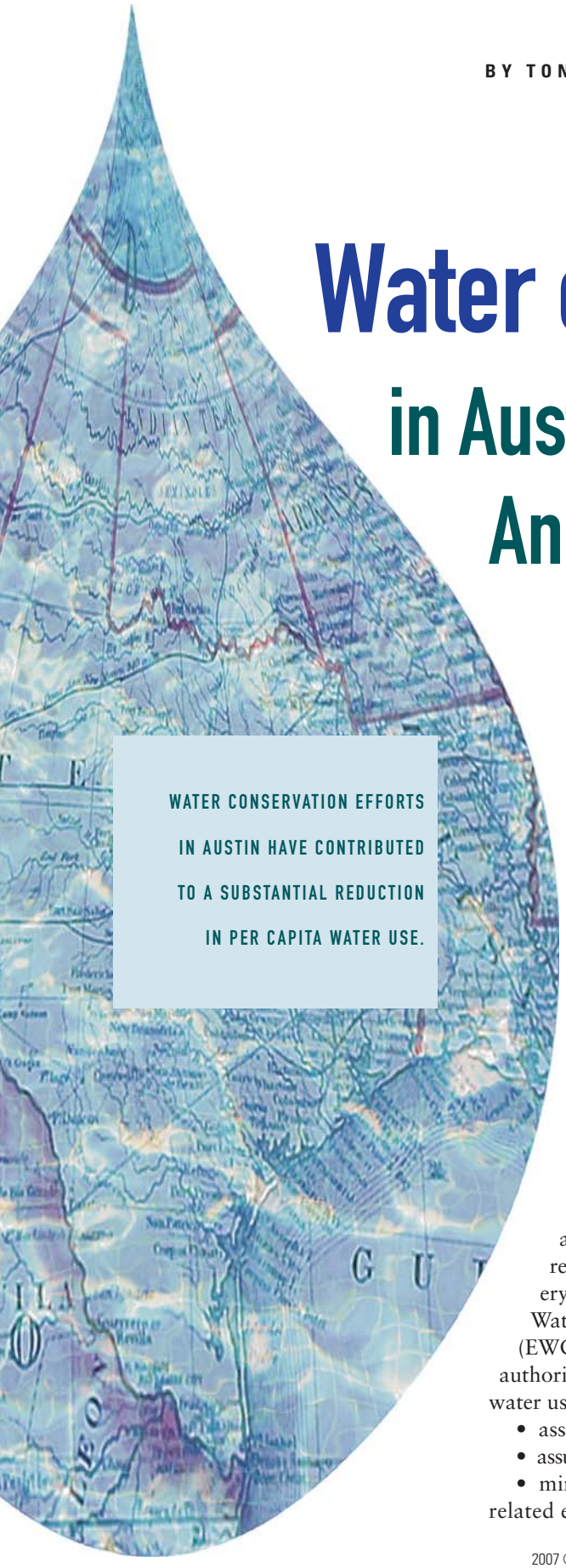
BY TONY T. GREGG, DAN STRUB, AND DREMA GROSS

Water efficiency in Austin, Texas, 1983–2005: An historical perspective



WATER CONSERVATION EFFORTS IN AUSTIN HAVE CONTRIBUTED TO A SUBSTANTIAL REDUCTION IN PER CAPITA WATER USE.

The city of Austin is located in central Texas and receives approximately 34 in. (812 mm) of rainfall on average each year (National Climatic Data Center, 2006). The months of July and August are the driest and are often without rainfall for three to four weeks at a time. The extended dry periods increase overall water use in summer by almost 100% over water use in winter.

Austin receives all of its water from the Colorado River (Texas) through water rights granted by the state of Texas and backed by storage in lakes managed by the Lower Colorado River Authority (LCRA). Austin's water supply is backed by storage as firm water rights (325,000 acre-ft/year [65 mil m^3/year]), which are expected to meet demand through 2040 without an aggressive conservation and reclaimed water program. With an aggressive conservation and reclaimed water program, these water rights should be sufficient through 2050.

INCREASING DEMAND LEADS TO CONSERVATION

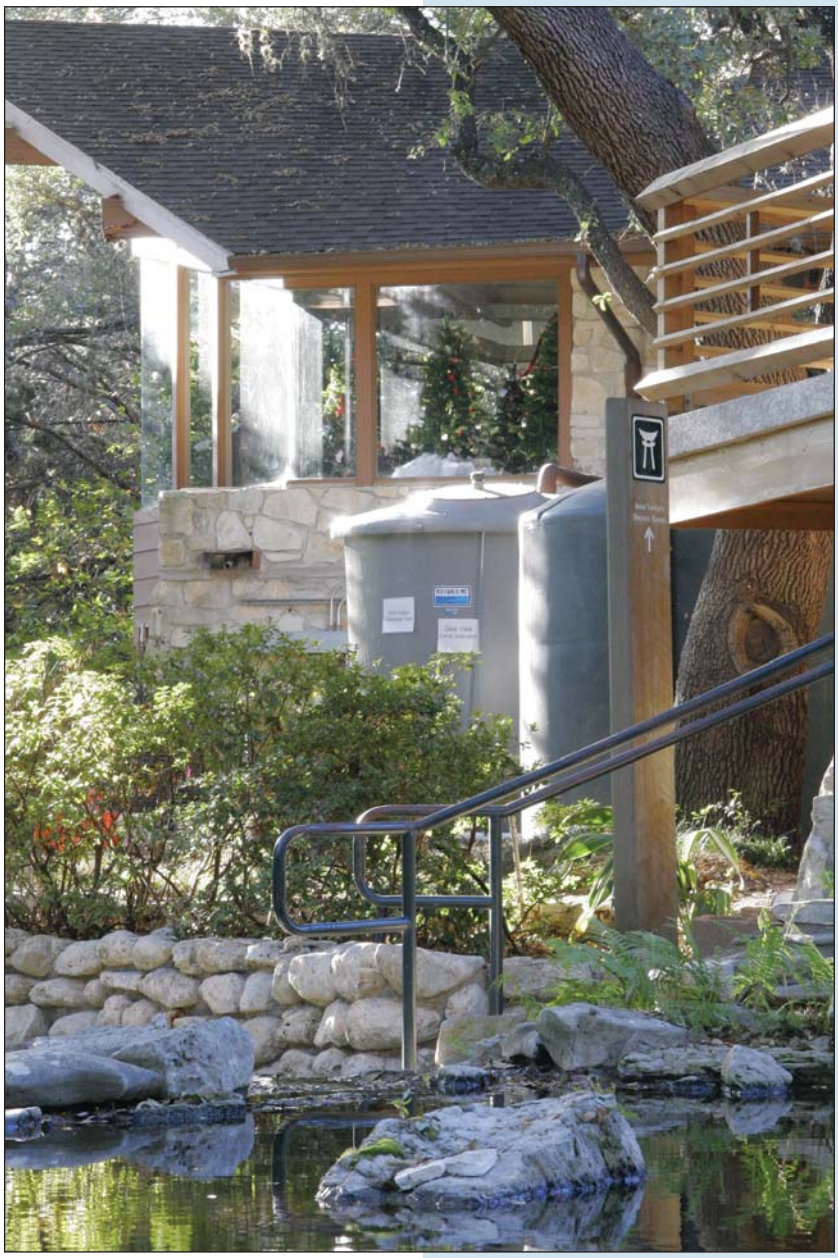
In the late 1970s and early 1980s, Austin voters rejected bond authorizations for system improvements despite rapid growth in the region. As a result, high water pumpage levels threatened service delivery in the summer of 1982. To reduce the demand for water, Austin Water Utility developed the Emergency Water Conservation Ordinance (EWCO). This ordinance, approved by the city council in February 1983, authorized the city manager to impose mandatory restrictions on outdoor water use to

- assure adequate capacity to meet firefighting needs;
- assure adequate service to all customers by spreading out peak demands; and
- minimize the potential for service disruptions resulting from stress-related equipment failures.

From 1984 to 1987, demand management was primarily seen as an emergency or crisis response to infrastructure inadequacies. Since then, however, water conservation efforts in Austin have evolved into programs designed to reduce peak-day demand and average per capita use. Water conservation efforts are also aimed at delaying the construction of additional water treatment plant capacity and extending the time before which the city will exceed its water rights.

The city now views efficiency as one of the strategies required to meet its long-term water needs. Austin's current water conservation goals are to

- reduce the 1990 projection of 2005 peak-day water use and average per capita daily water use by 10 and 5%, respectively;
- reduce the projected demand in 2050 of 376,000 acre-ft/year (75 mil m^3/year) to 325,000 acre-ft/year (65 mil m^3/year) by 2050 in conjunction with Austin Water Utility's reuse project; and
- achieve as much of this savings as feasible by 2016 to delay an annual payment to the LCRA of $8 million–$13 million. (Under the 1999 agreement between the city and the LCRA, the city prepaid for water use up to 201,000 acre-ft [40 mil m^3] per year. Once the city exceeds 201,000 acre-ft per year for two consecutive years, it must pay annually for all water use over 150,000 acre-ft [29.9 mil m^3] per year.)



An award-winning demonstration at Zilker Botanical Gardens shows Austin customers how to design, install, and maintain rainwater harvesting equipment.

SERVICE AREA GROWTH SPURS ADDITIONAL CONSERVATION NEED

The city of Austin has been growing steadily over the past few decades. Figure 1 illustrates both the burgeoning population levels and increasing total water consumption. Between 1984 and 2004, the population of the Austin service area grew from approximately 466,100 to 789,000—a 69% increase.

Through a combination of programs targeting inefficient water use practices, Austin has managed to keep demand growth well below the rate of population growth. Total water pumpage between 1984 and 2004 increased only 35%, from 35.071 to 47.519 bil gal (133 to 180 GL).

PROGRAMS DESIGNED TO ADDRESS SPECIFIC WATER USE ISSUES

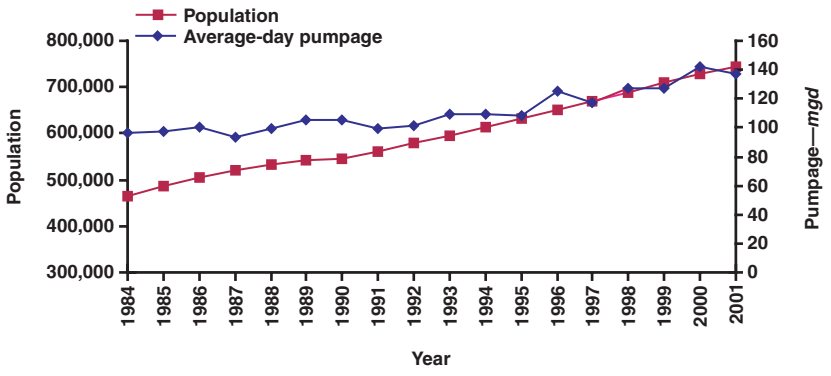
Tools assist customers in easing excessive landscape irrigation. As much as 50% of August water use is for irrigation, which puts a tremendous load on Austin's water treatment plants and system. In a particularly hot, dry summer, unchecked demand could exceed treatment capacity. The 1983 EWCO addressed the immediate problem by limiting landscape irrigation to a five-day schedule during drought restrictions, with additional limitations imposed if the drought worsened. The ordinance was enforced by ticketing violators with fines of up to $500 per violation. Restrictions were imposed

again in the summers of 1984–1986, but lifted each year once the summer irrigation season had ended.

By the late 1980s, increased capacity had alleviated pressure on the system; however, excessive outdoor watering continued to be a highly visible indicator of water waste. Most of the worst offenders were properties with automatic irrigation systems. In response, Austin's Water Conservation Division (WCD) established a free irrigation audit program. Customers often have a poor understanding of how their controllers work, have multiple programs or start times they are unaware of, lack a backup battery in their controller, or have heads that mist because of excessive pressure. As part of the irrigation audit program, the city water auditor checks customers' systems for leaks, water application rates, and adequate coverage. The auditor also assesses the adequacy of the equipment and recommends replacement of components if appropriate. (In many cases, recommended upgrades are eligible for rebates.) Customers are given a watering schedule that takes into account factors such as plant type and shade coverage, allowing them to water to the evapotranspiration rate. On the basis of internal data comparing average summer water use before and after irrigation audits, these audits often result in reductions of 30% or more in irrigation water use.

Although the irrigation audits assisted customers who had automatic irrigation systems, it was felt that more could be done to assist homeowners who irrigated using hose-end sprinklers. It was observed that many homeowners who irrigate with hose-end sprinklers often leave them on longer than they intend. Thus in 1997, the WCD began offering free hose timers. These timers are attached between a faucet and a hose and will shut off the water flow after the amount of time set by the user.

FIGURE 1 Austin area population and total water use changes, 1984–2001



By the late 1990s, Austin was once again experiencing explosive growth that put pressure on water treatment system capacities. A drought in the summer of 2000 caused the imposition of watering restrictions for the first time since 1986. Enforcement of the restrictions highlighted several of the shortcomings in the EWCO, and revisions to the ordinance were made before the summer of 2001. These revisions included clarifying restrictions on car washes and the irrigation of sports fields and newly installed landscapes, and extending the prohibition on wasting water to a year-round basis. The EWCO is used largely as a marketing tool in Austin; the city prefers to contact customers and work with them directly to eliminate the problem rather than turning immediately to fines and citations.

Xeriscape programs discourage use of inappropriate landscape materials. Many Austin residents have come to the city from other parts of the country, often from areas with a different climate and different native vegetation. To re-create familiar landscapes in Austin's hotter, drier climate, residents must use excessive amounts of water, which drives up peak-day water demand in the late summer months. Xeriscaping, which emphasizes the practice of using plants that are native or adapted to the climate, can reduce or even eliminate the need for irrigation.

Austin has used several programs to encourage native landscapes, including the "Xeriscape It" education program launched in 1984. This program promoted the principles of Xeriscaping through a variety of outreach and education programs. In addition, the WCD produced a quarterly Xeriscape newsletter; organized and conducted Xeriscape schools, seminars, and garden tours; and worked closely with Austin's Xeriscape Advisory Board and the Xeriscape Garden Club on joint activities.

By 1994, it was evident that these efforts were not as successful as planned. Most residential and commercial landscapes continued to comprise large areas of poorly adapted and water-inefficient turfgrasses. In response, two new initiatives were introduced. The first was a residential rebate program for installing plants and turfgrasses that were better adapted to Austin's climate. The second initiative was an ordinance that required all new commercial landscapes to use native or adapted plants and established standards for irrigation systems.

Both of these initiatives met with mixed success. The program attracted customers with already low water use. As a result, residences participating in the rebate program showed little to no change in water use. In addition, though the plants they in-

Austin has distributed more than 8,900 subsidized rain barrels, like these at a customer's home.

stalled required less irrigation, some owners continued to water them as if they were high-water-need plants. Thus the program was altered to emphasize only trees and shrubs in order to promote a hardier group of plants with long-lasting savings, provide shade for thirsty turfgrasses, and reduce the evapotranspiration from the rest of the landscape.

The commercial landscape ordinance was a compromise, because it was based on an existing ordinance intended to promote beautification. The revised ordinance retained most of the beautification elements, even though they sometimes conflicted with water-wise management practices. For example, the ordinance required irrigation systems for all landscapes whether or not the plants needed irrigation, and required raised islands for landscape areas in parking lots although ground-level plants could have taken advantage of water draining from the pavement.

Inefficient plumbing fixtures offer retrofit opportunities. In 1985, the Texas Water Commission issued an enforcement order to the city of Austin for water quality violations. Under order to reduce its wastewater discharges and with its water treatment system under pressure of high demands, Austin was required to implement retrofit programs to replace inefficient plumbing fixtures. Because many toilets and showerheads were using excessive amounts of water and contributing to capacity problems at the city's wastewater treatment plants, the WCD teamed with the electric utility in the Residential Energy Efficiency audit program to install low-flow showerheads and toilet dams, which are barriers installed in toilet tanks that prevent some of the water from being released when the toilet is flushed. This program resulted in the installation of 37,903 low-flow showerheads and 52,471 toilet dams in 34,880 residences between 1984 and 1990 at a cost of approximately $17 per household.

In late 1985, the Austin City Council adopted the Commercial Water Conservation Retrofit Ordinance to comply with an Agreed Enforcement Order from the Texas Water Commission. The ordinance required all commercial customers, including multifamily properties, to retrofit all plumbing fixtures to meet compliance standards outlined in the 1983 plumbing code amendments, which required toilets to flush 3.5 gpf (13 Lpf) or less. Between 1986

Violations of Austin's water use management ordinance, such as this broken sprinkler head, are subject to fines of up to $500 per occurrence per day.

and 1990, the WCD expanded the retrofit effort to residential customers, offering door-to-door installation of low-flow showerheads, faucet aerators, and toilet dams.

Savings from the toilet dams in residential toilets were unreliable and were seen as a stopgap measure until additional capacity was constructed. At the same time, the 3.5-gpf standard for commercial properties was considered excessive. A more direct strategy was required to solve the problem. In 1991, the city passed an ordinance prohibiting the installation of any toilet that flushed more than 1.6 gpf (6 Lpf). This was followed in 1992 by state and federal legislation mandating the 1.6-gpf models.

These new laws ensured that all new toilets would be low-flow models, but did nothing to address toilets that had already been installed. In response, the Water Conservation Division instituted a toilet replacement program. The first incarnation of the program in 1992 allowed residential, multifamily, and commercial customers replacing old, large-capacity toilets with low-flow models to get rebates of $60–80 per toilet (depending on the toilet price).

In 1994, it was recognized that low-income homeowners might not have the means to participate in the rebate program, so the WCD began a free toilet program. The city contracted with a local plumbing distributor to supply toilets to customers who presented city-issued vouchers at the distributor's store. The program was initially limited to low-income residential customers, but it was opened to all residential customers in 1996 and to multifamily and commercial customers in 1998. Finally, in 1999, customer feedback indicated that the cost of installing the toilets was an impediment to participation, so the WCD instituted a $30 per toilet rebate for installation by a licensed plumber.

In the spring of 2002, research showed that the savings gained by low-flow toilets was often lost once the flapper was replaced. Finding the correct replacement flapper for a toilet was often difficult, if not impossible, and using the wrong flapper could change a 1.6 gpf (6 Lpf) toilet into a 5 gpf (19 Lpf) toilet. As a result, the toilet rebate program was suspended.

The rebate program resumed in December 2002, with rebates limited to toilet models that did not lose their low-flush volumes when the flapper was replaced with a commonly available one. Rather than use the Los Angeles Department of Water and Power's Supplemental Purchase Specification, developed in 2000, Austin refined the list to exclude all toilets with early-closing flappers.

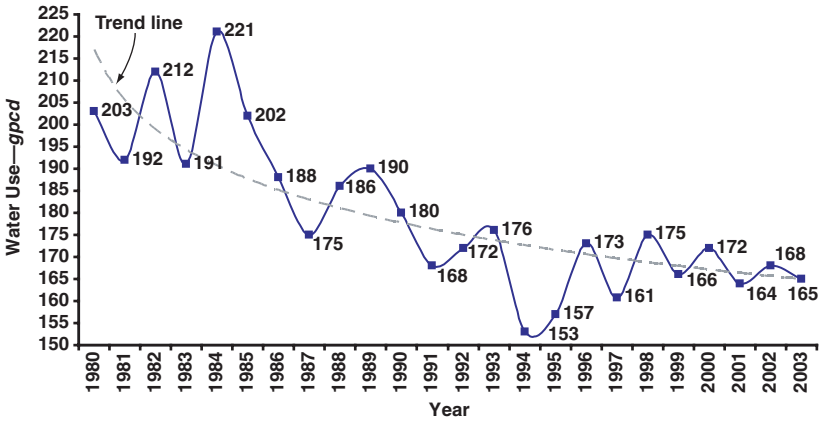
In 2004, Austin added a performance specification based on the Maximum Performance (MaP) testing protocol. Toilets eligible for Austin's rebates must not use an early-closing flapper and must flush a minimum of 250 g of waste material (Gauley & Koeller, 2003). The free toilet program was not affected because the toilet distributed through that program retained its low-flush volume even with a standard flapper replacement.

Austin's program was not the only one grappling with this problem. Many water conservation programs began limiting the toilet models that qualified for their replacement programs, but without coordination among those programs, toilet manufacturers were faced with many different sets of qualification criteria to meet. In response, a group of conservation professionals met in January 2004 and agreed that the failure to maintain flush volumes, as well as long-standing complaints about toilet performance, demanded a unified standard for toilet performance.

This new standard, known as the Unified North American Requirements (UNAR), will set limits on the flush volume of a toilet after it is fitted with a standard flapper. Flushing performance, which has been a barrier to acceptance since the 1.6-gpf toilets were introduced, will be evaluated by incorporating the MaP testing protocol.

The UNAR will also address a number of other factors, including replacement part identification and availability, standards for chemical-resistant flappers, and the use of fill valves that are not susceptible to creep or leakage. The UNAR will be a strictly voluntary system but could lead to a single, uniform list of toilet models that qualify for many replacement programs. This clear set of stan-

FIGURE 2 Nonindustrial per capita water use per day in Austin, 1980–2003*



Texas Water Development Board data to 2000, city data to 2003

Licensed irrigator and water conservation staffer Jessica Woods performs a commercial irrigation system evaluation.

dards, coupled with the market force of multiple toilet replacement programs, will send a clear signal to toilet manufacturers and drive the market toward better-performing and -conserving toilets.

In November 2004, dual-flush toilets became available in the Austin market. These toilets have two flushing options: a standard 1.6 gpf and a reduced flush, usually 0.8 or 1 gpf, that clears liquid waste from the bowl. Studies have shown that these toilets can result in average flush volumes of 1.2 gpf (Koeller, 2003). Four models (three manufactured by Caroma and one by Kohler's Sterling Division) met the UNAR standards and were added to the toilet rebate program in 2004.

The toilet replacement program in Austin has been successful, with well more than 50,000 toilets distributed under its various initiatives. As of 2005, the program has saved in excess of 700,000 gpd of water through commercial, multifamily, and single-family retrofits.

ADDITIONAL WATER CONSERVATION EFFORTS SEEK TO EXPAND SAVINGS

Commercial and industrial initiatives offered. By 1996, the WCD had active programs to address landscape irrigation and retrofitting old toilets, but nothing to assist commercial or industrial customers who use water in the course of their business. If incentives could be offered to conserve water, savings could be significant. For example, Austin has several large computer chip manufacturers whose manufacturing processes can use more than 2 mgd (7.57 ML/d) of water per plant. By changing water use practices (e.g., reusing reject water from reverse osmosis filters), water use could be reduced by 20–40%. However, manufacturers needed incentives to shorten the payback period on the necessary equipment.

The WCD responded by offering rebates of up to $40,000 per project, with the amount of the rebate limited to half the cost of the improvement up to $1/gal saved per day. Manufacturers such as Motorola, AMD, and Samsung have taken advantage of the program, conserving 1.5 mgd (5.68 ML/d) of water.

In 2004, the WCD identified a new opportunity for water savings in restaurants. The spray valves that most restaurants use to rinse dishes before washing often use 3–6 gpm (12–24 L/min), although new valves are available that use only 1.6 gpm (6 L/min). These valves are relatively inexpensive and easy to install, but most restaurants were not aware of the valves or of the savings they would bring. To raise awareness of these valves, WCD staff members visited restaurants, performing water audits and replacing old spray valves with new 1.6-gpm valves. In less than 1 year more than 300 spray valves had been replaced, saving 60,000 gpd (225,000 L/d) of water.

In 2005, the Texas Legislature passed House Bill 2428, which mandates that as of Jan. 1, 2006, only spray valves with a flow rate of 1.6 gpm or less can be sold or distributed throughout the state. Once the water-efficient spray valves hit market saturation, the state has the potential to save approximately 2.6 bil gal of water each year (SBW Consulting, 2004).

Clothes washer rebates offered. In the United States, nearly all clothes washers have been top-loading designs, traditionally using 40%

more water than newer front-loading models. However, the front-loading machines are more expensive than traditional washers, with suggested retail prices ranging from $500 to $1,500.

The WCD has addressed this problem by giving rebates for high-efficiency washing machines. The rebate program is designed to bring these prices more in line with traditional machines with the same level of features. The program offers rebates of up to $100 for the purchase of a new front-loading washer. As a result, the front-loading machines have been gaining in popularity, and more models have been introduced as sales have increased.

In August 1998, 12 models available from five manufacturers were eligible for the rebate. As of 2005, 145 qualifying models were available from 28 manufacturers. The program determines eligible models from a list published by the Consortium for Energy Efficiency, offering rebates on washing machines located in tiers 3a and 3b of the list.

The number of rebates given annually has also increased from 925 in 1998 to 2,220 in 2004. By 2005, more than 12,300 rebates had been issued for a total water savings of more than 187,000 gpd.

In addition to generating water and energy savings, these efficient washing machines have also expanded the market, allowing some manufacturers to begin lowering prices as a result of economies of scale.

Submeters encouraged in multifamily dwellings. All properties have always had metered water service in Austin. However, many properties with multiple dwelling units have had a single master meter for the entire property. Thus people living in multifamily properties often did not pay directly for the amount of water they used. Absent this direct link, they lacked financial incentives to conserve. Studies have shown that savings of 15–30% can be achieved by switching a multifamily property from master meter billing to direct metered billing (Mayer, 2004).

In Austin, local and state codes divide multifamily dwellings into two classes: those with two to four dwellings and those with five or more. In 2000, the WCD was able to work with Austin Water Utility to require that all new two-, three-, and four-dwelling properties have a dedicated water meter for each unit. In addition, because most of these properties are rental properties and may share a single irrigation system, a separate meter is required to serve any irrigation system for the property. This enables the irrigation water to be separated from the tenants' usage and either paid for by the landlord or divided equally among the tenants.

In apartments with master meters, state law permits the management to divide water bills among tenants using a formula on the basis of the number of people living in the property, the number of square feet in the tenant's apartment, or a combination of the two. They can also install private submeters for each apartment and charge each tenant only for the water he or she uses. Although installing and reading the meters is more costly for the property owners, it is much more equitable than charging on the basis of an arbitrary formula and is overwhelmingly preferred by the tenants.

Nevertheless, the majority of apartment properties that charged tenants separately for water were doing so using a formula. In response, the WCD supported a bill in 2001 to change state law in order to encourage new properties to be equipped with submeters for each apartment unit or to have the water utility install a meter in each unit, with the meters to be supplied, maintained, read, and billed by the utility.

Commercial irrigation meters required. For years the WCD received complaints about commercial properties that wasted water irrigating. However, many of the properties

As shown at this Austin-area Sears store, point-of-purchase displays help promote the WashWise Rebate Program.

were not aware of how much water the irrigation system was wasting because the system drew water from the same meter as the rest of the property's water uses. To give these property owners the information needed to manage their water use, in 2000 the WCD and the Austin Water Utility established criteria requiring that all new commercial properties over a minimum size install a meter to register irrigation use. Because the water that passes through this meter is not returned through the sanitary sewers, the owners are not charged for sewage on this water, helping to offset the cost of the meter.

Rainwater harvesting encouraged. Texas has a rich history of rainwater harvesting. Many ranches and homes in the Hill Country immediately west of Austin are dependent on rainwater. However, with the advent of modern water treatment and distribution systems, rainwater harvesting has fallen from favor and by 2000 was virtually unheard of in the city's water service area.

Rainwater is a highly valuable resource and can effectively increase the amount of water available for irrigation. People who use rainwater become more aware of their water use patterns as a result of managing their private supplies. Rainwater is also more beneficial than treated water for irrigating plants, a characteristic highly valued by gardeners. As a result, in 2000, the WCD offered rebates for rainwater harvesting: a $30 rebate for purchasing approved rain barrels and a rebate of up to $500 for larger systems, depending on the storage capacity and cost of the system. Unfortunately, there were few local suppliers of rain barrels, and few residential customers had the room to accommodate a larger system.

In April 2001, the WCD instead decided to supply barrels to its customers at a reduced, subsidized price. Purchasing 1,000 barrels by the truckload, the program offered them to customers at $20 each and sold out in approximately 8 hours. Demand has continued despite an increase in the price to $60 per barrel, and sales and distribution dates are now scheduled every two to three months. Since its inception, the program has sold more than 6,000 rain barrels.

Although water savings from rain barrels are marginal compared with other water conservation programs (approximately 0.5 gpd [1.9 L/d]), the program has been an effective marketing tool. The popularity of the program has spurred interest in larger rainwater systems and increased the number of rain barrel rebates issued. Rain barrel distributions also provide an opportunity to introduce customers to other programs and have generated substantial repeat participation.

Though the city of Austin offers rainwater harvesting rebates to encourage homeowners to add rainwater harvesting systems to existing homes, no program currently exists to encourage the incorporation of rainwater harvesting systems into newly constructed homes. The city is considering extending rainwater harvesting rebates to area homebuilders; rebate amounts would likely continue to be based on the storage capacity of rainwater cisterns up to a maximum rebate amount.

Newsletter used to reach customers. Customer communication and awareness have long been a challenge to the conservation program. Despite ongoing awareness campaigns using utility bill inserts and radio and newspaper advertisements, many customers still know little about water conservation. In March 2004, the WCD began the WaterWise Newsletter to communicate more regularly with customers and increase participation in water conservation initiatives. Each month a

Water Conservation Division's Bill Hoffman escorts a tour group through Samsung's on-site water reuse facilities. The recycled water system supplies all of Samsung's landscape water, up to 125,000 gpd, and reduces wastewater discharge by more than 250,000 mgd. The plant currently recycles more than 60% of the water it uses.

new issue of the newsletter is created and distributed electronically to nearly 10,000 subscribers.

The newsletter facilitates cross-promotion of city programs by informing customers who have participated in one program about other programs available and by alerting all subscribers to upcoming events and special offers. The newsletter also includes related topics that may be of interest to customers, including material on gardening, energy conservation, and water quality.

AUSTIN WATER UTILITY SEEKS NEW WAYS TO SAVE

Austin Water Utility is currently faced with the need to expand treatment capacity by adding a fourth water treatment plant to meet the expected water demands of its growing population. However, the environmental sensitivity of the proposed plant location and heightened concern for potential rate increases have raised a lot of interest in the expansion plans.

To address stakeholder concerns, Austin Water Utility is working with a consulting firm to examine new and innovative ways to save water. The Water Resources Planning Study will examine the effectiveness of existing and potential conservation programs ranging from incentive programs to enhanced communications and ordinance or policy changes. A number of the following programs were included in the latest version of the city's five-year Water Conservation Plan and are in discussion at this time.

Block rate for commercial properties. The city of Austin commercial and multifamily water rates are currently structured at peak and off-peak rates, unlike the increasing block rate charged to residential customers. Implementing a conservation rate for commercial and multifamily properties' irrigation accounts could potentially create a disincentive for outdoor overwatering and increase property management oversight of the irrigated area.

Water budgeting and conservation rate structures. Increasing block rate structures discourage high water use by charging those with high use increasingly greater amounts, but such structures are not well targeted because total landscaped area varies widely among properties. For example, the amount one home uses to water to the evapotranspiration rate may be three times as much as required by the house next door. In addition, some high-water-use customers are not sensitive to the price signals given by the rate structure.

One solution is to establish a water budget for each property on the basis of landscaped area and historical evapotranspiration data. All customers would be charged the same rate for water if they stay within their defined water budgets. Once a customer exceeds the budget, he or she would encounter inclined block rates that are steep enough to send a price signal to even the most wasteful customer.

This approach was first introduced in the Irvine Ranch Water District in Southern California and was adopted by Boulder, Colo., in December 2004. Although the water budget approach requires an intensive data collection effort to calculate landscape areas and the appropriate evapotranspiration amount, the equity of the system and the water savings it produces may make it increasingly popular.

Onsite water reuse. In some situations it is both feasible and economical to collect the condensate water

WATER WISE NEWSLETTER

AUSTIN WATER UTILITY CONSERVATION PROGRAM

May 2006 VOLUME 3 ISSUE 4 May 13, 2006

Austin WATER CONSERVATION

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Summer Watering Season is Here!
Starting May 1 of each year, Austin enters Stage 1 Water Restrictions. Conservation measures are voluntary for most customers -- learn more about how you can help, and about what happens if drought conditions worsen.
Read full story...

Are Your Weeds Out of Control?
Learn how to show 'em who's boss... without all the nasty chemicals.
Read full story...

Use More, Pay More
There's no "quantity discount" when it comes to residential water use -- in fact, the more you use, the higher your unit cost! Find out more about Austin's Conservation Rate Structure.
Read full story...

Rainbarrel Sales Move to Pre-Pay
We're still offering rainbarrels to City customers at a substantial discount, but our distribution dates will now be for prepaid customers only. Find out more on our website at: www.cityofaustin.org/watercon!

Stop the 'Phantom Flush'
Does your toilet ever flush all by itself? Do you ever hear the water start to run into the tank, even though you haven't flushed recently? Your toilet flapper is the likely culprit. Luckily, it's an easy, inexpensive problem to solve...
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A sample of Austin's WaterWise Newsletter, winner of multiple communications awards.

TABLE 1 Summary of Austin water conservation efforts and success

Year	Inefficiency	Program	Peak Day Savings Per Measure	Savings Through 2005 *gpd*	Avoided Cost of Infrastructure *$3.48/gpd*
1984	Excessive irrigation	Watering restrictions	Not quantified		
1984	Excessive irrigation	Xeriscape education	1 gpd/person	4,676	$16,272
1986–90	Inefficient shower heads	Door-to-door retrofit	Not quantified		
1986–90	Inefficient toilets (existing)	Door-to-door retrofit with dams	Not quantified		
1991	Inefficient toilets (new)	City ordinance for 1.6 gpf (6 Lpf)	13.8 gpd/single family, 15.2 gpd/multifamily, 26.0 gpd/commercial	993,099	$3,455,984
1991–92	Inefficient fixtures (new)	State and federal legislation	No additional savings beyond 1991 city ordinance		
1992	Excessive irrigation	Irrigation audits	100 gpd/single family	483,500	$1,682,580
1993–present	Inefficient toilets (existing)	Incentives for retrofitting	13.8 gpd/single family, 15.2 gpd/multifamily, 26.0 gpd/commercial	1,424,163	$4,956,087
1993–present	Inefficient shower heads	Distribute free shower heads	7 gpd/fixture	197,428	$687,049
1994	Excessive irrigation	Incentives for water-wise plants	100 gpd/property	75,900	$264,132
1994	Excessive commercial irrigation	Revised commercial landscape ordinance	100 gpd/property	65,500	$227,940
1996	Water-inefficient commercial processes	Incentive to switch to efficient processes	Dependent on savings achieved	2,192,503	$7,629,910
1997	Irrigation water waste	Provide free hose timers	5 gpd	26,040	$90,619
1998	Inefficient clothes washers	Efficient clothes washer rebates	15 gpd/appliance	244,250	$849,990
1999	Irrigation water waste	Ordinance prohibiting water waste	Not quantified		
2000	Two-, three-, and four-dwelling properties not separately metered	Rule requiring separate meter for new construction	Not quantified		
2000	Commercial buildings not managing water use	Rule requiring separate irrigation meter for new construction	Not quantified		
2001	Apartments not individually metered	State submetering legislation	Not quantified		
2001	Rainfall not collected	Sell subsidized rain barrels; offer rebates for larger systems	5.5 gpd/barrel; larger systems dependent on storage capacity	49,177	$171,136
2003	Ultralow-flush toilets not retaining flush volumes	Offer rebates for toilets that maintain flush volume	Reinforces previous savings		
2004	Restaurant water waste	Distribute free spray rinse valves; conduct indoor and outdoor audits	200 gpd/spray valve	19,200	$66,816
2004	Limited customer awareness	Electronic newsletter founded	N/A; boosts participation in other programs		

N/A—not applicable

from air-conditioning units for reuse either as feedwater for manufacturing processes or for irrigation. Several businesses and institutions in Austin already collect their condensate water, most notably the University of Texas.

Irrigation permitting. A city of Austin study showed that homes with irrigation systems use an average of 132 gpd more than those without irrigation systems (Strub et al, 1999). Water utilities throughout the country are therefore justifiably concerned that these inground systems operate as efficiently as possible. The city of Austin could require rain shutoff sensors, five-day programmable controllers, pressure regulators (where needed), and head-to-head sprinkler spacing for all new systems.

Evapotranspiration irrigation controllers. Some cities are studying the potential savings from evapotranspiration controllers that automatically adjust the amount of water applied to the landscape on the basis of weather conditions. The "smart" evapotranspiration controller receives radio, pager, or Internet signals with evapotranspiration information and

directs the irrigation system to replace only the moisture the landscape has lost to heat, humidity, and wind. Other evapotranspiration controllers use historical data to adjust the watering program.

However, unlike many conservation measures (such as efficient toilets), evapotranspiration controllers cannot offer a guarantee of water savings, and savings will vary based on the total landscape area, landscape type, prior watering habits, and irrigation equipment efficiency. The monthly fees charged by some controller service providers may also reduce a customer's financial savings.

Although evapotranspiration controllers take some of the guesswork out of watering, customers cannot "set it and forget it." Evapotranspiration controllers still require initial schedule setup, monitoring, and adjustments to determine appropriate schedules. Additional testing is under way to more accurately predict water savings from evapotranspiration controllers.

Commercial rainwater and stormwater harvesting incentives. Rainwater and stormwater collection systems at commercial and multifamily properties offer tremendous water conservation potential. Unfortunately, the marginal cost of storing this water makes it 20 times more expensive per gallon than potable water. However, many multifamily and commercial properties are already required to collect and retain stormwater for 72 hours following a rainfall event for water quality and flood control reasons.

Retention ponds could also be used as a water source for irrigation and other nonpotable uses if the 72-hour requirement is relaxed. In addition, inclusion of rainwater and stormwater collection into Austin's Green Building Program criteria gives developers additional social and financial incentives to collect rainwater or stormwater.

CONCLUSIONS

Each of Austin's water conservation efforts has addressed distinct problems using different methods: monetary incentives, equipment giveaways, subsidized sales, plumbing code changes, ordinance enforcement, and new state and federal laws. These strategies have been promoted and enforced with the partnership and cooperation of the water utility, the building code enforcement department, and energy companies. These efforts have met with differing degrees of success, as summarized in Table 1. Combined, however, the water conservation efforts in Austin have contributed to a substantial reduction in per capita water use (Figure 2).

Austin's Water Conservation Program is as comprehensive as it is today because of its 22-year history of trial, error, revision, and evolution. Austin continues to look for new tools, new methods of saving water, and new partners that can help further its goals. It is hoped that the lessons learned from this long-running program will be equally helpful to communities beginning to address water supply issues and to those looking for ways to expand current water conservation efforts.

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