven (7) feet.

(3) Street trees shall be maintained so as to reach a height of at least forty-five (45) feet at maturity.

E. Front yards. With the exception of certain overlay zones, front yards may be formal, naturalized or undisturbed so long as all surface areas which are not parts of walkways or driveways are completely covered by vegetation within three (3) years.

(1) Front yards in Water Resource Protection Districts (see Article XV) or in Coastal Pond Recharge Districts (see Article XXI) shall be naturalized or undisturbed.

(2) Front yards in the Wildlife Corridor Overlay District (see Article XX) shall be undisturbed.

F. Parking lot screens. Between the front yard and the parking area, a screen is required so that automobiles cannot be viewed from the street. This may be achieved using any combination of the following:

(1) A row of evergreen and deciduous trees at least six (6) feet high, with no more than fifty percent (50%) being deciduous, from the approved list of buffer species, and planted at intervals recommended on the approved list.

(2) A hedge at least three (3) feet high, to grow to a minimum of four (4) feet high at maturity.

(3) A berm at least four (4) feet high with no slope greater than three to one (3:1), mulched and planted so as to be completely covered by vegetation in three (3) years.

(4) A solid fence or wall at least four (4) feet high, the faces of which shall be planted with shrubs at an interval of not less than one (1) every twenty (20) feet with the intervening faces planted with herbaceous perennials, annuals or bulbs in an area not less than two (2) feet wide.

G. Parking lot interiors. Vegetated islands are required within paved areas behind the street setback according to the following specifications:

(1) For each parking stall, forty (40) square feet of vegetated island shall be provided within the paved area. The minimum dimension of each vegetated island shall be four (4) feet, except at corners, and the minimum area shall be one hundred sixty-two (162) square feet.

(2) No fewer than one (1) street tree as described in Subsection D(1) shall be planted for each one hundred sixty-two (162) square

feet of vegetated island.

(3) The remainder of the parking area not used for stalls or driveways shall be planted with any combination of trees, shrubs, ground cover, herbaceous perennials, annuals or bulbs so that the ground is completely covered after three (3) growing seasons.

(4) Plants within necessary sight triangles shall be no greater than two (2) feet high.

(5) Vegetated islands are required to separate rows of parking stalls and interior driveways.

H. Service area screens. Where service areas exist, they shall be screened from view of the street, parking areas and adjacent properties. This may be achieved using any combination of the following:

(1) A row of evergreen and deciduous trees, at least six (6) feet high, with no more than thirty percent (30%) being deciduous, from the approved list of buffer species, and planted at intervals recommended on the approved list.

(2) A solid fence or wall at least six (6) feet high.

I. Residential buffers. A buffer is required between business or industrial uses and residences, nursing homes, hospitals or similar uses. The buffer shall protect abutting properties from glare, noise, dust, fumes. heat and traffic. This may be achieved using any of the following:

(1) Two (2) rows of evergreen trees, from the approved list of buffer species, at least six (6) feet high, planted at intervals recommended on the approved list, and faced with a row of shrubs at least three (3) feet high.

(2) One (1) row of evergreen trees, from the approved list of buffer species, at least six (6) feet high, planted at intervals recommended on the approved list, and faced with a row of shrubs at least three (3) feet high, and backed with a solid fence or wall at least six (6) feet high.

(3) A berm a minimum of five (5) feet high, with no slope greater than three to one (3:1), planted with trees and shrubs so that the ground is completely covered with vegetation.

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