

Retrofitting Residential Fixtures – Showerhead, Aerator and Toilet Flapper Programs

Background

The typical U.S. family of four uses 280 gallons of water per day. In North Carolina, 80 percent is indoor water use (AWWA website). The average indoor use in a home with water efficient fixtures and appliances is approximately 35 percent less than without these fixtures (Vickers, 2001). This substantial savings makes residential indoor water efficiency an important component to consider in a comprehensive water efficiency plan. Residential indoor water efficiency programs have many aspects, with varying degrees of cost and water savings outlined in this best management practice. They include:

- Residential showerhead, aerator and toilet flapper retrofit programs;
- Residential toilet replacement programs; and
- Residential clothes washer incentive programs.

Applicability

A showerhead, aerator and toilet flapper retrofit program seeks to replace older, inefficient showerheads, aerators and toilet flappers with high quality, low-flow devices. These can either be installed directly by the utility, a contractor for the utility or by the resident or housing management directly.

This BMP is intended for a water system (“utility”) that has at least 20 percent of the homes and apartment units it serves constructed prior to 1995, and for which there has not been an active retrofit program for efficient showerheads and aerators. This BMP is often implemented in conjunction with the Residential Ultra Low-flow Toilet Replacement BMP.

Description

Plumbing retrofits usually include showerheads and kitchen and bathroom faucet aerators, but may include toilet flappers as well. Four types of high quality, low-flow devices can be installed under this program: showerheads rated at 2.5 gallons per minute (gpm) or less, kitchen faucet aerators of 2.2 gpm or less, bathroom faucet aerators of 1.5 gpm or less, and if included, toilet flappers that flush the toilet at the designed flush volume for that toilet model.

Studies have shown that many 1.6 gallons per flush (gpf) toilets that have been installed are flushing at more than 1.6 gpf. If the utility decides to do a direct install of the low-flow devices, the flush volume of the 1.6 gpf should be checked and, if needed, adjusted to restore the flush volume to 1.6 gpf. If after the water level in the tank is adjusted and the flush volume is still well above the 1.6 gpf, it is likely that the toilet originally had an

early closure flapper. Using the model number on the inside of the toilet tank, determine which flapper is required. Replace the flapper or provide the customer with the replacement information for the flapper.

Implementation

1. The utility should identify the number of single-family (SF) and multi-family (MF) residences constructed prior to 1995. If there is no data of SF homes existing at the end of 1994 readily available, census data can be used. For the most accurate estimate of SF and MF residents, census data from 1990 and 2000, which includes the number of housing units by type, should be used. This data can be used to estimate SF units at the end of 1994, assuming linear growth.

To estimate the number of residences constructed prior to 1995

$$(\# \text{ 2000 SF} - \# \text{ 1990 SF} \times 40\%) + (\# \text{ 1990 SF}) = \text{estimate of end of 1994 SF or detached units}$$

Where # 2000 SF: Number of Single Family Homes or detached units in the 2000 Census data

Where # 1990 SF: Number of Single Family Homes or detached units in the 1990 Census data

The 40% assumes linear growth at 10 percent per year for four years.

A similar calculation can be done for multi-family residences, replacing SF with MF or attached units.

Source: Texas Water Development Board Report 362, Water Conservation Best Management Practices Guide, November 2004.

2. Develop a plan for disseminating the retrofit kits, either by directly installing the plumbing devices in single-family homes and multi-family residential facilities, by providing the kits for installation with follow-up inspections, or by distribution directly to customers with no follow-up.
3. If doing a direct install program, include a program to restore the flush volume of 1.6 gpf toilets to the design flush volume, if feasible.
4. After determining the potential number of participants, begin distribution to customers. See *Table 1: Distribution Methods, Potential Participation Rates, and Approximate Costs for Plumbing Fixtures* for more information on various aspects of different distribution methods.

Table 1: Distribution Methods, Potential Participation Rates, and Approximate Costs for Plumbing Retrofit Kit Programs

Kit Distribution Method*	Description	Pros	Cons	Potential Customer † Participation Rates	Approximate Cost ‡ of Program Per Household
Door to Door Canvass	Retrofit kits are delivered directly to households for installation by residents. Follow-up canvassing by trained technicians encourages or assists residents with installation.	High participation rates reported by targeted customers who respond to telephone surveys	Discrepancy between customer-reported installation rates; not all customers who receive a kit can be certain to install it.	50-75%	\$13-\$20
Direct Installation	Trained technicians are hired to install fixtures directly in homes, helping to ensure that the devices are installed correctly and not wasted. This method is often combined with other indoor and outdoor water-use audit.	Perhaps the most reliable installation technique for achieving water savings with retrofit devices because it is verified by installers; particularly effective for multifamily dwellings where users may not be motivated to install devices themselves	Usually the most expensive installation method.	40-60%	\$17-\$30
Mass Mailing	Kits are mailed directly to all customers or targeted customers for installation by residents.	Low-cost delivery method gets kit directly to customers who return cards requesting mail-out kit.	No direct contact with customer installation unless they request help of information; not all customers who receive a kit can be certain to install it.	15-60%	\$10-\$15
Depot Pickup	Customers are notified of depot locations, such as public buildings, libraries, and schools, where they can pick up the free kits.	Low administrative costs and responsibility	May attract only customers who are motivated to pick up a kit; it cannot be assumed that all customers who pick up kits will install the devices.	5-40%	\$8-\$13
Rebate	Utility provides rebates to customers who install a low-volume showerhead (and possibly other devices or fixtures).	Reward for customers who install conservation devices	May attract only customers who are motivated to install devices; rebate application process may be time-consuming and expensive for both program sponsor and customer without significant water savings if participation rate is low.	5-30%	\$15-\$20
Kit Requests	Water utility or sponsoring agency offers kits to customers who request them. Kits can be customized for residents' needs.	Minimal program design, management, and administrative responsibilities for program sponsor.	Not all customers who request a kit can be certain to install it. Verifying installation is difficult.	Poor	\$7-\$12

* Assumes each delivery method provides the same type of kit: two toilet displacement devices, two 2.5 gpm showerheads, two faucet aerators, toilet leak-detection tablets, and water conservation information booklet.

† Range shown is possible but not certain depending on a particular program's design, implementation, and targeted base.

‡ Includes approximate cost of kit and delivery method; actual costs vary according to unit price per kit and program-specific costs for promotion, contract labor, postage, printing, surveys, and other program specifics.

Source: Handbook of Water Use and Conservation, Vickers, 2001, page 99.

Schedule

Based on the approach(es) selected, the following schedule should be followed:

1. Direct Install and Kit Distribution Approach

In the first 12 months: Plan a program including stakeholder meetings as needed. Locate plumbing contractors or retrofit companies who may be interested in bidding on the program. Determine a plan for educating homeowners, apartment owners and managers, plumbers and realtors about this program. Solicit bids and initiate the program. Include inspections by utility personnel, or a third party, to verify the plumbing devices installation. Each year, 10 percent of eligible single-family homes and 10 percent of eligible multi-family units should be retrofitted to maintain program development. Continue the program until 50 percent of eligible single-family houses and multi-family units are retrofitted.

2. Direct Giveaway of Kits by Customer Request, Targeted Giveaways and/or General Public Outreach Events.

In the first 12 months: Plan a program to target general distribution of the retrofit kits to neighborhoods of single-family and multi-family residences that were built before 1995. For information on strategies for retrofit kit distribution directly to customers, see Table 1. For years 2-5, continue with the distribution of the retrofit kits.

Scope

To accomplish this BMP, the utility should:

- Develop and implement a plan to distribute or directly install high quality, efficient plumbing devices to single-family and multi-family units constructed prior to 1995.
- Implement the distribution or installation programs to achieve retrofits on at least 10 percent of eligible single-family units and 10 percent of eligible multi-family units each year. Utilities with more than 200,000 connections should retrofit at least 20,000 eligible homes and units each year.
- Within five years of implementing this program, retrofit at least 50 percent of eligible single-family houses and multi-family units with the specified devices. For utilities with more than 200,000 connections, at least 100,000 eligible homes and units should be retrofitted within five years.

Documentation

To track the progress of this BMP, the utility should gather:

- An inventory of the number of single-family and multi-family buildings prior to 1995, which are targeted by this BMP.
- For each year of implementation, maintain records of the number of single-family and multi-family units retrofitted;
- For each year of implementation, maintain records of the number of showerheads, bathroom faucet aerators, kitchen faucet aerators and toilet flappers (by category) installed in single-family and multi-family units;
- If kits are given directly to customers without follow-up installation verification, the utility should maintain records of the number and type of plumbing devices distributed.

Determination of Water Savings

Calculate water savings as follows:

$$\text{Water Savings} = \text{Number of Devices Retrofitted} \times \text{Device Savings}$$

- Device Savings may be found in Table 2: Retrofit Device Savings Table
- Number of Devices Retrofitted = 1.0 x Number Devices Installed (when using Direct Installation Approach) OR
- Number of Devices Retrofitted = 0.3 x Number of Devices Installed (when using Kit Distribution Directly to the Customer Approach)

Source: Texas Water Development Board Report 362, Water Conservation Best Management Practices Guide, November 2004.

Table 2: Retrofit Device Savings Table

Device	Initial Savings (gallons per day or gpd per device)	Device Life Span (Savings)
Showerheads and Faucet Aerators	5.5 gpd	Permanent*
Toilet Flapper	Up to 12.8 gpd **	Five years

Notes:

(*) The actual device life span is five to 15 years; the savings are permanent because inefficient equipment can no longer be purchased. In 1992, Congress passed the Energy Policy Act of 1992 which, among other things, mandated maximum flow rates for toilets, urinals, showerheads, and faucets.

(**) Residential End Use Study 5 average for toilet leakage was 9.5 gpcd, which can be translated to gpd per toilet by multiplying by average household size (2.7) and dividing by average number of bathrooms (2) Per single-family house. The utility should try to estimate actual savings based on measured leakage rate. $(9.5\text{gpcd} \times 2.7) / 2 = 12.8$ gpd per toilet

Source: Texas Water Development Board Report 362, Water Conservation Best Management Practices Guide, November 2004.

The showerheads and faucet aerators should result in 5.5 gallons per day savings for between five years and 15 years. If the toilet flapper program is also used, then approximately up to 12.8 gallons per day could be saved for around five years.

Cost-Effectiveness

The significant expenses associated with this BMP will be the costs of purchasing the devices, the distribution costs and administrative costs. Usually contractors have been hired to conduct kit installation and door-to-door distribution programs. Labor costs are usually bid based on a unit cost per showerhead, aerator or flapper installed or per kit delivered. Labor costs exist for utility staff to bid the project, oversee the contractor, and conduct spot inspections of the contractors' work.

Utilities often have programs where customers pick up the kits. Labor costs range from \$10 to \$30 per single-family customer for showerhead and aerator installation and an additional \$5 to \$20 per toilet replacement. Multi-family residences will usually have their own staff for installation.

High-quality showerheads purchased in bulk are available starting at less than \$2 each with aerators costing less than \$1 each. Flappers range in cost from \$3 to \$10. When choosing between models of equipment that have varying degrees of water efficiency, only the incremental cost of the more water efficient device should be compared with the benefits to the utility in order to determine the maximum water efficiency benefit.

Administration of the program can be conducted by utility staff or contracted out. Marketing and outreach costs may range from \$5 to \$10 per single-family customer. Administrative and overhead costs range from 10 to 20 percent of labor costs. If this program is combined with the Residential Ultra Low-flow Toilet Replacement BMP, there should be efficiencies in these costs. If the distribution of kits through public outreach events is the sole option undertaken, then only the costs of the devices, staff time, and cost of attending the event would be incurred.

For inclusive overall costs per household, please see *Table 1: Distribution Methods, Potential Participation Rates, and Approximate Costs for Plumbing Fixtures* on Pg. 24.

For comments or questions regarding the Retrofitting Residential Fixtures BMP, please contact the water efficiency specialist of the Water Supply Planning Branch at 919-707-9009.

References

- Handbook of Water Use and Conservation, Amy Vickers, Waterplow Press, May 2001.
- DrinkTap.Org, AWWA – Water Use Statistics
<http://www.drinktap.org/consumerdnn/Home/WaterInformation/Conservation/WaterUseStatistics/tabid/85/Default.aspx>.
- Tampa Bay Water Potable Water Conservation BMPs, January 2010.
- Texas Water Development Board Report 362, Water Conservation Best Management Practices Guide, November 2004.
- Legislative Report – Recommendations for Water Efficiency Standards for Water Using Fixtures in Residential and Commercial Buildings, NCDENR, January 2009. http://portal.ncdenr.org/c/document_library/get_file?uuid=5cddf8ca-cf3d-41f3-a84f-6e4985ba1f43&groupId=38322.

Case Study for Retrofitting Residential Fixtures Program

The average indoor use in a home with water efficient fixtures and appliances is approximately 35 percent less than without these fixtures (Vickers, 2001). Many water systems choose to work with residential customers as part of their water reduction efforts to bring these water savings to the residents and the water system. Methods for delivering these services, however, vary depending on the staff and funds available.

Direct Installation – Raleigh, North Carolina

In 2007 and 2008, Raleigh, N.C. experienced a drought of record. The city responded by developing a conservation plan that included retrofitting residential fixtures such as showerheads, as well as offering rebates for the purchase of High Efficiency Toilets (HETs). As part of that program, the city recognized that many low-income families were living in rented, water-inefficient housing. Because traditional rebate programs do not take into account the burden that overhead costs have on low-income communities and renters, a different approach was needed to reach those audiences.

The City of Raleigh Public Utilities Department partnered with the Raleigh Housing Authority and AmeriCorps VISTA members to design a program that would tackle the issues of these community members, while creating a high return on investment (ROI) for the participants. This comprehensive program included:

- Replacing 5,000 3.5 gallon per flush – 5 gallon per flush toilets with new WaterSense labeled ones;
- Replacing 1,000 old showerheads with new 1.6 gallons per minute ones;

- Constructing a water efficiency checkup program with audits and instructor training;
- Engineering a WaterWise Landscaping & Gardening program with a demonstration garden;
- Promoting annual water savings events;
- Compiling brochures and educational presentations.

The program was highly effective. Many, if not all, water bills showed a significant decrease in water consumption, a few by as much as 50 percent. All the public events were well-attended, and the garden still serves as an educational tool for water conservation and efficiency. For more information on this unique partnership or other aspects of their program, please contact the Water Conservation & Efficiency Specialist with the City of Raleigh at 919-996-3468.

General Distribution – Greensboro, North Carolina

As early as 1993, Greensboro recognized growing water supply vulnerabilities and an increasing need for enhanced water efficiency. As part of a comprehensive plan, Greensboro's Water Resources Department partnered with organizations to distribute free water saving showerheads, faucet aerators and toilet flappers to Greensboro customers at all Greensboro libraries, recreation centers, the Farmer's Curb Market and Water Customer Service. From 1996 to 2003, more than 165,000 total pieces of hardware were distributed. Customer rebates of \$4 were credited to 1,488 Greensboro water customers, who purchased closing flappers between 1995 and 1997. For more information about this method of distribution or other aspects of this program, please contact the Water Education Program Coordinator at 336-373-4601.