Water Conservation Best Management Practices

Best Management Practices for Municipal Water Users

Texas Water Development Board

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1.0 Introduction

Water consumption by water utilities serving municipal water customers is driven by a wide variety of domestic, commercial, industrial and institutional needs. BMPs have been developed for utilities to both improve water use efficiency of their own operations and for programs to improve the efficiency of their customers.

It is important that water utilities focus on the efficiency of their supply operations while promoting water efficiency to their customers. A utility can reduce water loss through careful and regular monitoring of its water delivery systems through the System Water Audit and Water Loss BMP. In addition, the Water Conservation Pricing BMP can provide an effective method of encouraging water efficiency by the customer through feedback from the cost of the water to the user. The Prohibition on Water Wasting BMP can help send a message to users about the value of water as well as educate the general populace about simple steps to save water.

Despite the variety of water uses and numbers of water users, many patterns of water use, especially in domestic water use are common. As a result a number of conservation measures have been developed in municipal settings over the past several decades to reduce the total gallons consumed for daily activities without reducing the benefit of the water used. The Showerheads, Faucet Aerators and Toilet Flapper Retrofit BMP and the Residential Toilet Replacement Programs BMP focus on indoor water use. The Residential Clothes Washer Incentive Program BMP encourages the installation of water efficient clothes washers.

The School Education BMP affects water consumption through changes in behavior as students learn about water resources and the wise use of water. The Water Survey for Single-Family and Multi-Family Customers BMP educates customers about specific water saving opportunities as well as water wasting practices which may be present in their home or business.

Outdoor water uses driven by climatic differences, and water needs of different plants, and used for diverse purposes result in BMPs which are focused on good landscape management principles. The Landscape Irrigation Conservation and Incentives BMP focuses on water savings that can be obtained through efficient operation of automatic irrigation systems, while the Water Wise Landscape Design and Conversion Programs BMP focuses on landscape materials.

A utility can reduce water loss through careful and regular metering of water delivered to billed as well as unbilled water uses and through proper maintenance of meters as through the Metering of All New Connections and Retrofit of Existing Connections BMP. For agencies or utilities offering water to wholesale customers who in turn serve retail customers, the Wholesale Agency Assistance Programs BMP offers methods for promoting water conservation among the retail water utilities. In addition, the Conservation Coordinator BMP can provide an effective method of ensuring that the utility's conservation programs are well administered and

effective. The Reuse BMP outlines how utilities can make more efficient reuse of their existing supplies.

The Public Information BMP can affect water consumption through changes in behavior as customers learn about water resources, the wise use of water and the utility's conservation program. The Rainwater Harvesting/Condensate Reuse BMP focuses on water savings that can be obtained through capturing rainwater or the condensate from large cooling systems while the New Construction Graywater BMP focuses on reuse of water which has been used in washing clothes.

Commercial water uses also have a variety of practices and equipment that can benefit from efficiency measures. The Municipal BMPs also include those focused on good water use practices for Park Conservation and for Conservation Programs for Industrial, Commercial, and Institutional Accounts.

Best-management practices contained in the BMP Guide are voluntary efficiency measures that save a quantifiable amount of water, either directly or indirectly, and can be implemented within a specified timeframe. The BMPs are not exclusive of other meaningful conservation techniques that an entity might use in formulating a state-required water conservation plan. At the discretion of each user, BMPs may be implemented individually, in whole or in part, or be combined with other BMPs or other water conservation techniques to form a comprehensive water conservation program. The adoption of any BMP is entirely voluntary, although it is recognized that once adopted, certain BMPs may have some regulatory aspects to them (e.g. implementation of a local city ordinance).

2.1 Conservation Coordinator

Applicability

This BMP is intended for all Municipal Water User Groups ("utility"). A common element in successful conservation programs[1] is a conservation coordinator who is responsible for implementing and maintaining the conservation program.

Description

A Conservation Coordinator is an individual designated to oversee and coordinate conservation efforts within a utility's service area. A regional supplier may have a coordinator that works with all of its wholesale customers. Under this BMP, the utility designates a Conservation Coordinator to be responsible for preparation and implementation of the utility's water conservation and drought contingency plans, preparation and submittal of annual conservation status reports to utility management, and implementation of the utility's conservation program. Other duties should include preparation of the annual conservation budget, promotion of water conservation programs, developing marketing strategies for conservation programs, coordination with other utility staff and promoting the value of conservation programs within the utility, participation in regional water planning conservation and drought period initiatives and management of conservation staff, consultants and contractors when appropriate.

The Conservation Coordinator may have other duties and job titles within the utility. Small utilities may share costs with other small utilities by jointly hiring a Conservation Coordinator. Wholesale suppliers may hire a Conservation Coordinator to serve the retail utilities that receive water from them.

Implementation

Implementation should consist of identifying a Conservation Coordinator and support staff (when needed), whose duties can include the following:

1) Manage and oversee conservation programs and implementation;
2) Document water conservation program implementation status as this relates to state requirements and BMPs adopted;
3) Communicate and promote water conservation to utility management;
4) Coordinate utility conservation programs with operations and planning staff;
5) Prepare annual conservation budget
6) Manage consultants and contractors assisting in implementing the water conservation program;
7) Develop public outreach and marketing strategies for water conservation; and
8) Participate in regional water conservation planning and drought planning initiatives

Often, the Conservation Coordinator is the spokesperson for the utility on conservation issues. For small utilities, the Conservation Coordinator may have other responsibilities. Utilities that jointly operate regional conservation programs are not expected to staff duplicative and redundant Conservation Coordinator positions.

Schedule

Utilities pursuing this BMP should begin implementing this BMP within six (6) months of adoption of the official resolution to initiate the program. Implementation should be completed in a timely manner.

Scope

A utility should staff and maintain the position of Conservation Coordinator and provide support staff as necessary. This includes providing the Conservation Coordinator with the necessary resources to prepare and implement the water conservation program. Depending upon the size of the utility or opportunity to collaborate with neighboring utilities or wholesale agencies within its region, this BMPs objective may be achieved by sharing resources and implementation efforts with other utilities.

Documentation

To track this BMP, the utility should gather the following documentation:

1) Description of the Conservation Coordinator position.
2) The date the Conservation Coordinator was hired.
3) Annual or more frequent reports on progress of water conservation program implementation, costs and water savings.

Determination of Water Savings

Water savings are not quantified for this BMP. The Coordinator assists in the implementation of other BMPs and this additional effort can be considered as essential to the savings accrued by the implementation of the whole range of conservation program(s) which are offered by the utility.

Cost-Effectiveness Considerations

Without specific water savings, it may be difficult to do a true cost-effectiveness analysis for this BMP. However, this BMP is essential to the successful implementation of other BMPs the utility chooses to undertake. There will be non-financial benefits as a result of implementing this BMP such as enhanced public image through increased outreach and visibility in emphasizing conservation programs. The salary and associated overhead expenses for the Coordinator would be the primary costs that would be incurred in implementing this BMP. Depending on size and scope of the water conservation programs, the Coordinator position could be full-time, part-time, shared with others, or contracted out.

References for Additional Information

1) Texas utilities and regional suppliers with conservation coordinators include (but are not limited to) Austin, Corpus Christi, Dallas, El Paso, Lower Colorado River Authority, San Antonio,San Marcos, Post Wood Municipal Utility District, and Harris Galveston Coastal Subsidence District.
2) *Memorandum of Understanding*, California Urban Water Conservation Council, 1999.
3) *Groundwater Conservation Plan*, Edwards Aquifer Authority, 2000.

2.2 Cost-Effectiveness Analysis

Discussion

The decision whether to implement a water conservation program should be based on some type of benefit-cost or cost-effectiveness analysis. The underlying concept is a comparison of the inputs of any action with the outcomes, usually expressed in dollars. In evaluating water conservation efforts, the decisions center around comparison of the costs of implementing a program against the "costs of conserved water" or the "avoided costs" of acquiring new sources of water. In the strictest sense, if the analysis shows that the water user will gain positive value (benefit-cost) or that the costs of one option are less than the costs of another (cost effectiveness), then the conservation program should be implemented. In reality, there are external factors that are also considered such as public perception, long term environmental considerations, or political factors that may affect the decision.

A variety of analytical processes are used in making these types of decisions. One of the most common is use of present value techniques to evaluate expenditures or income incurred at different times. Present value takes into account the time value of money. Basic principles that are part of making valid present value analyses include:

- Selection of the appropriate discount rate.
- Consistency in the consideration of inflation.
- Matching the time period for the analysis.
- Ensuring that all appropriate cost and benefits are considered.

There are many studies, models and worksheets that have been developed to guide the decisions for implementing water conservation programs using present value analysis. For these decision models to be more accurate and consistent, they may be quite detailed in the assumptions made, statistical smoothing of data, and consideration of influencing parameters such as weather or natural replacements.

The challenge is to make an analysis that reflects real life situations and is complete, but still comprehensible and usable. It is important that in an analysis that consistently compares the costs of implementing a conservation program to the costs of water saved or deferred, that the costs themselves be consistently developed.

Program Costs

To determine the program costs of a BMP it is important to include those costs associated with both administration and implementation. They can be categorized generally along the lines of:

- Capital expenditures for equipment or conservation devices.
- Operating expenses for staff or contractors to plan, design, or implement the program.
- Costs to the customers.

Program costs should be measured in reference to the opportunity costs of a program – that is, what must be foregone in order to provide the service. The costs should be realistic costs, both direct and indirect, that would be incurred above and beyond those the entity would normally incur if the program were not implemented. The timing of the costs is extremely important, whether up front, one time only, intermittently recurring, or ongoing on a periodic basis. The analysis should use all of the costs incurred over the life of the program. Specific program considerations for the different BMPs will be developed.

Each BMP has one or more of the costs and benefits categorized below. Cost considerations specific for BMPs are summarized in Section H under the individual BMPs.

- Start up: Any equipment necessary to initiate a BMP such as a computer for database tracking, software, specialized equipment, etc.
- Staff and administrative costs: Water conservation staff or contractor costs for implementing the BMP on an ongoing basis.
- Marketing and promotion: Costs for bill stuffers, media advertising, direct mail, etc., to let customers know about the BMP program. In many cases, marketing and outreach costs and expenses can be reduced or spread out when multiple BMPs are implemented by an entity.
- Materials: Costs for education and other materials provided to customers such as student workbooks and plant guides, etc.
- Incentive: Cost of incentives or rebates and/or any free equipment provided to customers.

Costs of Saved Water

If a conservation program will result in less water used (saved water) from existing supplies or less water needed from a wholesale supplier, then the benefits to the user are developed along the lines of:

- Direct avoided costs of treatment and delivery of water, including labor, energy, and chemicals.
- Costs of water not purchased from a wholesale supplier.
- Other expenses associated with the cost of providing water.

These costs are sometimes known as marginal operating costs. In the case of saved water, the costs that are to be compared to the costs of implementing the program are those directly saved by the provider, and not always the same as the lost revenues at the retail rate that would have been charged to the consumer.

Other benefits that may be considered include:

- Direct benefits: reductions in hot water use, energy use, and landscape labor costs when the frequency of watering and fertilizing is reduced.

- Indirect benefits: better air quality when energy use is decreased; and improved runoff water quality when fertilizer and herbicide use is reduced in landscape related BMPs.
- Environmental: One example would be reduced water withdrawals from rivers due to implementation of BMPs, resulting in more inflows to bays and estuaries.

Avoided Costs of Supply

Avoided water supply costs are those total costs, both capital and operational associated with new water supply that is deferred, downsized, or eliminated because of the conservation effort. These include:

- Capital costs of construction of production, treatment, transportation, storage, and related facilities.
- Costs of obtaining water rights and permits.
- These costs may also include avoided costs of additional wastewater treatment facilities if significant.
- Directs avoided costs of treatment and delivery of water, including labor, energy, and chemicals.

The Texas Water Development Board has very detailed cost guidelines for determining the values of the water management strategies in Section 4.2.9 of its Guidelines for Regional Water Plan Development. In making the comparisons it is very important that costs for water supply facilities still needed, but deferred until some point in the future, are discounted properly in the present value analysis.

Determination of Water Savings

Besides development of the costs themselves, the next most important number in a cost effectiveness analysis is the actual volume of water saved associated with a particular conservation BMP. Careful efforts should be made to ensure that the volumes of water savings are associated with the costs incurred. In some BMPs, the water savings associated with a conservation measure may be continual or permanent, where in other cases they can be determined over a defined life.

In some cases there can be an easy correlation. For example, each toilet retrofit measure is estimated to save 10.5 gallons per day per person. The total amount of water saved by the measure can then be estimated from the number of measures to be implemented. A toilet has an average life of 25 years so the savings due to the program would be estimated over the total life, even though the period of program implementation may be less than that.

In other cases, due to the nature of the BMP, there really are not easy ways to predict water savings. In reality, when BMPs such as these are included along with other water conservation activities, there will be a complementary or synergistic effect that should enhance the overall success of the initiatives.

Cost-Effectiveness Considerations

To make valid cost effectiveness decisions, costs must be presented on a comparable basis. In comparing the costs of conservation programs, the costs of saved water, or avoided costs of water, the costs are usually condensed down to terms of dollars per acre ft ($/ac ft) or dollars per measure ($/unit).

Two levels of comparison costs can be developed from the analyses. At the first level, for general comparison purposes, costs are given as an annualized or amortized value, which is the equivalent to an equal payment per time period over the life of the program for a one-time cost or stream of costs. The second level of costs for specific measures is the present value of all costs for a specific scenario, usually calculated and expressed in $/ac ft.

Example Cost Effectiveness Models

Two models have been developed to provide examples of how the cost effectiveness of conservation programs can analyzed. The example BMP Cost Analysis Spreadsheet is designed for use to evaluate the costs of implementing a BMP. The example Supply Analysis Spreadsheet allows future expenditures to obtain water supply over a period of time to be valued in the present. Then these expenditures can be compared with the present day costs of implementing conservation programs.

Cost of BMP versus New Water Supply: The cost per acre-foot of new water supply and treatment capacity can be compared to the cost per acre-foot achieved by implementing the BMP. The Municipal Supply Analysis Table provides an example of the water supply cost savings that can be achieved by implementing one or more BMPs.

Notes on Present Value and Discount Rate

In order to compute net present value, it is necessary to discount future benefits and costs. This discounting reflects the time value of money. Present value analysis allows a comparison of alternative series of estimated future cash flows – either costs or income. To do a present value analysis we use a “discount rate” which by general definition reflects the minimum acceptable rate of return for investments of equivalent risk and duration.

Benefits and costs are worth more if they are experienced sooner. The higher the discount rate, the lower is the present value of future cash flows. For typical investments, with costs concentrated in early periods and benefits following in later periods, raising the discount rate tends to reduce the net present value.

What discount rate should be used? In constant dollar analyses the real discount rates used reflect the treatment of inflation and the adjustment of future costs for real price escalation. In the private sector, discount rates can vary significantly from investor to investor. We are using the TWDB recommended discount rate of 6 percent that is in line with current economic expectations and those frequently seen used in energy and water conservation projects.

By comparison, the Office of Management and Budget in its Circular A-94 Update (2004) recommends a base rate for Federal project evaluations to be determined using a nominal discount rate of 5.5 percent for 30 year projects. This rate is supposed to approximate the marginal pretax rate of return on an average investment in the private sector in recent years. The Federal Energy Management Program uses life cycle costing for project decision making for potential energy and water conservation projects and has established a nominal rate (includes a general price inflation factor) of 4.8 percent for 2004. The TWDB Planning group periodically uses an EPA recommended 6.38 percent in water infrastructure cost effective analyses.

Example Spreadsheet for BMP Cost Effectiveness Analysis

Municipal conservation programs typically involve the implementation of a combination of several BMPs. In this spreadsheet example are models based upon existing state plumbing code which will account for expected changes in demand due to natural replacement of less efficient plumbing fixtures over the next several decades. These anticipated changes are accounted for in the Cost Savings Analysis and Program Planning sheets that the conservation analyst will use to determine cost-effectiveness. This model can be expanded to include additional BMPs in a scenario-building model that can be used in conjunction with the Supply Analysis Needs worksheet.

Utility baseline information is required to be put in, as well as confirmation of assumptions for program implementation. Information required to be input for these BMPs includes:

	Example
2000 SF Population	752,791
2000 MF Population	248,658
Institutional Population	0
2000 SF Units	270,788
2000 MF Units	207,215
1995 SF Units	63,294
1995 MF Units	203,574
SF Growth Rate (Calc Ann Avg)	0.6%
MF Growth Rate (Calc Ann Avg)	0.4%
No. of ICI Customers	20,000
SF Household Size	2.78
MF Household Size	2.44
No. of Bathrooms per SF House	2.0
No. of Bathrooms per MF Unit	1.2

The following data is used by default, unless the user has more accurate data.

Category:	**Default**
No. of Bathrooms per SF House	2.0

No. of Bathrooms per MF Unit	1.2
No of Irrigation Months	6
% of High Use SF customers	10%
No. of MF Units per Washer	18
No. of MF Units per Complex	50
Additional Data:	
Toilet Natural Replacement Rate	2.0%
Showerhead Natural Replacement Rate	6.7%
Annual SF Program Goal (Housing Turnover Rate)	6.7%
Annual MF Program Goal (MF Housing Turnover Rate)	10%
Percent of SF Units with CWs	95%
Discount Rate	6.0%
Projected Inflation Rate	2.0%

These models also use net free ridership assumptions, a very real consideration in plumbing fixture program analysis. This considers the number of measures receiving an incentive that would have done the program anyway less the number of measures that were done because of the publicity about the conservation program without any incentives (free drivers).

The resulting information can be used in decisions to select cost effective BMPs to meet the water saving goals of the utility.

TABLE 1 EXAMPLE BMP COST SAVINGS MODEL

	Selected Length of Program (years)	Life of Measure (years)	Savings per Residential Capita (gpd)	Savings per Living Unit (gpd)
Residential	1	2	3	4
SF Toilet (ULFT) Retrofit BMP	10	25.0	10.5	29.2
SF Showerheads and Aerators BMP	10	15.0	5.5	15.3
MF Toilet (ULFT) Retrofit BMP	10	25.0	10.5	25.6
MF Showerheads and Aerators BMP	10	15.0	5.5	13.4
SF Irrigation Survey	10	10.0	18.0	50.0
ICI Irrigation Survey	10	10.0	NA	NA

	No. of Measures / Living Unit	Savings per Measure (gpd)	Natural Penetration Rate	Program Penetration Goal
Residential	5	6	7	8
SF Toilet (ULFT) Retrofit BMP	2.0	14.6	18%	80%
SF Showerheads and Aerators BMP	2.0	7.6	53%	80%
MF Toilet (ULFT) Retrofit BMP	1.2	21.4	20%	80%
MF Showerheads and Aerators BMP	1.2	11.2	53%	80%
SF Irrigation Survey	1.0	50.0	0%	50%
ICI Irrigation Survey	NA	470.0	0%	25%

	Number of Measures at Penetration Rate	Estimated Annual Savings (at Penetration Rate) (gpd)	Estimated Annual Savings (at Penetration Rate) (acre-ft/yr)	Number of Years to Reach Penetration Goal
Residential	9	10	11	12
SF Toilet (ULFT) Retrofit BMP	275,761	4,024,725	4,508	22
SF Showerheads and Aerators BMP	110,990	848,518	950	11
MF Toilet (ULFT) Retrofit BMP	138,200	2,950,563	3,305	15
MF Showerheads and Aerators BMP	64,077	716,600	803	8
SF Irrigation Survey	13,539	676,970	758	10
ICI Irrigation Survey	5,000	2,350,000	2,632	10

TABLE 1 cont.

	Penetration Estimated at 10 Yr	Program Costs per Measure	Estimated Net Free Ridership	Net Program Costs per Measure
Residential	**13**	**14**	**15**	**16**
SF Toilet (ULFT) Retrofit BMP	61%	$ 85	10%	$ 94
SF Showerheads and Aerators BMP	79%	$ 7	50%	$ 14
MF Toilet (ULFT) Retrofit BMP	70%	$ 75	10%	$ 83
MF Showerheads and Aerators BMP	82%	$ 4	50%	$ 8
SF Irrigation Survey	NA	$ 50	1%	$ 51
ICI Irrigation Survey	NA	$ 200	1%	$ 202

	Cost per AF of Water Saved (Amortized)	Total Program Costs (at Penetration Rate)	Present Value of Program Costs (year 1 = 2005)	Estimated Water Saved over Life of Measure (acre ft)
Residential	**17**	**18**	**19**	**20**
SF Toilet (ULFT) Retrofit BMP	$ 452	$ 26,044,051	$ 19,112,751	101,436
SF Showerheads and Aerators BMP	$ 168	$ 1,553,858	$ 634,306	7,128
MF Toilet (ULFT) Retrofit BMP	$ 273	$ 11,516,638	$ 9,117,548	74,364
MF Showerheads and Aerators BMP	$ 66	$ 512,620	$ 371,221	6,020
SF Irrigation Survey	$ 123	$ 683,808	$ 540,425	7,583
ICI Irrigation Survey	$ 52	$ 1,010,101	$ 980,392	26,323

	Present Value Per Acre Foot Saved	Standard Delivery Description	Other Delivery Options
Residential	**21**	**22**	**23**
SF Toilet (ULFT) Retrofit BMP	$ 188	free or rebate	direct install
SF Showerheads and Aerators BMP	$ 89	kits picked up by customer	door to door dist or direct
MF Toilet (ULFT) Retrofit BMP	$ 123	free or rebate	direct install
MF Showerheads and Aerators BMP	$ 62	kits picked up, installed by apt.mgmt	
SF Irrigation Survey	$ 71	audits performed by utility staff	contractor performs audits
ICI Irrigation Survey	$ 37	audits performed by utility staff	contractor performs audits

TABLE 1 cont.

Notes to Municipal cost Savings Model

SF=single-family, MF=multi-family *Population figures are from 2000 Census

Column 1 - user selects the length of time the program will be implemented for.

Column 2- assumed useful life of the measure

Column 3 - savings per person in gallons per day

Column 4 - savings per housing unit in gallons per day (Col 3 x No.of persons per living unit, input page)

Column 5 - the number of measures needed for each living unit

Column 6 - gallons saved per day for each measure

Column 7- estimated percentage penetration of efficient measures already accomplished: either defined or calculated from models

Column 8 - the potential number of customers who could be expected to implement the program with substantial marketing and outreach- includes natural replacements and retrofits

Column 9 - estimated number of measures ultimately accomplished by program (no. of MF or SF units x no. of measures per unit)

Column 10- potential savings in gallons per day (column 10 x column 7)

Column 11- potential savings for the region in acre-feet [(column 11 x 365) / 325,851]

Column 12- years to reach penetration goal selected in Column 9

Column 13- actual penetration achieved during life of program (Column 1) and desired retrofit goal per year (turnover rate, input page)

Column 14- program costs including rebates, staff time and marketing

Column 15- percentage of free ridership, or those that would participate even without incentive

Column 16- net program costs after adjusting for net free ridership

Column 17 - amortized cost per acre foot of water saved each year [(column 17 x 325,851 gallons/AF) / (column 6 x 365 days)]) amortized at discount rate over the life of the measure

Column 18 - total program cost (column 7 x column 10)

Column 19 - net present value of costs of program incurred each year

Column 20 - total acre feet of water expected to be saved over expected life of measure (col 7 x col 10 x col 2)

Column 21 - net present value of program per acre ft saved (col 20 divided by col 21)

Column 22 - delivery option(s) for which costs are estimated

Column 23 - other possible delivery options

Municipal Cost Effectiveness Example

This example shows a straight forward example of a midsize utility that is growing and that anticipates that it will have to purchase water rights or develop additional water supply. The utility would prefer to delay purchasing these additional rights if one of more BMPs would achieve the required savings to delay the purchase. This analysis does not take into account the reduced operating cost benefit to the utility of implementing the conservation measures.

A simple Example Municipal Supply Analysis spreadsheet has been set up for use by the utility to *Find the Benefit to the Utility of a Delay in Purchasing Water Supply*. The utility enters:

- increase in annual water demand (AF),
- number of AF to be purchased,
- number of years until the purchase will be made,
- cost for the additional water rights,
- years of the new supply contract,
- number of years of delay desired, and
- discount rate.

The Example Municipal Supply Analysis spreadsheet set up for this example contains the following assumptions (region-specific data from the State Water Plan or utility generated data should be used when performing this analysis for a particular conservation program):

- The utility water demand is increasing by 1000 AF per year.
- In 10 years, the utility anticipates being at 90 percent of its existing water supply and plans to purchase an additional 25,000 AF of water.
- The new water supply will cost $400 per AF and will be a 50-year contract.
- Water costs are anticipated to rise 2 percent per year.
- The utility hopes to delay the purchase by 3 years.
- The assumed discount rate is 6 percent.

Based on these assumptions, the utility would have to conserve 3000 AF of water. The Municipal Supply Analysis spreadsheet shows the present value of water saved ($/AF). To get to this number the spreadsheet includes several calculations. First the value of a 50-year water contract starting in 2015 is determined. It has been calculated using Microsoft Excel's NPV function. In this case, the NPV function is used to calculate the total amount that a series of future payments is worth in 2015.

- The syntax of the Microsoft NPV function is NPV(rate,nper,pmt1,pmt2, pmt3,…);
- Rate is the interest rate per period. For simplicity this is presented as 6 percent per annum;
- Pmt1, Pmt2, Pmt3, …, are the annual payments for the time period selected. For this example the contract is 50 years, starting at $400 per AF in year 1 and increasing by 2 percent per year.

- Next the NPV function is used to calculate the value of the 50-year water contract if it started after a 3-year delay, which would be 2018.

  To determine the present value of the water saved, the difference in the present value in 2005 for the 2015 NPV value and the 2018 NPV value is determined. This is done using the appropriate discount factor. The difference between the 2015 and the 2018 PV values in 2005 dollars is the value of the conserved water.

  Energy and chemical deferred cost savings are calculated in a separate tab and entered in this tab.

  The present value of the delay and deferred chemical and water savings is $930 per AF that could be compared to the cost of implementing the water saving BMPs.

TABLE 2 EXAMPLE MUNICIPAL SUPPLY ANALYSIS WORKSHEET

Utility Entered Variables

1	Cost per AF	$	400	
2	No. of AF Purchase		25,000	
3	No.of Years until Purchase: No Conservation		10	
4	Annual Increase in Water Demand (AF)		1,000	
5	No of Years of Contract		50	
6	Delay Projected Due to Conservation		3	
7	Discount Rate		6.0%	
8	Increase in Water Costs per Year		2.0%	
9	Annual Cost per AF for Energy and Chemicals	$	65.00	
10	Estimated Annual Inflation in Energy and Chemical Costs		2.0%	
11	Water Savings Required (AF)			**3,000**
12				

13	Present Value of Contract if Purchased in 2015		Present Value of Contract if Purchase Delayed Until 2018	PV Value of Conservation per AF
14			642.36	
15		$8,538.78	$9,061.42	
16		0.538615114	0.447365096	
17		$4,599.12	$4,053.76	**$545.35**
18				**$384.91**
19				**$930.26**

Notes

1 Negotiated or anticipate cost per AF
2 Amount of water to be purchased in AF
3 Anticipated date when water will be purchased without conservation
4 Projected annual increase in water demand without conservation
5 Length of supply agreement
6 Desired delay due to conservation
7 Rate that will be used to discount future cost back to present value in todays' dollars
8 Projected annual increase in user rates during the period of delay
9 Actual costs for Energy and Chemicals for water treatment per AF
11 This is the total water savings needed based on the annual growth in water demand and the length of delay selected
15 Cost per AF: This amount is the value for the 50 years of payment for 1 AF in 2015 and 2018.
16 Discount to Present: The calculated discount amount from 2015 to 2005; and 2018 to 2005
17 Present Value of Delay: The difference in the discounted value from 2015 to 2005; and 2018 to 2005
18 PV of Energy and Chemical Savings: From Energy and Chemicals tab
19 Total Present Value of Delay

References for Additional Information

1) *Waste Not, Want Not: The Potential for Urban Water Conservation in California,* Pacific Institute, November 2003.
2) *BMP Costs and Savings Study,* prepared for The California Urban Water Conservation Council, by A & N Technical Services, July 2000.
3) *Cost-Effective Cost Effectiveness: Quantifying Conservation on the Cheap,* David L. Pekelney, Thomas W. Chesnutt, and David L. Mitchell, Abstract of Paper presented at AWWA National Conference June 26, 1996.
4) Office of Management and Budget Circular No. A-94 Revised, October 29, 1992.
5) OMB Circular No. A-95, Appendix C (revised February 2004).
6) *Life-Cycle Costing Manual for the Federal Energy Management Program,* prepared for the U.S. Department of Energy, Sieglinde K. Fuller and Stephen R. Petersen, February 1996.
7) *Energy Price Indeces and Discount Factors for Life-Cycle cost Analysis – April 2004*, prepared for U.S. D.O.E, by U.S. Department of Commerce.

2.3 Water Survey for Single-Family and Multi-Family Customers

Applicability

This BMP is intended for a Municipal Water User Group ("utility") that has 20 percent of homes and apartments constructed before 1995 and/or more than 10 percent of landscapes with automatic irrigation systems. If the utility is unaware of the number or percentage of customers using automated irrigation systems, a drive-by survey can be conducted of a sample of customers to develop an estimate of how many have automatic systems. Once a utility decides to adopt this BMP, the utility should follow the BMP closely in order to achieve the maximum water efficiency benefit from this BMP.

Description

A Water Survey Program can be an effective method of reducing both indoor and outdoor water usage. Under this BMP, the utility conducts a survey of single-family and multi-family customers to provide information to them about methods to reduce indoor water use through replacement of inefficient showerheads, toilets, aerators, clothes washers, and dishwashers. If the customer has an automatic irrigation system, the survey includes an evaluation of the schedule currently used and recommends any equipment repairs or changes to increase the efficiency of the irrigation system.

Surveys should be offered based on water use starting with the highest single-family and multi-family accounts, respectively. Multi-family accounts should be analyzed based on gallons per unit, although almost all multi-family customers would benefit by this survey if they have not already retrofitted plumbing fixtures. The irrigation component of the single-family survey should target single-family customers using more than a certain amount of water per billing period that could be considered excessive for the particular geographic area and other characteristics of the service area. Typically, this is around 20,000 gallons per month in summer since that could represent an outdoor use of more than 12,000 gallons per month. Surveying outdoor water use in homes with water use below 20,000 gallons per month does not usually provide as significant an opportunity for water reductions. Customer water use records can give the utility a snapshot of which neighborhoods have higher than average water use. The drive by survey should note which lawns have monoculture of a turfgrass species and/or visible irrigation heads indicating an automated sprinkler system.

Once the scope of services is determined, there are three options for conducting the survey: train utility staff to conduct an onsite survey; hire an outside contractor to conduct the onsite surveys; or provide a printed or online survey for customers to complete on their own. When conducting an onsite survey for a customer with an automatic irrigation system that is managed by an irrigation or maintenance contractor, it is beneficial to have the contractor present for the irrigation system survey.

For the indoor water use survey, a form can be used to provide the information on water reductions that would be achieved with each type of equipment change and the length of the payback period, taking into account any utility incentives that may be available. If it is an onsite survey, showerhead and faucet aerators can be changed during the survey.

A leak check should be conducted to determine if there are any toilet leaks occurring and any dripping faucets. If 1.6 gallons per flush toilets have already been installed, the flush volume should be checked and, if needed, the water level in the tank should be adjusted to restore the flush volume to 1.6 gpf. If after the water level in the tank is adjusted, the flush volume is still well above 1.6 gpf, it is likely that the toilet originally had an early closure flapper. Using the model number on the inside of the tank and the Flapper Table (see References for Additional Information), the flapper required to restore the flush volume to 1.6 gpf can usually be determined. If the flapper is one of several early models of closure flappers, the flapper should be replaced during the survey and the information on the correct replacement flapper should be provided to the customer.

Information on water use habit changes such as shorter showers, for example, should also be provided at the time of the survey. The customer should be provided information on climate-appropriate landscaping and about any programs the utility has for incentives to replace inefficient landscaping.

The survey of automatic irrigation systems should include a check of the entire system for broken, misdirected or misting heads and pipe or valve leaks. The customer's service line and meter box should also be checked for leaks. The system should be run to determine precipitation rates for typical zones. Each zone should be checked to be sure that rotors and spray heads are not on the same zone since they have greatly different precipitation rates. Head spacing should be checked to determine if proper heads are installed. The schedule on the irrigation controller should be checked and the customer queried about how the schedule is adjusted during the year. A schedule should be provided based on evapotranspiration ("ETo")-based water-use budgets equal to no more than 80 percent of reference ETo per square foot of irrigated landscape. The statewide Texas Evapotranspiration Network (http://texaset.tamu.edu/) should be consulted for historical evapotranspiration data and methodology for calculating reference evapotranspiration and allowable stress. More aggressive landscape conservation programs can utilize stress coefficients lower than 80 percent (*See* website). For larger water users, a uniformity analysis can be conducted. The customer should be provided a written report on the system repairs and equipment changes needed and the appropriate efficient irrigation schedule by month. The controller should be reset with the efficient schedule. If the system does not have a rain sensor, it should be installed as part of the survey if feasible or provided to the customer to be installed by a contractor. Information should be provided on the installation of dedicated landscape meters for multi-family customers if offered by the utility.

Implementation

The utility should develop and implement a plan to market these surveys to both single-family and multi-family customers. Marketing should be done by ranking single-family customers according to water use on a monthly average and offer the program starting with those with the highest water use as a means of increasing cost effectiveness and water savings rapidly. Multi-family customers should be ranked by water use per unit. The survey can be offered by mail, telephone calls, email or through utility bill stuffers or other appropriate methods of communication. The Showerhead, Aerator, and Toilet Flapper Retrofit BMP outlines a method for determining the number of homes and apartments constructed before 1995.

The customer incentive to participate can be reduced utility costs and also recognition as a water efficient customer. If the utility has incentive programs for 1.6 gpf toilets, efficient clothes washers, irrigation systems upgrades, or water efficient landscape, the survey should include this information in the report to the customer.

Once a customer agrees to participate, the utility should collect the following information in the survey:

1) Calculation of the ratio of summer to winter use based on a review of the customer water bills;
2) Pressure on the customer's side of the meter;
3) Number and flush volume for each toilet;
4) If any 1.6 gpf toilets are flushing at greater than 1.6 gpf due to replacement of early closure flapper with standard flapper;
5) If any toilets are leaking around the flapper or over the overflow tube;
6) Showerhead and aerator flow rates in gallons per minute ("gpm") when valve is fully open;
7) Estimated capacity of current clothes washer. If it is a top loading inefficient model, use 41 gallons per load as an estimate;
8) If customer has a swimming pool, the frequency and duration of backflow. Check fill valve and float to determine if working properly. Turn fill valve off at the start of survey to see if any drop in water level is noticed. Ask customer if they have noticed any leakage from pool;
9) Irrigation schedule as indicated on the controller. Ask customer who is responsible for changing the schedule and how often that occurs, if the system is turned off in winter months and if turfgrass areas are over seeded in winter.

The changes that can be made immediately at the time of the survey include:

1) If needed, installation of showerheads using 2.0 gpm or less; kitchen faucet aerators using 2.2 gpm or less and bathroom faucet aerators using 1.5 gpm or less;

2) Resetting the toilet tank water levels to the correct level. Replacement of leaking flappers or flappers that cause the toilet to flush above the design flush volume.
3) Determination of irrigation system precipitation rate for representative zones or all zones if needed;
4) Resetting controller with efficient schedule based on ET and measured precipitation rates;
5) Providing the customer a copy of the twelve months irrigation schedule and attach a copy near the controller;
6) Showing the customer how to use the controller so they can adjust controller throughout the year;
7) Installing a rain sensor on the irrigation system if needed and feasible;
8) Explaining to customer any incentives that the utility offers and how to take advantage of these incentives; and
9) Providing customers a brief report on estimated savings for each item listed in the report and the estimated payback for each item.

The changes that may need to be done after the survey by either a contractor for the utility or by the customer include:

1) Replacing inefficient toilets with 1.6 gpf models;
2) Restoring correct flush volume of existing 1.6 gpf toilets by installation of early closure flapper correctly matched to the model of toilet;
3) Fixing faucet leaks;
4) Replacing the inefficient clothes washer with a new efficient model;
5) If needed, repairing the fill valve on the swimming pool;
6) Replacing damaged portions of the irrigation system;
7) Installing a new controller if warranted such as an ET based irrigation controller;
8) Installing a rain sensor; and
9) Installing a pressure reduction valve if needed.

To assure that the water savings measures recommended during and after the survey are achieved, the utility should follow up with the customer to determine which were actually implemented. The utility should begin a notification program to remind customers of the need for maintenance and adjustments in irrigation schedules as the seasons change and to check toilets and faucets for leaks.

Schedule

1) The scope of this BMP should be realized within five years of the date implementation commences.
2) Develop and implement a plan to target and market water-use surveys to all residential customers using more than 20,000 gallons per month in summer

months and all multi-family customers in the six months of the first year after implementing this BMP.

3) Repeat marketing efforts until the goals are reached.

Scope

To accomplish this BMP, the utility should:

1) In the first year, implement the program and complete a survey of at least 1 percent of eligible single-family customers and 1 percent of multi-family customers;
2) In years two through five, complete a survey of at least 5 percent of eligible single-family customers and at least 5 percent of multi-family customers;
3) Within 5 years, complete water-use surveys for at least 25 percent of eligible single-family customers and 25 percent of multi-family customers; and
4) Follow up on each survey completed within three months of completion and then annually thereafter to encourage implementation of survey recommendations.

Documentation

To track this BMP, the utility should gather the following documentation:

1) Number of residential customers,
2) Number of single family customers using more than 20,000 gallons per month in summer months;
3) Number of multi-family customers;
4) Number of surveys offered and number of surveys completed by customer type; and
5) Measures installed during the customer surveys or completed after the survey and verified through a follow-up phone call.

Determination of Water Savings

Saving should be based on measures implemented by each customer. Savings are calculated by multiplying the number of each type of measure implemented by the savings for that measure as listed below.

1) Single-Family Home
   - Irrigation Audit: Actual utility survey results or 26 gallons per day ("gpd")[1] per house.
   - Showerhead and aerator replacements: 5.5 gpd per person
2) Multi-Family Community

- Irrigation Audit: Actual utility survey results or 15 percent[2] of outdoor water use or 208 gpd[1]
- Showerhead and aerators: 5.5 gpd per person

Savings for resetting toilet tank levels, toilet leak repair, flapper replacement and installation of rain shut-offs should be estimated during the water survey. The rain shut-off savings depend both on the ET of the customer as well as the setting on the rain shut-off switch which can be set to shut off after rainfall of ¼ to 1 inch. If the survey results in toilet and clothes washer replacements, these savings can be included in either this BMP or the Toilet Retrofit or Efficient Clothes Washer BMP if the utility has adopted those BMPs.

Cost-Effectiveness Considerations

Surveys can be performed by utility staff or by contractors. The labor costs range from $50 to $150 for a SF survey and start at $100 for a MF survey and go up from there depending on the efficiency in scheduling and the scope of the survey.

If water efficient plumbing fixtures are distributed during the survey, the costs of that equipment should be considered. 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.

There may be other one-time costs such as purchase of leak detection equipment and meters. Marketing and outreach costs range from $5 to $15 per survey. Administrative and overhead costs range from 10 to 20 percent of labor costs.

References for Additional Information

1) *Project Review of the Irvine ET Controller Residential Reduction Study*, Irvine Ranch Water District, November 2003. http://www.irwd.com/Conservation/R3ProjectReview.pdf
2) *CUWCC BMP No. 5: Large Landscape Program and Incentives*. http://www.cuwcc.org/m_bmp5.lasso
3) *WaterWise Council of Texas.* http://www.waterwisetexas.org/
4) *Austin Green Gardening Program.* http://www.ci.austin.tx.us/greengarden/
5) *Texas Cooperative Extension for El Paso County.* http://elpasotaex.tamu.edu/horticulture/xeriscape.html
6) *San Antonio Water System Conservation Program.* http://www.saws.org/conservation/
7) *City of Corpus Christi Xeriscape Landscaping.* http://www.cctexas.com/?fuseaction=main.view&page=1047
8) *EWEB Home Water Survey Database: PowerPoint Presentation,* Jill Hoyenga, Eugene Water and Electric Board, Water Sources Conference Proceeding, 2004.

9) *CUWCC Cost Effectiveness Models, BMP 1 Water Surveys*. http://www.cuwcc.org/ce_spreadsheets.lasso
10) *Toilet Flappers: A Weak Link in Conservation in Water Conservation,* John Koeller, http://www.cuwcc.org/Uploads/product/Flappers_Weak_Link.pdf
11) *Tampa Bay Water List of Toilets and Replacement Flappers,* Dave Bracciano, Tampa Bay Water, Tampa, Florida
12) *CUWCC BMP No. 5: Large Landscape Program and Incentives.* http://www.cuwcc.org/m_bmp5.lasso
13) *Turf and Landscape Irrigation Best Management Practices*, Water Management Committee of the Irrigation Association, February 2004. http://www.irrigation.org/gov/pdf/IA_BMP_FEB_2004.pdf
14) *Waste Not, Want Not: The Potential for Urban Water Conservation in California,* Pacific Institute, November 2003. http://www.pacinst.org/reports/urban_usage/waste_not_want_not_full_report.pdf

3.1 Water Conservation Pricing

Applicability

This BMP is intended for all Municipal Water User Groups ("utility") wishing to send price signals to customers to encourage water conservation. A utility may have already accomplished this BMP if it currently has a conservation price structure.

Description

Water Conservation Pricing is the use of rate structures that discourage the inefficient use or waste of water. Conservation pricing structures include increasing unit prices with increased consumption such as inverted block rates, base rates and excess use rates such as water budget rates, and seasonal rates. Seasonal rate structures may include additional charges for upper block (outdoor) usage or excess-use surcharges for commercial customers to reduce demand during summer months. The goal of conservation pricing is to develop long run consumption patterns consistent with cost. Under this BMP, utilities should consider establishing rates based upon long-run marginal costs, or the cost of adding the next unit of capacity to the system. An established cost of service methodology should be followed whenever rates are developed or proposed for change.

This BMP addresses conservation pricing structures for retail customers. For utilities supplying both water and sewer service, this BMP applies to pricing of both water and sewer service. Utilities that supply water but not sewer service should make good faith efforts to work with sewer agencies so that those sewer agencies do not provide sewer services for a declining block rate.

For conservation pricing structures to be effective, customers should be educated on the type of rate structure that the utility uses and be provided monthly feedback through the water bill on their monthly water use. Most customers do not track water use during the month because of the difficulty and inconvenience of reading the meter. When customers read their bill, they most often just look at the total amount billed. Conservation pricing has the advantage of providing stronger feedback to the customers who will see a larger percent increase in their water bill than the increase in water use. Utilities should move toward adopting billing software that allows customers to compare water use on their bill with average water use for their customer class as well as their individual water use for the last 12 months. The rate structure should be clearly indicated on the water bill.

It is not recommended that a minimum monthly water allotment be included in the minimum bill. The AWWA notes that minimum charges are often considered to work counter to conservation goals and are unfair to those who use less than the monthly minimum. A customer who does not use the entire amount included in the minimum during the billing period will be charged for the water allotment regardless, and thus may feel he should find a way to use the additional water. A customer in a house with all efficient fixtures and appliances

can use 1000 gallons or less per month and may be inclined to increase their water use if a minimum bill includes more than 1000 gallons[1]. In the Residential End Use Study[2], approximately 6 percent of homes had a per capita use of less than 1000 gallons per month.

Implementation

Successful adoption of a new rate structure may necessitate developing and implementing a public involvement process in order to educate the community about the new rate structure. The new rate structure should adhere to all applicable regulatory procedures and constraints. If the conservation pricing structure to be implemented is substantially different from current practices, then a phase-in approach may be appropriate.

Public involvement in the development and implementation of conservation rates can help assure that the goals of the conservation pricing initiatives will be met and accepted by local constituents. Public meetings, advisory groups, and public announcements are among ways to generate public involvement.

Development of conservation-based rate structures is more than just selection of arbitrary usage breaks. The process requires consideration of the effect on water demand and water utility finances.

1) Basic rate structure considerations should include rates designed to recover the cost of providing service and billing for water and sewer service based on actual metered water use. Conservation pricing should provide incentives to customers to reduce average or peak use, or both. The conservation rate structure can be designed to bring in the same amount of revenue, often termed revenue neutral, as the previous rate structure.
2) Only one type of conservation pricing is required for this BMP. Conservation pricing is characterized by one or more of the following components:
    a. Seasonal rates to reduce peak demands during summer months. There are a variety of approaches including having increasing block rates only during the summer months or having a year round block rate structure with higher block rates during the summer months.
    b. Rates in which the unit rate increases as the quantity used increases (increasing block rates). For block rate structures, the rate blocks should be set so that they impact discretionary use. A utility should analyze historical records for consumption patterns of its customers. The first block should typically cover the amount of water for normal household health and sanitary needs. To increase the effectiveness of this rate structure type, the additional revenue from the higher blocks should be associated with discretionary and seasonal outdoor water use.
        - Rates for single family residential and other customer classes may be set differently to reflect the different demand patterns of the classes.

- The price difference between blocks is very important in influencing the customer's usage behavior. Price increases between blocks should be no less than 25 percent of the previous block. For maximum effectiveness, the price difference going from one block to the next highest block is recommended to be at least 50 percent of the lower block. For example if the third block of a four-block rate structure is $4.00 per 1000 gallons, the fourth and final block should have a rate of at least $6.00 (50 percent higher) per 1000 gallons. Any surcharge based on water usage should be included when calculating these percentages.

c. Rates based on individual customer water budgets in which the unit cost increases above the water budget. Water budget rate structures are based on the philosophy that a certain amount of water is adequate for all normal necessary uses, and uses above that amount are considered excessive and charged as excessive. For example, Irvine Ranch Water District in California[3] sets the excess use charges at 200 percent of the base rate. Typically there should be an indoor and an outdoor component to a water budget.
   - For residential rates, the indoor component should be based upon estimates of average family use. The outdoor component is based upon landscape area. For business customers, water budgets will often be based upon historical average for indoor water use, and outdoor component based upon landscape area.
   - To qualify as a conservation rate, utilities that implement water budget based rate structures typically begin excess rate charges for landscaped areas at no more than 80 percent of average annual reference evapotranspiration replacement rates.

d. Rates based upon the long-run marginal cost or the cost of adding the next unit of capacity to the system.

3) Conservation pricing should use a consumption charge based upon actual gallons metered. The minimum bill for service should be based on fixed costs of providing that service which generally includes service and meter charges. Including an allotment for water consumption in the minimum bill does not promote conservation and it is recommended that if a minimum is included, it not exceed 2000 gallons per month. Utilities including a water allotment in the minimum bill should consider eliminating that allotment within five years of implementing this BMP.

4) Adoption of lifeline rates neither qualifies nor disqualifies a rate structure as meeting the requirements of this BMP except that the minimum bill guidelines should be followed. Lifeline rates are intended to make a minimum level of water service affordable to all customers.

5) The utility should educate customers about the rate structure and use billing software that allows the customer to compare water use on their bill with average water use for their customer class as well as their individual water use

for the last 12 months. The rate structure should be clearly indicated on the water bill. The utility may want to consider implementing the Public Information BMP in conjunction with this BMP in order to provide customers information on how to reduce their water bill under a conservation rate structure.

6) In order to be able to set up an effective irrigation rate, the utility should consider adopting rules or ordinances requiring new commercial and industrial customers to install separate irrigation meters and consider retrofitting current commercial and industrial customers with irrigation meters. It is important for commercial and industrial customers to have a separate irrigation meter so they can better understand how much water they are using for irrigation. This provision is optional for this BMP.

Schedule

Utilities pursuing this BMP should begin implementing this BMP according to the following schedule:

1) The utility should follow applicable regulatory procedures and adopt a conservation oriented rate structure within the first twelve months. The conservation rate structure should be designed to promote the efficient use of water by customer classes as outlined in this BMP.
2) At least annually, a utility should review the consumption patterns (including seasonal use) and its income and expense levels to determine if the conservation rates are effective and make appropriate, regular rate structure adjustments as needed.
3) At least annually, the utility should provide information to each customer on the conservation rate structure.
4) If not already in place, within five years or when the utility changes billing software, whichever is sooner, the utility bill should provide customers with their historical water use for the last 12 months and a comparison of water use with the other customers in their customer class. The rate structure should be clearly indicated on the water bill.
5) While not required to be implemented as part of this BMP, within one year the utility should consider adopting service rules or an ordinance requiring all new commercial and industrial customers to install separate irrigation meters and the feasibility of retrofitting commercial and industrial current customers with irrigation meters.

Scope

To accomplish this BMP, the utility should implement a conservation-oriented rate structure and maintain its rate structure consistently with this BMPs definition of conservation pricing and implement the other items listed in D above.

Documentation

To track this BMP, the utility should maintain the following documentation:

1) A copy of its legally adopted rate ordinance or rate tariff that follows the guidelines of this BMP;
2) Billing and customer records which include annual revenues by customer class and revenue derived from commodity charges by customer class for the reporting period;
3) Customer numbers and water consumption by customer class at the beginning and end of the reporting period;
4) If a water allotment is included in the minimum bill, a cumulative bill usage analysis similar to Figure C-3 in the AWWA M1 Manual;
5) A copy of the education materials on the conservation rate sent to customers for each calendar year this BMP is in effect;
6) A utility bill meeting the parameters and schedule in Section D;
7) Optional provisions:
    a. A copy of the rule or ordinance requiring all new commercial and industrial customers to install separate irrigation meters; and
    b. Implementation and schedule for an irrigation meter retrofit program for current commercial and industrial customers or a feasibility analysis of an irrigation meter retrofit program for current commercial and industrial customers.

Determination of Water Savings

The effect of conservation pricing implementation is very specific to each utility. Elasticity studies have shown an average reduction in water use of 1 to 3 percent for every 10 percent increase in the average monthly water bill.[1] When implementing a conservation pricing structure, consideration should be given to the factors that influence whether the new structure results in a reduction in water use. The *Water Price Elasticities for Single-Family Homes in Texas* (*See* Section I. References for Additional Information, 1) study included several significant findings that water savings can be expected:

1) Average price is better than marginal price in explaining the quantity of water demanded by customers.
2) Customers have a general lack of awareness of their block rates.
3) The water savings that accompanies a switch to a block rate may be lost in subsequent years if water rates do not keep up with inflation.
4) Customers do not understand the link between water use and sewer billing and therefore do not tend to factor sewer prices into their water use decisions.

5) The study did find price elasticities of approximately -0.20, which translates into a reduction of 2 percent in water use for a 10 percent increase in price.

The utility should focus on a rate design that sends the appropriate price signal to customers to reduce discretionary water use. To remain effective, the rates need to be adjusted periodically to take into account inflation as well as other factors.

Cost Effectiveness Considerations

A cost effectiveness analysis can be done by comparing the cost of implementing this BMP to the anticipated water savings from adopting the conservation rate structure. The costs for implementing a rate structure change are associated with managing a stakeholder involvement process and costs for consultant services, if needed, and there may be one time only costs associated with developing and adopting ordinances and enforcement procedures. There may be significant costs associated with reprogramming the billing system if this step isnecessary.

References for Additional Information

1) *Principles of Water Rates, Fees, and Charges (M1 Manual)*, AWWA, 2000.
2) *Residential End Uses of Water,* AWWA Research Foundation, 1999
3) *Irvine Ranch Excess Use Residential Water Rate*
4) http://www.irwd.com/FinancialInfo/ResRates.html
5) *Water Price Elasticities for Single-Family Homes in Texas*, Texas Water Development Board, August 1999.
6) *Designing, Evaluating, and Implementing Conservation Rate Structures*, California Urban Water Conservation Council, July 1997.
7) *Effectiveness of Residential Water Price and Nonprice Programs*, AWWARF, 1998.
8) *San Antonio Sample Water Bill*
http://www.saws.org/service/ebill/saws%20ebill%20sample.htm
9) *Example Rate Structures*
   - *City of Austin Water Rates*
   http://www.ci.austin.tx.us/water/rateswr03.htm
   - *Dallas Water Utilities*
   http://www.dallascityhall.com/dallas/eng/pdf/dwu/conservation_rate_100101.pdf

3.2 Wholesale Agency Assistance Programs

Applicability

This BMP is intended for Wholesale Municipal Water User Groups ("agency") supplying potable water. The specific measures listed as part of this BMP can be implemented individually or as a group. Upon review, an agency may find that it is already implementing one or more of these elements and may want to adopt additional elements outlined below.

Once an agency decides to adopt this BMP, the agency should follow the BMP closely in order to achieve the maximum benefit from this BMP.

Description

Wholesale agency assistance program measures are designed to deliver assistance to its wholesale utility customers who purchase water and provide retail water service to customers. Under this BMP, the wholesale agency will provide financial and/or technical support to wholesale purchasers to advance water conservation efforts both for the wholesale customer and its retail water customers. Financial support should consist of incentives or equivalent resources as appropriate and beneficial. All BMP programs that target retail water customers should be supported when they can be shown to be cost-effective in terms of avoided cost of water from the wholesaler's perspective.

Financing for water conservation programs can be built into the rate structure as a dedicated fund available to wholesale customers who are retail purveyors. The wholesale agency can offer its BMP programs either to the wholesale customer or directly to its retail customers and should provide technical assistance to implement them. When mutually agreeable and beneficial, the wholesale agency may operate all or any part of the conservation-related activities for one or more of its retail customers.

Wholesale agencies should work in cooperation with their wholesale customers to identify and remove potential disincentives to conservation that are created by water management policies including, to the extent possible, when considering the nature of wholesale water service, its water rate structure. Wholesale rate structures should be designed upon the basic principal of increased cost for increased usage. Incentives to conserve can be built into the base rate/volumetric rate ratio with greater emphasis on volumetric rates or with a seasonal increment.

Implementation

Agencies are encouraged to consider stakeholder group information meetings, especially for those affected by this BMP. Working with stakeholder groups will be important to achieving

"buy in" from the stakeholders. Implementation of this BMP will exceed the requirements of §TAC 288.5, Water Conservation Plans for Wholesale Water Suppliers. To implement this BMP, the following elements and strategies should be included:

1) Wholesale agency baseline profile: A description of the wholesaler's service area, including population and customer data, water use data, water supply system data, and wastewater data;
2) Wholesale agency goals: Specification of quantified five- and ten-year targets for water savings including, where appropriate, target goals for municipal use in gallons per capita per day (Total "GPCD") for the wholesaler's service area, maximum acceptable water loss and the basis for the development of these goals;
3) Wholesale water system accounting and measurement:
    a. A description as to which practice(s) and/or device(s) will be utilized to measure and account for the amount of water diverted from the source(s) of supply;
    b. A monitoring and record management program for determining water deliveries, sales, and losses;
    c. A program of metering and leak detection and repair for the wholesaler's water storage, delivery, and distribution system;
4) A requirement in every wholesale water supply contract that each successive wholesale customer develops and implements a water conservation plan that meets TAC 288 rule requirements for public water suppliers. Because no state mechanisms are in place to enforce implementation of these plans, the wholesale agency should consider developing and adopting penalties for non-compliance of this requirement.
5) Conservation-oriented water rates. During the process of contracting for water service, either new or renewed, the wholesale agency should implement wholesale water rate structures that provide incentives to conserve.
6) Wholesale customer assistance. A program to assist customers, which could include, but not be limited to, the following:
    a. Technical assistance with the development of plans and program implementation;
    b. Development of consistent methodologies for accounting and tracking water loss and gallons per capita per day;
    c. Development of procedures for calculating program savings, costs and benefits;
    d. Coordination of conservation incentive activities. Examples of pooling funds and providing grants; offering bulk purchase of equipment such as ULF toilets;
    e. Implementation of wholesale service area-wide education and outreach programs, such as school education programs, public information programs, etc. (*See* BMP for school education and public information);

f. Cost-sharing, including joint management of retrofit and education programs and partial funding of rebates for specific conservation measures.

7) A program for reuse and/or recycling of wastewater and/or gray water and
8) Any other water conservation practice, method, or technique which the wholesaler shows to be appropriate for achieving the stated goal or goals of the water conservation plan.
9) A means for implementing this BMP, which will be evidenced by official adoption of the wholesale agency's BMP initiatives by the wholesale customers.

Schedule

Program participants should begin implementing this BMP within twelve (12) months of official adoption.

Scope

To accomplish this BMP, the agency should adopt wholesale agency assistance policies, programs or rates consistent with the provisions for this BMP as specified in Section C.

Documentation

To track the progress of this BMP, the agency should gather the following documentation:

1) Copy of wholesale agency assistance BMP enacted in the service area;
2) Copy of Conservation Plan pursuant to §TAC 288.5;
3) Annual report of measures accomplished; and
4) Copies of progress reports of BMPs implemented by wholesale customers that are done in conjunction with the wholesaler or which are cost-shared through this BMP.

Determination of Water Savings

Using historical records as appropriate, calculate water savings due to implemented BMPs, such as water loss programs or programs delivered to retail customers. Calculated savings should be based upon equipment changes, quantified efficiency measures, or alternative water sources as appropriate.

Cost-effectiveness Considerations

The labor costs for technical services to retail customers are dependent upon the type of conservation BMPs which the wholesale agency decides to implement. Wholesale providers should evaluate each of the BMPs to determine the appropriate costs associated with technical

assistance. Cost-share costs also depend upon the cost of the BMP and the percentage of BMP implementation the wholesaler determines is appropriate. It is recommended that the wholesaler determine the NPV of avoided costs for new supply projects to determine the appropriate level of financial support to offer retailers for cost-share programs.

References for Additional Information

1) *A Water Conservation Guide for Public Utilities,* New Mexico Office of the State Engineer, March 2001.

2) *Pulling Utilities Together: Water-Energy Partnerships*, Home Energy Magazine Online July/August 1993. http://hem.dis.anl.gov/eehem/93/930709.html

3) *Memorandum of Understanding,* California Urban Water Conservation Council, 1999.

4.1 Metering of All New Connections and Retrofit of Existing Connections

Applicability

This BMP is intended for all Municipal Water User Groups ("utility") that do not have 100 percent metering of all customer connections. Improved accuracy of meters resulting from increased maintenance efforts should result in increased revenue and reduced "water loss." Metering of all new customer connections and retrofit of existing connections are effective methods of accounting for all water usage by a utility within its service area.

Description

Proper installation of meters by size and type is essential for good utility management. Using and maintaining the most accurate meter for each type of connection will generate adequate revenues to cover the expenses to the utility, equity among customers, reduce water waste and reduce flows to wastewater facilities. The American Water Works Association (AWWA) provides a number of resources listed in the reference section of this BMP. The purpose of this BMP is to ensure that all aspects of meter installation, replacement testing and repair are managed optimally for water use efficiency.

For a utility's meter program to qualify as a BMP it should have several elements:

1) Required metering of all new connections and existing connections.
2) A policy for installation of adequate, proper-sized meters as determined by a customer's current water use patterns. The use of compound meters for multi-family ("MF") residential connections or other industrial and commercial accounts is recommended.
3) Direct utility metering of each duplex, triplex, and fourplex unit whether each is on its own separate lot or whether there are multiple buildings on a single commercial lot.
4) Metering of all utility and publicly owned facilities, as well as customers.
5) Use of construction meters and access keys to account for water used in new construction.
6) Required separate irrigation meters for all new commercial buildings with a site plan area of more than 10,000 square feet and for all duplexes, triplexes and fourplexes.
7) Implementation of the State requirements in HB 2404, passed by the 77th Legislature Regular Session and implemented through Texas Water Code 13.502, that requires all new apartments to be either directly metered by the utility or submetered by the owner.

8) Review of capital recovery fees to determine whether the fees provide any disincentive to developers to use utility metering of apartment units.
9) Annual testing and maintenance of all meters that are larger than two inches since a meter may underregister water use as the meter ages.
10) Regular testing and evaluation of 5/8 and ¾ inch meters which are 8 to 10 years in service to determine meter accuracy or a periodic, consistent replacement program based on the age of the meter or cumulative water volume through the meter. This program should be based on testing of meters at each utility to determine the optimal replacement/repair period since it depends both on the quality of water and the average flow rate through the meter versus the capacity of the meter.
11) An effective monthly meter-reading program where readings are not estimated except due to inoperable meters or extenuating circumstances. Broken meters should be fixed within 7 days or a reasonable time frame.
12) An accounting of water savings and revenue gains through the implementation of the Meter Repair and Replacement Program.

Implementation

To accomplish this BMP, the utility should do the following:

1) Conduct a Meter Repair and Replacement Program following the methodology and frequency currently recommended in industry practices and specified by the AWWA.
2) Develop and perform a proactive meter-testing program and repair identified meters.
3) Notify customers when it appears that leaks exist on the customer's side of the meter. An option would be to repair leaks on the customer's side of the meter.

Schedule

To accomplish this BMP, the utility should do the following:

1) The utility should develop procedures for implementation of this BMP within the first twelve months.
2) The procedures should include annual or more frequent benchmarks for measuring implementation.
3) The program participant should develop procedures for and maintain a proactive Leak Detection and Repair Program (*See*, Water Loss BMP) within the first twelve months.

Scope

To accomplish this BMP, the utility should do the following:

1) Develop and implement a metering program based on current AWWA practices and standards.
2) Produce a regular schedule for the utility meter repair and replacement program based upon total water use and the consumption rates of utility accounts.
3) Effectively reduce real water losses though implementation of the meter replacement and repair programs.

Documentation

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

1) Copy of meter installation guidelines based upon customer usage levels.
2) Copy of meter repair and replacement policy.
3) Records of number and size of meters repaired annually.
4) Report on the method used to determine meter replacement and testing intervals for each meter size.
5) Estimate of water savings achieved through meter replacement and repair program.

Determination of Water Savings

Every year the utility should estimate its annual water saving from the BMP. Savings can be estimated based upon a statistical sample analyzed as part of the meter-testing program. Project potential savings into future years and include in utility water savings targets and goals.

Cost-Effectiveness Considerations

Capital costs to the utility in implementing this BMP may include the costs of installing new meters and retrofitting older ones, as well as one-time or periodic costs such as purchase of meter testing and calibration equipment. A replacement meter can run from as little as $50 for a residential meter to several thousand for larger compound meters. Meter testing and repair can be done by utility staff or by outside contractors. Smaller utilities could consider sharing testing facilities. A typical residential meter test can be done from $15 to $50. There also may be administrative costs for additional tracking and monitoring of meter replacements.

References for Additional Information

1) *Water Loss Control Manual,* Julian Thornton, McGraw-Hill, 2002.
2) *M6 Water Meters – Selection, Installation, Testing and Maintenance,* AWWA 4th Edition, 1999.

3) *Applying Worldwide BMPs in Water Loss Control,* AWWA Water Loss Control Committee, Journal AWWA, August 2003.
4) *HB 2404 2001 Session.* http://www.capitol.state.tx.us/cgi-bin/tlo/textframe.cmd?LEG=77&SESS=R&CHAMBER=H&BILLTYPE=B&BILLSUFFIX=02404&VERSION=5&TYPE=B
5) *Texas Water Code, Submetering Rules for Apartments, Subchapter M, Section 13.502.* http://www.capitol.state.tx.us/statutes/docs/WA/content/htm/wa.002.00.000013.00.htm#13.502.00

4.2 System Water Audit and Water Loss

Applicability

This Best Management Practice is intended for all Municipal Water User Groups ("utilities"). This practice should be considered by a utility that:

1. would like to analyze the benefits of reducing its water loss and other nonrevenue water,
2. does not conduct a water audit on an annual basis,
3. wants to determine if under-registering meters are impacting its revenues, or
4. wants to reduce main breaks and leaks.

To maximize the benefits of this Best Management Practice, a utility would use the information from the water audit to revise meter testing and repair practices, reduce unauthorized water use, improve accounting for unbilled water, and implement effective water loss management strategies.

Texas Water Code Section 16.0121(b) requires retail public water utilities to conduct a water audit every five years, **unless they have an active financial obligation with the Texas Water Development Board or have more than 3,300 connections, in which case they must conduct an audit annually**. By adopting this practice, a utility may be conducting a more frequent implementation of water auditing and loss reduction techniques than required. Small utilities may want to use this Best Management Practice in part or its entirety.

Description

Water loss audits and water loss programs are effective methods of accounting for all water usage by a utility within its service area. Performing a reliable water audit is the foundation of production-side water resource management and loss control in public drinking water systems. The structured approach of a water audit allows a utility to reliably track water uses and provides the information to address unnecessary water and revenue losses. The resulting information from a water audit will be valuable in setting performance indicators and in setting goals and priorities to cost-effectively reduce water losses.

Compiling a water audit is a two-step approach, a top-down audit followed by a bottom-up audit. The first step, the top-down audit, is a desktop audit using existing records and some estimation to provide an overall picture of water losses. For those utilities that are required to gather information necessary to complete the Texas Water Developments Board's Utility Profile (http://www.twdb.texas.gov/conservation/municipal/plans/UP.asp) or the Texas Commission on Environmental Quality's Utility Profile (http://www.tceq.texas.gov/assets/public/permitting/forms/10218.docx), that information is the first step of a top-down audit. The records needed include quantity of water entering the system, customer billing summaries, leak repair summaries, average pressures, production and

customer meter accuracy percentages, permitted fire hydrant use, and other records that may be kept on water theft and unmetered uses such as street cleaning.

The second step of the audit, the bottom-up approach, involves a detailed investigation into actual policies and practices of the utility. This part of the audit can be phased in over several years. There are several areas to be addressed including development of better estimates of water use by the fire department, water used in line flushing and street cleaning, metering of all authorized uses, and improved measurement of meter accuracies. Other tools to identify and isolate water loss include conducting a system-wide leak detection program, using night flow and zonal analysis to better estimate leakage, analyzing pressure throughout the system, and analyzing leakage repair records for length of time from reporting to repair of the leak.

Several indicators from the analyses in a water audit should be considered by utilities in order to improve water loss control procedures. These include:

(1) Real Losses
Losses due to leakage and excess system pressure. With these losses the water is not beneficially used by any party. Real losses can be reduced by more efficient leakage management, improved response time to repair leaks, improved pressure management and level control, and improved system maintenance, replacement, and rehabilitation. The cost of real losses is estimated using the marginal production costs, such as costs of energy and chemicals needed to treat and deliver the water.

(2) Apparent Losses
Losses due to meter accuracy error, data transfer errors between meter and archives, data analysis errors between archived data and data used for billing/water balance, and unauthorized consumption including theft. These losses are experienced by the utility as forgone revenues, even though the water is still being beneficially used. The cost of apparent losses is estimated using the retail commodity rates.

(3) Unavoidable Annual Real Losses
This represents the theoretically low level of annual real losses in millions of gallons per day that could exist in a system if all loss control efforts are exerted to reduce losses, without regard to cost effectiveness. It is based on data obtained from systems where effective leakage management was implemented. The calculation of the Unavoidable Annual Real Losses is based on number of miles of water mains, number of service connections, and average water pressure. The Unavoidable Annual Real Losses is only applicable to utilities with 3,000 or more connections. The Texas Water Development Board's Water Loss Audit Manual for Texas Utilities provides details on how to calculate unavoidable annual real losses.

(4) Infrastructure Leakage Index
The Infrastructure Leakage Index is the ratio of annual real losses divided by Unavoidable Annual Real Losses. The Infrastructure Leakage Index provides a ratio of current leakage relative to the best level obtainable with current Best Management Practices for leakage. A

ratio of 1.0 would indicate that the utility has reduced losses to the theoretically lowest level possible.

(5) Economic Level of Leakage
This is a calculation based on the cost of reducing leakage. It is the theoretical level at which the cost of leakage reduction meets the cost of the water saved through leakage reduction. These costs include not only the cost of producing water but also the avoided cost of replacing the water. Further details on this measure can be found in the Water Research Foundation report Evaluating Water Loss and Planning Loss Reduction Strategies.

In order to reduce water losses due to leakage, a utility should maintain a proactive water loss program. A structured approach to leakage management has proven to be successful in limiting losses. Potential elements of an active water loss program include:

1. reducing repair time on leaks since long-running small to medium size leaks can be the greatest percentage of annual leakage;
2. conducting regular inspections and soundings of all water main fittings and connections;
3. installing temporary or permanent leak noise detectors and loggers;
4. conducting a large/transmission main leak detection program;
5. metering individual pressure zones;
6. establishing district metering areas and measuring daily, weekly, or monthly flows with portable or permanently installed metering equipment;
7. continuous or intermittent night-flow measurement;
8. controlling pressure just above the utility's standard-of-service level, taking into account fire requirements, outdoor seasonal demand, and requisite tank filling;
9. operating pressure zones based on topography;
10. limiting surges in pressure; and
11. reducing pressure seasonally and/or where feasible to reduce losses from background leaks.

If a utility has not had regular leak surveys performed, it will probably need at least three leak surveys performed in consecutive years or every other year for these reasons:

1. the first survey will uncover leaks that have been running for a long time;
2. the second survey will uncover additional long-running leaks whose sounds were masked by larger nearby leaks; and
3. by the third survey, the level of new leaks should start to approximate the level of new reported leaks.

The utility should make every effort to inform customers when leaks exist on the customer side of the meter. If customer service line leaks are significant, a utility might consider the option of making the repairs itself.

The utility should also reduce apparent losses since reducing these losses will increase utility revenue. Some of the areas that should be examined are:

1. customer meter inaccuracy due to meter wear, malfunction or inappropriate size or type of meter;
2. data transfer error when transferring customer metered consumption data into the billing system;
3. data analysis errors including poor estimates of unmetered or unread accounts;
4. inaccurate accounting resulting in some accounts not being billed for water use; and
5. all forms of unauthorized consumption including meter or meter reading tampering, fire hydrant theft by contractors and others, unauthorized taps, and unauthorized restoration of water service cutoffs.

Implementation

The Texas Water Development Board's Water Loss Audit Manual for Texas Utilities is a comprehensive guide to performing a water loss audit. It provides a framework for gathering data, calculating performance measures, and reporting requirements under Texas Water Code Section 16.0121(b). Utilities implementing this Best Management Practice should use the methodology from the Texas Water Development Board manual. The American Water Works Association also offers products that can assist performing a water audit. They have published the M36 Manual, which can provide additional guidance on implementing this Best Management Practice, and offer free water loss audit software that allows utilities to quickly compile a preliminary water loss audit.

Utilities implementing this Best Management Practice should start by forming a working group from the following work areas: management, distribution, operations, production, customer service, finance, and conservation. Each of these work areas has an essential role to play in implementing this Best Management Practice. Smaller utilities may have the same person doing several of these functions and therefore the working group may just be one or two individuals. The utility should also consider a public involvement process to solicit outside input as well as to enhance public relations.

Initially the working group should focus on gathering relevant data and identifying current practices that form the basis for the top-down audit. Some of the questions that should be addressed during the top-down audit are:

1. How often do we test production meters? Are they tested or just calibrated?
2. How often do we test commercial meters over 1 inch? Over 2 inches?
3. How often do we replace or repair $^{5}/_{8}$ and $^{3}/_{4}$ inch meters?
4. How inaccurate are the $^{5}/_{8}$ and $^{3}/_{4}$ inch meters on average when they are replaced?
5. Do we estimate total leakage from each leak based on the leakage flow rate and length of leakage from time reported when we fix leaks?
6. How long does it take to repair leaks, itemized by size of leak?
7. Are customers encouraged to report leaks?

8. Do we have a system for tracking location of leaks and a method to calculate when it is cost-effective to replace mains and service lines?
9. Are meter readers trained to look for and report leaks?
10. Do we adjust consumption records when billing records are adjusted?
11. Is backwash and other in-plant water use optimized?
12. How effective is our theft reduction program?
13. How do we track water used for flushing both new and existing lines?

Based on the data collected and information from the questions above, the utility should have enough information to complete a top-down audit.

A utility should set an Infrastructure Leakage Index goal based on its available and potential water supplies, its excess treatment capacity, its projected growth, and the Economic Level of Leakage. A guide for setting Infrastructure Leakage Index target ranges is available in the Texas Water Development Board's *Water Loss Audit Manual for Texas Utilities*.

In conducting the bottom-up audit, the utility addresses the relevant issues identified during the top-down audit and further investigates any areas where the data may be lacking or incomplete. The utility uses the results of the audit to focus on the best approaches to reduce both real and apparent losses. Depending on whether the Infrastructure Leakage Index is relatively high or low determines the number of years it may take to reduce the Index.

Each subsequent year, the utility completes another audit. Over time the utility should be able to gradually reduce its Infrastructure Leakage Index. If the utility finds the Infrastructure Leakage Index is increasing, then it should look to identify the causes using the annual audit results.

Data validity is critical for developing an accurate water loss picture. The Water Loss Manual for Texas Utilities provides an assessment scoring matrix for the data used in the water loss audit, scoring 17 categories on a scale from 1 to 5, with a maximum of 85. The scoring matrix also provides guidance on improving the assessment score. Utilities with a score below 40 should view that data as preliminary and should not use it to design long-term loss programs or to benchmark with other utilities. Utilities with scores between 40 and 70 can place greater faith in their data and can begin using the data to plan and develop water loss control reduction programs, as well as benchmarking the data with utilities with similar scores. Utilities with scores of 70 or more have mature water loss control and data collection efforts can have great confidence in the reliability of their water audit results.

Efforts to improve data validity include metering all water accounts and connections, including municipal connections; annually testing or calibrating all production meters; implementing district metering areas and automatic meter reading; tracking all unmetered water use, such as fire suppression and line flushing; conducting a theft identification and reduction program; tracking and quantifying all repaired leaks; and conducting a leak detection program.

Scope and Schedule

To accomplish this Best Management Practice, the utility should:

1. Conduct a water loss audit annually following the methodology contained in the Texas Water Development Board's Water Loss Manual for Texas Utilities manual, yielding an Infrastructure Leakage Index and a data validity assessment score.
2. Develop and perform a proactive distribution system water loss program and repair identified leaks.
3. Implement a program to reduce apparent losses.
4. Advise customers when it appears that leaks exist on the customer's side of the meter and evaluate a program to repair leaks on the customer's service line.
5. If the utility's Infrastructure Leakage Index is greater than 3:
    a. Implement a program to reduce real losses, including a leak detection and repair program;
    b. Implement a pressure reduction strategy if warranted; and
    c. Take steps to account for and minimize all unmetered water, and
6. If the audit data validity assessment score is below 70, implement a plan to identify areas where data collection can be improved, using the matrix in the Water Loss Manual for Texas Utilities manual.

Measuring Implementation and Determining Water Savings

To track the progress of this Best Management Practice, the utility should gather and have available the following documentation:

1. a copy of each annual water loss audit, the Infrastructure Leakage Index for each year, the audit data validity assessment scoring for each year, and a list of actions taken in response to audit recommendations.
2. annual leak detection and repair survey, including number and sizes of leaks repaired.
3. number of customer service line leaks identified, actions taken to repair these leaks, and the average time to make repairs.
4. pressure reduction actions taken, if any; and
5. annual revenue lost to real and apparent losses.

Potential water savings are an integral part of the water loss audit process and can be tracked by comparing trends from the annual water loss audits. Based on the results of the audit, the utility should set goals for reducing its losses.

Cost-Effectiveness Considerations

Direct costs that should be considered in implementing this Best Management Practice include the initial and ongoing costs for performing and updating the water audits and capital costs for items such as leak detection equipment and billing system upgrades. Utilities may wish to do the work in-house with technical staff or by using outside consultants and contractors.

A recommended method to make cost-effectiveness decisions is based on the economic value of real losses and apparent losses. Real losses are losses due to leaks and are valued at actual costs to produce and deliver the water. Apparent losses, sometimes called paper losses, are those attributable to meter and billing inaccuracies and are valued at the retail rates charged by the utility. The amount of lost revenue due to real losses, based on the utility's marginal production cost, and apparent losses, valued at the retail rate charged to customers, can be compared to the costs of reducing the sources of loss.

References

1. *Water Loss Manual for Texas Utilities*, Mark Mathis, George Kunkel, and Andrew Chastain-Howley, Texas Water Development Board, 2009.
2. *Water Audits and Loss Control Programs M36 Manual*, AWWA, 2009.
3. *Water Loss Control Manual*, Julian Thornton, McGraw-Hill 2002.
4. *Evaluating Water Loss and Planning Loss Reduction Strategies*, Water Research Foundation, 2007.
5. *AWWA Water Loss Audit software*, http://www.awwa.org/publications/opflow/abstract.aspx?articleid=18141.
6. *Validated Water Audit Data for Reliable Benchmarking*, AWWA Water Loss Committee, 2011.

Determination of the Impact on Other Resources

Water loss impacts the supply side of water delivery. Therefore, any reductions carry not only the traditional conservation benefits of reducing demand, electricity and chemicals used in treatment and pumping, and water procurement costs, but also do so without reducing utility revenues. Reducing apparent losses by improving data management and meter accuracy can even increase utility revenues.

Reducing water loss can require a range of resources which vary depending on the age of the utility's distribution system, pipe materials, soil types, and system design. A responsive leak repair program is essential to reducing water loss. Leak detection and meter testing can be done by the utility or contracted out. Timely repairs and an ongoing preventative maintenance and replacement program will allow the utility to operate efficiently, minimizing operational losses.

5.1 Athletic Field Conservation

Applicability

This Best Management Practice is intended for all Municipal Water User Groups ("utilities") which manage irrigated athletic field(s) and/or serve a customer with irrigated athletic field(s). An athletic field Best Management Practice addresses the efficiency concept that all desired management goals are accomplished with the minimum amount of water required.

Athletic fields often involve a visible use of water during the day, facing scrutiny by the public and water resource managers both because of large water demand to maintain an athletic field and the perception that the water use may be excessive. The specific measures listed as part of this Best Management Practice can be implemented individually or as a group. Once a utility decides to adopt this practice, the utility should follow it closely in order to achieve maximum water efficiency benefit.

Description

Athletic field conservation is an effective method of reducing system water demands as it results in the athletic field manager following a watering regimen that uses only the amount of water necessary to maintain the viability of the turf and the health of its users. Water is only applied to areas that are essential for use of the field.

Several opportunities for improved efficiency exist for athletic field management. The water savings obtained depends on how poor the water management practices were before initiating the Best Management Practice.

1. A standard athletic field maintenance regimen should be provided in written form to athletic field managers. This document should include:
    a. Basic horticulture practices that maximize the health of the playing turf. Specifically, these should include: fertilization, aeration, mowing heights, weed control, and turf disease management.
    b. Minimum requirements for maintenance of the irrigation system that supports the athletic field include: application of water in a uniform pattern, pressure, checking irrigation system for appropriate direction of spray, adjustment of nozzles when needed, prompt repair of leaks and malfunctioning heads, and the presence of a rain sensor tested for efficacy if the system has automatic controls.
    c. A seasonal irrigation schedule for athletic fields that will support the field during normal weather conditions each month of the year.
    d. Reasonable expectations of monthly water consumption for athletic fields during each season of the year based on a water budget calculation.

2. Athletic field maintenance workshops should be considered to assist managers in maintaining their fields. Workshops may be accomplished in cooperation with the

AgriLife Extension Service or as part of a Texas Turf Association workshop. Full- to half-day workshops include topics such as:

a. Basic horticultural practices for the unique challenges of athletic fields.
b. Recognizing problems common to athletic fields.
c. Suggested best practices for maintaining healthy turf to include weed control, fertilization, aeration, mowing heights, soil improvement and other options.
d. Instructions on trouble-shooting irrigation challenges such as adjustment of irrigation nozzles, recognizing irrigation components that must be replaced, and accomplishing changes in irrigation schedules to reflect seasonal variation of water need.
e. Instructions on how to adjust weekly and monthly applications of water based on locally available evapotranspiration data.
f. How to read the meter that services the irrigation of the athletic field so that the meter may be used to estimate monthly water bills and to identify changes in flow to the system.

3. Upgrades in irrigation technology should be considered if such improvements will result in lower water consumption. Some considerations of technology changes should include the following:
    a. Increased automation of irrigation may provide convenience to athletic field managers but may increase overall consumption. A system that must be turned on manually may be run less frequently than systems that are managed by an automatic controller.
    b. Evapotranspiration-based controllers require strong knowledge of horticulture practices and an understanding of agronomy terminology that may be beyond the skill sets of athletic field managers. If complex devices are provided without extensive training, water usage could increase due to use of default settings or inappropriate assumptions in setting the controller.
    c. Irrigation systems that have poor distribution uniformity may result in athletic field managers running the total system longer than is necessary to eliminate one dry spot. A licensed irrigator experienced in retrofits should be consulted to determine if there is a cost-effective fix for dry spots evident in irrigation systems.

4. Full irrigation audits may identify the extent to which water is wasted due to poor spray patterns and poor scheduling. Audits utilizing full catch technology and calculations of distribution uniformity can be completed by individuals with appropriate audit certification. Considerations of whether to invest in a full irrigation audit include:
    a. The aesthetic and playing condition requirements of the athletic field manager. If the field is one that is highly groomed with high expectations of uniform green, it may be worth the cost of the irrigation audit.
    b. Willingness of the athletic field manager to make improvements to the irrigation system based on the results of an irrigation audit should also influence the decision to make the expense.

5. Proper irrigation scheduling is important for athletic field safety. Utilizing the irrigation audits, a turfgrass manager can properly monitor an athletic field evapotranspiration status. Adjusting the schedule to meet water needs will help ensure efficient irrigation to properly maintained athletic fields which can decrease the risk of athlete injury.

Implementation

1. Identify Stakeholders: Different organizations responsible for maintenance of athletic fields may include: school district staff, nonprofit athletic associations, private sports complex managers, and city staff. It is important to identify stakeholders and determine the best way to interact with them to achieve cooperation and long-term results whether irrigation of the athletic field is under the direction of someone trained in agronomy, a busy coach, or community volunteer.

2. Determine whether the approach of achieving conservation will be voluntary compliance or regulatory compliance.

   If there have been no prior athletic field conservation initiatives, it may be best to begin with a voluntary approach. Athletic field managers may be motivated to cooperate in workshops that can assist them in maintaining high quality fields.

3. Development of ordinances requiring appropriate irrigation of athletic fields can be accomplished through a variety of related regulatory measures. These include:
   a. Athletic fields may be required to submit annual irrigation efficiency checks completed by the athletic field manager or by a licensed irrigator to the appropriate city or utility staff.
   b. Conservation plans may be required for each athletic field or athletic field facility to document how best practices are being followed to minimize the need for irrigation.
   c. When individual meters are available to document monthly usage at athletic field sites, it is possible to determine if fields are using excess amounts of water. If sites appear to utilize an excessive amount of water when compared to a reasonable evapotranspiration-based water budget calculated for the area, they may be required to follow further measures.
   d. Prohibition of water waste and mid-day irrigation may be used to require improved efficiency. This would make it unlawful to have water flow from an athletic field irrigation pool or be exhibited through broken or misdirected irrigation heads. Requiring irrigation to take place during early morning hours or evening hours may increase efficiency by eliminating some evaporative losses during peak heat and wind periods.
   e. Excess use pricing may be directed at athletic fields that do not stay within reasonable consumption levels or that fail to comply with best practices such as submitting an annual maintenance checkup.

f. Requirements for separate metering of irrigation water should be reviewed for the utility. If separate irrigation meters are not already required, a measure should be passed to require them for all future development. Installation of submeters for athletic fields should be considered where feasible.
g. A review of utility data should be completed to determine if it is possible to identify athletic fields from customer service records of consumption. If billing coding is not yet detailed enough to allow this, it should be considered. A review of customer service data is available through Best Management Practice: Customer Classifications.

4. The use of recycled or reclaimed water may be appropriate for athletic fields. If such a source is available, then its implementation should be considered. A review of recycled water programs is available through Best Management Practice: Recycled Water Retrofits.

5. Athletic field owners may be willing to exchange their grass fields for artificial turf ones. Although this is an expensive investment, it yields savings in maintenance that are as important as water savings. A cost benefit analysis of this option can be completed for owners taking all current expenses and capital investment into account to determine return on investment.

Scope and Schedule

A 12-month implementation schedule may be followed. Steps that require ample time include:

1. Data review to identify the amount of water utilized by athletic fields. Athletic fields that do not have dedicated irrigation meters or are not coded in the utility customer service system could create difficulties.
2. Identifying and making contact with appropriate stakeholder groups that may include athletic associations, coach groups, school district facility management, and city staff.
3. Identifying and making contact with appropriate education partners such as AgriLife Extension, Texas Turf Association, the local irrigation association, or others.
4. Development of annual schedules for education opportunities for athletic field managers.
5. Development of a written document providing guidance on athletic field best management to be reviewed by representatives from as many stakeholder groups as possible as well as by education partners to improve buy-in and acceptance of measures.
6. Development of draft ordinance measures that may be phased in or adopted immediately after review by stakeholders and education partners.

Measuring Implementation and Determining Water Savings

Measurement of implementation can be accomplished by checking the steps for the Best Management Practice. Some additional goals that may be documented include:

1. Athletic field stakeholder contact list.

2. Schedule of education opportunities for athletic field managers.
3. Completion and distribution of Athletic Field Best Practices document.
4. Copy of conservation ordinances or rules enacted.
5. Copy of conservation plans submitted by athletic field managers.
6. Copy of irrigation check-up forms submitted by athletic field managers.
7. Records documenting enforcement of regulatory measures.
8. Changes in water consumption patterns based on meter reads available.
9. Decreases in public complaints about water waste at athletic fields.

The best documentation of water savings is to look at water use consumption at athletic fields before and after measures are adopted. It may be necessary to track actual consumption against expected consumption both before and after implementation. Expected consumption can be adjusted based on locally available evapotranspiration data in order to adjust for weather changes.

It may be necessary to utilize average savings achieved in other locations as a basis for estimating reductions in water if fields are not metered separately from other water uses. When similar measures are adopted, an assumption may be made that similar savings may be obtained.

Cost-Effectiveness Considerations

Improvements in irrigation practices are often very cost-effective to achieve. If water is being wasted by excessive application, then stopping the practice may yield significant savings in a short period of time at a low cost. Staff time to provide education and time spent on enforcement measures can be tracked to compare the cost against the water saved.

Changes to irrigation technology require greater investment, but yield significant savings. It is important to determine what the technology will change in order to actually reduce consumption. A rain sensor may prevent irrigation after rain events. A flow sensor may alert a manager to irrigation breaks so that repairs are timely. In contrast, if a site is run manually the addition of an automatic controller may save time but not water. An audit of an irrigation system may cost up to $100-$150 or more per zone. The funds for this will only be well spent if there is a strong intent to follow up on the conclusions of the audit report.

It is important to determine if the technology requires training to utilize correctly or requires human intervention to be effective. If the human investment is not available, technology will not solve the challenge of efficiency without it.

References for Additional Information

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5.2 Golf Course Conservation

Applicability

This BMP is intended for all Municipal Water User Groups ("utility") that serve a golf course customer. Golf courses often involve a visible use of water, which comes under scrutiny by the public and water resource managers both because of large water demand to maintain the course, and because of the perception that the water use may be excessive. Golf courses are often good candidates for reuse water or other alternative sources of water. The specific measures listed as part of this BMP can be implemented individually or as a group. Utilities may already be implementing one or more of the elements of this BMP and they may want to adopt additional elements outlined below.

Once a utility decides to adopt this BMP, the utility should follow the BMP closely in order to achieve the maximum water efficiency benefit from this BMP.

Description

Golf course conservation is an effective method of reducing water demands. Under this BMP, the utility requires each golf course to develop a conservation plan that includes the elements described in this section. The golf course manager conducts a landscape and irrigation survey to determine water needed to efficiently irrigate the course. A water budget should be developed using reference evapotranspiration ("ETo"). The manager implements a watering regimen that uses only the amount of water necessary to maintain the viability of the course. In addition to commercially available information from irrigation controller equipment companies, the Texas Evapotranspiration Network (http://texaset.tamu.edu/) has information to assist golf course managers and utility planners with proper management of large turf areas. Golf course managers should be encouraged to limit their water use to areas essential to the use of the golf course. An example of a use that has been eliminated on some golf courses is irrigation of the roughs.

The golf course plan utilizes methods of achieving enhanced water conservation such as a Computer Controlled Irrigation Systems ("CCIS") or similar technology. In order to achieve maximum efficiency a CCIS should include at least the following components: computer controller ("digital operating system"), software, interface modules, satellite field controller, soil sensors, and weather station. A CCIS should be designed so as to prevent overwatering, flooding, pooling, evaporation, and run-off of water and should prevent sprinkler heads from applying water at an intake rate exceeding the soil holding capacity. The golf course plan provides an analysis of the cost-effectiveness of utilizing a CCIS.

If potable water is used and if non-potable water is available, the golf course converts to use of non-potable water as soon as is practicable. The golf course plan should include projected implementation dates to convert to alternative water supplies. Use of reclaimed, reused,

and/or recycled water by golf courses must meet TCEQ water quality standards for treated effluent and human contact.

Soil improvement is an effective method for reducing irrigation water usage while maintaining healthy soils. Soil improvement programs on high visibility areas such as golf courses can demonstrate to the public the effectiveness of this method. For golf courses compost applications of 1/4 to 1/2 inch annually on turf areas and one inch annually on flower beds are recommended. Compost is most beneficial when applied in the fall.

Implementation

The utility should consider stakeholder information meetings. Working with stakeholder groups will be important to achieving "buy in" from golf course businesses. Also a number of voluntary environmental management programs exist in which golf courses may already be participating. There are two approaches to be considered to implement the golf course conservation plan described in Section B: an incentive or voluntary approach and an ordinance or other enforceable requirement approach.

1) Incentive or Voluntary Compliance Approach

The utility may provide staff or contract with a third party to provide a water audit of the golf course. The water-use surveys should, at a minimum, include measurement of the irrigated turf areas; measurement of the greens, tee boxes and fairways; determination whether hydrozones within the irrigation system are proper for the type of turf present; irrigation system checks and distribution uniformity analysis; review or development of irrigation schedules; and provision of a customer survey report and information packet.

If indicated by survey results and if cost-effective, the utility may offer incentives to the golf course user for upgrading irrigation systems, installing or upgrading controllers, changing hydrozones to eliminate irrigation of rough, or reducing the amount of fairway watering.

When cost-effective, the utility should offer golf course management and staff workshops by trained professionals on pesticide and nutrient management for optimal water-use efficiency. An advantage to working with programs like the Audubon Cooperative Sanctuary Program ("ACSP") for Golf program is that the third party can assist in implementation at no cost to the utility. To ensure that water-savings goals are met, the utility should be explicit about the efficiency expectations of voluntary programs.

2) Ordinance or Enforceable Requirements Approach

a. For utilities with ordinance-making powers, in the first twelve (12) months plan, develop, and pass an ordinance that requires development and implementation of the golf course conservation plan, including stakeholder meetings as needed. Develop a plan for educating

customers, especially those directly affected by the requirements of the ordinance. Plan customer follow-up compliance and education after ordinance passage. Implement ordinance and tracking plan for violations, compliance notifications, and enforcement.

In the second year and on (after ordinance passage): Continue implementation and outreach programs for customers. Continue compliance education and initiate enforcement programs. Enforcement can include citations with fines and service interruption for repeat offenders.

b. For utilities that lack ordinance-making powers, in the first twelve (12) months plan a program including stakeholder meetings as needed. Develop a plan for educating customers, especially those directly affected, about the requirements of a golf course conservation plan. Develop follow-up compliance and education program. Implement water conservation program and tracking plan for violations and compliance notifications. Consider passing excess-use rates as a disincentive to golf courses that do not stay within a budgeted amount of water (*See* Conservation Pricing BMP).

Schedule

1) The utility should adopt an incentive program or an ordinance or rules within twelve (12) months of commencing this BMP.
2) The utility implements the incentive plan or commences enforcement upon adoption of the ordinance or rule**.**

Scope

To accomplish this BMP, the utility adopts golf course conservation policies, programs or ordinances consistent with the provisions for this BMP specified in Section C.

Documentation

To track the progress of this BMP, the utility should gather and have available the following documentation:

1) Copy of incentive plan or golf course conservation ordinances or rules enacted in the service area;
2) Copy of compliance or enforcement procedures implemented by utility, if applicable;
3) Records of enforcement actions including public complaints of violations and utility responses, if applicable;
4) Water savings from implemented changes; and
5) Number of customers completing the incentive plan.

Determination of Water Savings

Estimating total water savings for this BMP may be difficult, however, water savings can be estimated from each water-wasting measure eliminated through the actions taken under this BMP. For an irrigation survey, water savings can be expected in the range of 15 percent to 25 percent for courses without a CCIS that choose to implement the efficiency measures recommended by the results of the survey. There will be additional savings from the education of customers about golf course watering efficiency, which will be difficult to calculate but will encourage public goodwill toward the golf course water user and the utility. Switching to reuse or other non-potable alternatives can save up to 100 percent of the potable water supply used in irrigation. These savings are determined by measuring water use before and after the conversion to the new water supply.

Cost-Effectiveness Considerations

The one-time labor costs for producing golf course conservation plan guidelines and meeting with golf course stakeholders are dependent upon the level of staffing, the number of meetings, and time allotted to the planning process. Costs for annual review of golf course water use and conservation plan updates should be less than $100 per plan.

Marketing and outreach costs range from $5 to $15 per plan. Administrative and overhead costs are approximately 10 to 25 percent of labor costs. The costs to the golf course facility for an irrigation system survey and CCIS or other systems upgrades or switching to reuse water are highly variable. Costs are dependent upon the efficiency in scheduling the surveys, the size of the course, and the scope of the survey. Surveys can be performed by golf course staff or by contractors.

References for Additional Information

1) *Audubon Cooperative Sanctuary Program (ACSP) for Golf*. http://www.audubonintl.org/programs/acss/golf.htm
2) *Environmental Principles for Golf Courses in the United States*, United States Golf Association, 1996. http://www.usga.org/green/download/current_issues/print/environmental-principles.html
3) *Golf Course Irrigation: Environmental Design and Management Practices*, James Barrett, et al., Wiley & Sons Publishers, 2003.
4) *Irrigation Information Packet*, Golf Course Superintendents Association of America. http://www.gcsaa.org/resource/infopacks/pdfs/irrigation.pdf
5) *Turf Management for Golf Courses, 2nd Edition*, James B. Beard, United States Golf Association, 2002.

6) *U.S. Air Force Golf Course Environmental Management Program*, Air Force Center for Environmental Excellence, San Antonio, Texas. http://www.afcee.brooks.af.mil/ec/golf/default.asp

7) *Wastewater Reuse for Golf Course Irrigation*, edited by James T. Snow, United States Golf Association, 1994.

5.3 Landscape Irrigation Conservation and Incentives

Applicability

This BMP is intended for use by a municipal water user group ("utility") with a substantial percentage of customers using automated landscape irrigation systems and is targeted to customers who have automated irrigation systems. If data on the number of customers with irrigation systems are lacking or absent, the summer peak/winter average ratio can be used as an evaluation tool to determine whether to proceed with this BMP. A ratio of 1.6 or greater indicates the potential for substantial water savings with implementation of this BMP. For maximum water-use efficiency benefit, the utility should adhere closely to the measures described below.

Description

Landscape irrigation conservation practices are an effective method of accounting for and reducing outdoor water usage while maintaining healthy landscapes and avoiding run-off. Using this BMP, the utility provides non-residential and residential customers with customer support, education, incentives, and assistance in improving their landscape water-use efficiency. Incentives include rebates for purchase and installation of water-efficient equipment. Four approaches are outlined below. Successful implementation of this BMP will be accomplished by performing one or a combination of the approaches listed.

1) ETo-Based Water Budgets

If the utility chooses the water budget approach, the utility also develops reference evapotranspiration ("ETo")-based water-use budgets equal to no more than 80 percent of ETo per square foot of irrigated landscape area for customers participating in its Landscape Irrigation Conservation Program. More aggressive landscape conservation programs can utilize stress coefficients lower than 80 percent.

Evapotranspiration is the combined amount of the water transpired by plants and the water evaporated from the soil. ETo is defined as the estimate of evapotranspiration that occurs from a standardized reference crop of well-watered, clipped, cool-season grass. The amount of supplemental irrigation water needed is the shortfall between plant water need (which is a fraction of ETo) and precipitation.

The statewide Texas Evapotranspiration Network (http://texaset.tamu.edu/) should be consulted for historical evapotranspiration data, historical precipitation, and methodology for calculating reference evapotranspiration and allowable stress. (Communities located in the North Plains areas may find local historical data on potential evapotranspiration at: http://amarillo2.tamu.edu/nppet/whatpet.htm.

2) Water-Use Surveys, Metering, and Budgeted Water Use

If the utility chooses the survey approach, the utility develops and implements a plan to promote landscape water-use surveys to industrial/commercial/institutional ("ICI") and residential accounts with mixed-use meters. The water-use surveys, at a minimum, include: measurement of the landscape area; measurement of the total irrigable area; irrigation system checks and distribution uniformity analysis; review of irrigation schedules or development of schedules as appropriate; and provision of a customer survey report and information packet. When cost-effective, the utility should offer the following: landscape water-use analyses and surveys; voluntary water-use budgets; installation of dedicated landscape meters; acceptance of site conservation plans; and follow-up to water-use analyses and surveys.

At the start and end of the irrigation season, irrigation systems should be checked, and repairs and adjustments made as necessary. Notices should be included in bills to remind customers of seasonal maintenance needs. For accounts with water-use budgets, the utility should provide notices with each billing cycle showing the relationship between budgeted water usage and actual consumption. When soil conditions allow, and landscape managers are familiar with the use and maintenance of soil moisture sensors, water budgets can be allocated based upon soil moisture status, thereby providing a closer estimate of actual evapotranspiration.[3]

Many utilities require dedicated irrigation meters for all commercial and/or industrial accounts with automatic irrigation systems or if the lot is above a minimum size. For municipalities with ordinance-making powers, this can be accomplished by ordinance. Otherwise, dedicated meters may be implemented as a new customer policy.

3) Landscape Design

If the utility chooses the landscape design approach, the utility provides information on climate-appropriate landscape design and efficient irrigation equipment and management for new customers and change-of-service customer accounts (*See* the Landscape Design and Conversion Programs BMP for more detail). To serve as a model, the utility should install climate-appropriate, water-efficient landscaping at water agency facilities and landscape meters where appropriate. Municipalities with ordinance-making powers should consider adopting ordinances that require all new apartment complexes and commercial buildings to install a water conserving landscape. This can often be accomplished by amending an existing commercial landscape ordinance.

4) Minimum Standards and Upgrades

If the utility chooses the landscape standards approach, the utility should require new commercial and industrial customers to install separate irrigation meters and consider retrofitting current commercial and industrial customers with irrigation meters. The utility should consider this requirement for new residential customers installing automatic irrigation systems. For municipalities with ordinance-making powers, this can be accomplished by ordinance. Otherwise, this may be implemented as a new customer policy.

Irrigation system design and maintenance components and landscape design may be systematically upgraded through use of municipal ordinance-making powers where possible. Minimum water efficient design features can be mandated for new construction, while existing systems or landscapes are offered incentives to upgrade. Rainwater sensors, soil moisture sensors, irrigation controllers, pipe specifications, and hydrozone specifications are all potential elements of an irrigation systems ordinance. Total turf grass areas, buffer zone plant material, and hydrozones are all potential elements of landscape design ordinances. Buffer or median areas represent additional savings when all landscaped areas less than five feet in any dimension are restricted to drip or other surface or subsurface (non-spray) irrigation system or no irrigation system.

Implementation

The utility should consider offering the Landscape Irrigation Program to customers with large landscapes first as a means of rapidly increasing cost-effectiveness and water savings. Marketing the Program to the customer via bill inserts will allow the utility to target the largest summer peak users first. The utility should consider also approaching local weather announcers, radio gardening show hosts, and newspaper columnists for assistance in notifying the public about the program. Public/private partnerships with non-profits such as gardening clubs, Cooperative Extension offices and/or with green industry businesses such as landscape and irrigation maintenance companies are potential avenues to market the program and leverage resources.

Incentives can include rebates for irrigation audits and systems upgrades, recognition for water-efficient landscapes through signage and award programs, and certification of trained landscape company employees and volunteer representatives who can promote the Program. Utility staff can also be trained to provide irrigation audits which can include resetting irrigation controllers with an efficient schedule.

Approximately one year after conducting an irrigation audit, the utility should consider conducting a customer-satisfaction survey. The objective of the customer-satisfaction survey is to determine the implementation rate of recommended modifications and to gauge customer satisfaction with the program.

The initial step in assisting customers with landscape irrigation systems is a thorough evaluation of the existing landscape area and irrigation systems. This includes:

1) A list of landscape areas, measurements, plant types, irrigation system hydrozones, and controller(s);
2) A list of existing irrigation policies or procedures including maintenance and irrigation schedules;
3) A distribution uniformity analysis on irrigated turf areas;
4) A review of water bills with attention to the ratio of summer to winter use; and
5) An initial report summarizing the results of the evaluation.

The water customer who participates in this program needs to maintain and operate its irrigation systems in a water-efficient manner. Maintenance programs include pre-irrigation system checks, adjustment of irrigation timers when necessary, installation of rain sensors, and regular review of irrigation schedules and visual inspection of the irrigation system. When landscape management companies are utilized, contracts should include a required report showing regularly scheduled maintenance and seasonal adjustments to irrigation systems controllers. A more advanced form of contracting would be to build into the contract a dollar amount based on 80 percent of ET and require the contractor to pay for any water use above that amount. The utility should consider implementing a notification program to remind customers of the need for maintenance and adjustments in irrigation schedules as the seasons change.

When appropriate, the utility should consider offering the following services:

1) Training in efficiency-focused landscape maintenance and irrigation system design;
2) Financial incentives (such as loans, rebates, and grants) to improve irrigation system efficiency and to purchase and/or install water efficient irrigation systems;
3) Financial incentives to replace high-water use plants with lopw water use ones;
4) Rebates and incentives to purchase rain sensors or soil-moisture sensors; and
5) Notices at the start and end of the irrigation season alerting customers to check irrigation systems and to make repairs and adjustments as necessary.

The utility should need to ensure that landscape irrigation system specifications are coordinated with local building codes.

Evaluations and/or rebate processing could be done by the utility staff or be outsourced. If a utility chooses to perform the evaluations using in-house staff, they may take advantage of irrigation evaluation training programs provided by the Texas A&M School of Irrigation or the Irrigation Association.

An outsourcing option for the non-residential sector is to use or recommend a water-based performance contractor. Performance contracting is a financing technique that uses cost savings from reduced utility (water and sewer) consumption to repay the cost of installing

water conservation measures. This technique allows for the development of a water-savings program without significant up-front capital expenses on the part of the customer. Instead, the costs of water-efficiency improvements are borne by either the contractor or a third party lender who recoups cost and shares water savings profits with the user.

Schedule

1) Realize the Scope of this BMP within ten years of the date implementation commences.
2) Develop ETo-based water-use budgets for all accounts with dedicated irrigation meters by the end of the second year from the date implementation commences.
3) Develop and implement a plan to target and market landscape water use surveys to ICI accounts with mixed-use meters by the end of the first year from the date implementation commences.
4) Develop and implement a customer incentive program by the end of the first year from the date implementation commences.
5) Follow up with the participating customer approximately one year after a water use survey has been conducted and/or a rebate processed.

Scope

To accomplish the goals for this BMP, the utility should do the following:

1) <u>Landscape Irrigation System Management Programs</u>
   a. Within one year of implementation date, develop and implement a plan to market water-use surveys to ICI accounts with mixed-use meters;
   b. Within one year of implementation date, develop and implement a customer incentive program;
   c. Within two years of implementation date, develop ETo-based water-use budgets for 90 percent of ICI accounts with dedicated irrigation meters;
   d. Within ten years contact and offer landscape water-use surveys to 100 percent of ICI accounts with mixed-use meters;
   e. Within ten years complete landscape water-use surveys for at least 15 percent of ICI accounts with mixed-use meters.
   f. Within ten years contact and offer landscape water-use surveys to 100 percent of residential accounts with summertime monthly use of greater than four times annual average; and
   g. Within ten years complete landscape water-use surveys for at least 15 percent of residential accounts with summer monthly use of greater than four times annual average.

2) <u>Ordinance Approach</u>
   In the first twelve (12) months: Plan a program, including stakeholder meetings as needed. Consider offering rebates for all or a portion of the time this program

is in place. For example, offer rebates for only the first five years to encourage customers to take advantage of rebates and retrofit early in the program. Develop a plan for educating real estate agents, landscape companies, and irrigation installers about this requirement. Plan a follow-up inspection program after retrofit. Develop and pass ordinance. Implement ordinance and tracking plan for number of units retrofitted.

In the 2nd year and all subsequent years: Continue implementation; continue outreach program for real estate agents, landscape companies, and irrigation system installers; and continue verification inspections.

Documentation

To track this BMP, the utility should gather the following documentation:

1) Number of dedicated irrigation meter accounts;
2) Number of dedicated irrigation meter accounts for which water budgets have been developed;
3) Aggregate water use for dedicated landscape accounts with budgets;
4) Aggregate budgeted water use for dedicated landscape accounts with budgets;
5) Number of mixed-use accounts;
6) Number of surveys offered and number of surveys accepted and completed;
7) Number, type, and dollar value of incentives, rebates, and loans offered to and accepted by customers;
8) Estimated water savings achieved through customer surveys; and
9) Estimated landscape area converted and water savings achieved through low water landscape design and conversion program.

Determination of Water Savings

Landscape surveys as described in this document are assumed to result in a 15 percent reduction in water demand for landscape uses by surveyed accounts. The utility should provide estimates of water savings from landscape irrigation survey programs based upon actual metered data. The water budget calculation is as follows:

80 percent ETo calculation: I = (ETo x Kc x AS) where I is the irrigation amount to be applied for a given period (daily, twice weekly, weekly, etc.), in inches or centimeters

ETo is the measured reference evapotranspiration over the irrigation period
Kc is a turf coefficient for turf grasses, and can be found at http://texaset.tamu.edu/
AS is allowable stress of 0.8 (or less if the landscape manager wishes)
For those wishing to convert inches of irrigation to gallons, multiply landscape area by 0.62. Irrigation Volume (gals.) = I (in.) x LA (sq ft) x 0.62

When applying irrigation, the equation should be modified to gain greater water savings by accounting for precipitation: I = (ETo x Kc x AS) – Pe where P is precipitation in inches or cm. In calculating an irrigation amount, it is important to consider effective precipitation (Pe). Effective precipitation is less than natural precipitation since some rainfall runs off or percolates below the root zone. The amount of effective precipitation will vary with region and rainfall trends. Each rainfall event will have a unique characteristic, and a good source for estimating Pe is the county office of the Texas Cooperative Extension Service.

Cost Effectiveness Considerations

Surveys can be performed by utility staff or by contractors. The labor costs range from $50 to $100 for a SF irrigation survey and start around $100 and go up from there for an ICI irrigation survey, depending on the efficiency in scheduling the surveys, the size of the landscape, and the scope of the survey.

There may be other one-time costs such as purchase of leak detection equipment and meters. Marketing and outreach costs range from $5 to $15 per survey. Administrative and overhead costs range from 10 to 20 percent of labor costs.

References for Additional Information

1) *Landscape Irrigation Scheduling and Water Management.* Water Management Committee of the Irrigation Association, September 2003. http://www.irrigation.org/PDF/IA_LIS_AND_WM_SEPT_2003_DRAFT.pdf
2) *Turf and Landscape Irrigation Best Management Practices*, Water Management Committee of the Irrigation Association, September 2003. http://www.irrigation.org/PDF/IA_BMP_SEPT_2003_DRAFT.pdf
3) *Waste Not, Want Not: The Potential for Urban Water Conservation in California,* Pacific Institute, November 2003. http://www.pacinst.org/reports/urban_usage/waste_not_want_not_full_report.pdf
4) *Handbook of Water Use and Conservation*, Amy Vickers, Waterplow Press, May. 2001.
5) *ET and Weather Based Controllers CUWCC Web Page.* http://www.cuwcc.org/Irrigation_Controllers.lasso
6) *Smart Water Technology Initiative Web Page.* http://www.irrigation.org/swat1.asp
7) *Soil moisture instrumentation: Sensors & strategies for the 21st century*, Richard Mead, in Irrigation Journal, Sept/Oct 1998.
8) *San Antonio Water System Conservation Program.* http://www.saws.org/conservation/
9) *WaterWise Council of Texas.* http://www.waterwisetexas.org/
10) *Texas Evapotranspiration Network*. http://texaset.tamu.edu/
11) North Plains areas of Texas may find local historical data on potential evapotranspiration at: http://amarillo2.tamu.edu/nppet/whatpet.htm.

5.4 Park Conservation

Applicability

This BMP is intended for all Municipal Water User Groups ("utility") which manage parks or serve customers with parks which consume water. These include facilities such as irrigated parks, recreation centers, fountains or pools at which the visible use of water often comes under scrutiny by the public and water resource managers both because of large water demand to maintain a park and because of the perception that the water use may be excessive.

The specific measures listed as part of this BMP can be implemented individually or as a group. Utilities may already be implementing one or more these elements and they may want to adopt additional elements outlined in this document. Once a utility decides to adopt this BMP, the utility should follow the BMP closely in order to achieve the maximum water efficiency benefit from this BMP.

Description

Park irrigation conservation practices as well as the careful use of water in operation and maintenance of park facilities can effectively reduce water demands. Under this BMP, the utility requires the management of each park with an irrigation system to develop a conservation plan that includes the elements described in this section. A Municipal Park Department should develop comprehensive written water conservation policies and procedures that cover all irrigated parks under its jurisdiction. Maintenance and operations of park facilities such as pools are also addressed. All park facilities should be metered and water use billed as means of reinforcing the importance of water use efficiency to park management.

Under the plan the park manager implements a watering regimen that uses only the amounts of water necessary to maintain the viability of the turf and landscape material appropriate for the use of the park. Water should only be applied to areas that are essential to the use of the park. For parks with athletic fields, the fields should be irrigated in accordance with the guidelines of the Athletics Fields BMP. Utilities should consider methods to encourage park managers to cease irrigation of areas that do not affect the use of the park by the public.

The utility should coordinate with Park Department or customer staff to ensure implementation of a large landscape water-use survey of irrigated areas and develop reference evapotranspiration ("ETo")-based water-use budgets equal to no more than 80 percent ETo per square foot of landscape area. The landscape survey should include the following elements: measurement of landscape area; measurement of total irrigable area; irrigation system checks and distribution uniformity analysis; and review or development of irrigation schedules. Alternatively, the utility may allow individual customers to perform their own surveys with properly trained staff or consultants and provide documentation of the survey to the utility.

The statewide Texas Evapotranspiration Network (http://texaset.tamu.edu/) should be consulted for historical evapotranspiration data, historical precipitation, and methodology for calculating reference evapotranspiration and allowable stress. Communities located in the North Plains areas may find local historical data on potential evapotranspiration at http://amarillo2.tamu.edu/nppet/whatpet.htm

At a minimum, compliance with this BMP should require the replacement of all manually controlled or quick couple irrigation systems with automatic irrigation systems and controllers. The automatic controllers must be capable of shutting off flow when a sudden pressure loss occurs from a broken system. It is important that access to such controllers be limited to the authorized landscape manager, or be designed to shut off flow automatically if the irrigation system is activated manually. The authorized landscape manager should be trained in good soil management and cultural practices such as proper aeration, nutrient management, mowing and soil testing as well as in irrigation management.

When cost-effective, the park irrigation user should be required to provide methods for achieving enhanced water conservation through computer controlled irrigation systems ("CCIS") or similar technology. In order to achieve maximum efficiency a CCIS should include at least the following components: computer controller (digital operating system), software, interface modules, satellite field controller, soil moisture sensors, and weather station. A CCIS should be designed so as to prevent overwatering, flooding, pooling, evaporation, and run-off of water, and should prevent sprinkler heads from applying water at an intake rate exceeding the soil holding capacity. Park organizations with a number of remotely located park irrigation systems should consider a CCIS with satellite systems. The utility may choose to offer incentives for park irrigation management in direct relation to the size and sophistication of the system.

The utility implementing this BMP should consider offering training for park irrigation management or co-sponsoring training with qualified horticulture or park management programs. Documentation of cultural practices and soil management measures should be included in a successful program.

Water wasting practices during park irrigation should be eliminated, including water running in gutter, irrigation heads or sprinklers spraying directly on paved surfaces, operation of automatic irrigation systems without a functioning rain shut off device, operation of an irrigation system with misting or broken heads, and irrigation during summer months between the hours of at least 10 a.m. and 6 p.m.

Use of reclaimed, reused, and/or recycled water for park irrigation offers excellent opportunities for conservation of potable water. However, specific uses must meet Texas Commission on Environmental Quality ("TCEQ") water quality standards for reclaimed water and human contact and must be appropriate for the specific use of the park. Reclaimed water should be applied based on the appropriate water budget.

1) Park Facilities

Playground equipment and facilities such as recreational facilities, tennis courts, basketball courts, and park and pool buildings should be swept for regular sanitary purposes and only cleaned with the amounts of water needed for human health and safety purposes. Showerheads, faucets and toilets in park facilities should be retrofitted with efficient fixtures.

All public swimming pools should be equipped with recirculation and chlorination equipment. While not common, there are pools that are filled and drained everyday with potable water and that practice should be discontinued. Overflow drains should be plumbed back into the recirculation system. Swimming pools should be managed to minimize operational losses due to evaporation, splashing and filter backwashing. Proper design, optimal backwash scheduling, and use of a pool cover can help limit all these losses. Regular maintenance during the off-season should include testing for water loss and repair of leaks. Use of pool covers is also an important consideration for reducing water losses due to evaporation, although safety concerns where pools are accessible after hours require careful implementation.

Decorative water features at parks including fountains and augmented streams should use recirculation systems. During high temperature seasons reduced operating procedures and use of covers can reduce evaporation losses. Reuse of non-potable water such as reclaimed water should also be considered where available. Rainwater harvesting is also an option for many park facilities with large roof areas.

2) Botanical Gardens

Botanical Gardens or other related areas in parks are usually run by staff trained in proper water management techniques to meet plant needs. However, water saving opportunities should be explored in leak detection and repair, installation of low-water-use demonstration gardens, and the use of rainwater harvesting or alternative water supplies as conservation techniques. The planting and maintenance of low-water-use demonstration gardens can assist the utility in the implementation of the WaterWise Landscaping, School Education, and Public Information BMPs.

Soil improvement is an effective method for reducing irrigation water usage while maintaining healthy soils. Soil improvement programs on high visibility areas such as public parks can demonstrate to the public the effectiveness of this method. For parks, compost applications of 1/4 to 1/2 inch annually on turf areas and one inch annually on flower beds are recommended. Compost is most beneficial when applied in the fall.

Implementation

Prior to development of a specific park conservation plan, the utility should consider a series of planning meetings with park irrigation personnel and management to discuss water

conservation issues and to prepare an adequate scope of action for the plan. Additionally, a number of voluntary environmental management programs exist in which park irrigation staff could participate. There are two approaches to be considered for implementing the park irrigation conservation plan: an incentive or voluntary approach and an ordinance or other enforceable requirement approach.

1) Incentive or Voluntary Compliance Approach

The utility may provide staff or contract with a third party to develop the conservation plan, including a water audit of the park irrigation system and practices. The water-use survey, at a minimum, includes measurement of the irrigated turf areas; determination if hydrozones within the irrigation system are proper for the type of turf present; irrigation system checks and distribution uniformity analysis; review of irrigation schedules or development of schedules as appropriate; and provision of a customer survey report and information packet.

If indicated by survey results and if cost-effective, the utility may offer incentives to the park irrigation user for upgrading irrigation systems, installing or upgrading controllers, changing hydrozones to eliminate irrigation of areas that do not receive high foot traffic, or for reducing the amounts of potable water used.

When cost-effective, the utility should offer workshops by trained professionals on pesticide, soil and nutrient management for optimal water use efficiency. An advantage to using third parties is that assistance in implementation can be provided at minimal cost to the utility.

To ensure that water savings goals are met, the utility should be explicit about the efficiency expectations of any voluntary or incentive programs. Park facilities and operations other than irrigation systems should also be included in the incentive or voluntary compliance approach.

2) Ordinance or Enforceable Requirements Approach

For utilities with ordinance or rule making powers:
In the first twelve (12) months: Plan, develop, and pass an ordinance that requires development and implementation of the conservation plan, including stakeholder meetings as needed. Develop a plan for educating customers, especially those directly affected by the requirements of the ordinance. Plan customer follow-up compliance and education after ordinance passage. Implement ordinance and tracking plan for violations, compliance notifications, and enforcement.

After ordinance passage (in the 2nd year and on): Continue implementation and outreach program for customers. Continue compliance education and initiate

enforcement programs. Enforcement can include citations with fines and service interruption for repeat offenders.

For utilities that lack ordinance or rule making powers:
In the first twelve (12) months: Plan a program including stakeholder meetings as needed. Develop a plan for educating customers, especially those directly affected, about the requirements of park irrigation conservation plans. Develop follow-up compliance and education program. Implement water conservation program and tracking plan for violations and compliance notifications. Consider passing excess-use rates as a disincentive to park irrigation operations that do not stay within a budgeted amount of water (See Conservation Pricing BMP).

Schedule

To accomplish this BMP, the water user should do the following:

1) The utility with ordinance or rule making powers should adopt an incentive program or an ordinance or rules within twelve (12) months of commencing this BMP.
2) The utility with ordinance or rule making powers should implement the incentive plan or commence enforcement upon adoption of the ordinance or rule.

Scope

To accomplish this BMP, the utility should adopt park irrigation conservation policies, programs or ordinances consistent with the provisions for this BMP specified in Section C.

Documentation

To track the progress of this BMP, the utility should gather and have available the following documentation:

1) Copy of incentive plan or park irrigation conservation ordinances or rules enacted in the service area;
2) Metered water readings before and after any changes are implemented.
3) Copy of compliance or enforcement procedures implemented by utility, if applicable;
4) Survey of public swimming pools and actions taken to increase the efficiency of the pools.
5) Records of enforcement actions including public complaints of violations and utility responses, if applicable;
6) Where incentives are used, the number of park facilities completing the incentive plan;
7) Changes to irrigation systems, retrofits, or upgrades, regular leak detection and maintenance policies, and estimated water savings from conservation practices.
8) Water savings attributable to changes implemented; and

9) Costs of incentive plan(s) or ordinance if applicable.

Determination of Water Savings

Estimating total water savings for this BMP may be difficult; however, water savings can be estimated from each water-wasting measure eliminated through the actions taken under this BMP. For the replacement of inefficient equipment, the water savings are the difference in use between the new or upgraded equipment and the inefficient equipment. For landscape water waste, the savings can be calculated based on estimated savings from each water waste incident. For an irrigation survey, water savings can be expected in the range of 15 percent to 25 percent for park irrigation operations that do not yet have a CCIS and which choose to implement the efficiency measures recommended by the survey.

Switching to reuse or other nonpotable water or other alternatives can save up to 100 percent of the potable water supply used in irrigation. The savings are determined by comparing water use before and after the conversion to the new water supply. The savings for swimming pools that have been modified or repaired can be measured in the same way.

Cost-Effectiveness Considerations

The labor costs for an irrigation survey of a park range from $250 to more than $1000 for an irrigation survey depending on the efficiency in scheduling the surveys, the size of the facility, and the scope of the survey. Surveys can be performed by utility staff or by contractors.

Marketing and outreach costs range from $5 to $15 per survey depending upon whether parks are owned by the same municipality as the utility. Administrative and overhead costs are in the range of 10 to 20 percent of labor costs. Costs for upgrades to irrigation systems and controllers can be much more extensive depending upon the scale of changes needed. While less expensive, costs for pool leakage repair and other water efficient equipment are also very site specific. Incentive programs for park conservation equipment upgrades or maintenance will need to evaluate costs on a case-by-case basis.

References for Additional Information

1) *Handbook of Water Use and Conservation*, Amy Vickers, Waterplow Press, May 2001.
2) *Maintaining Park Irrigation,* J. A. Murphy. http://www.rce.rutgers.edu/pubs/pdfs/fs105.pdf
3) *Managing Bermudagrass Turf: Selection, Construction, Cultural Practices, and Pest Management Strategies*, L. B. McCarty, Grady Miller, John Wiley & Sons, July 2002.
4) *Managing Healthy Sports Fields: A Guide to Using Organic Materials for Low-Maintenance and Chemical-Free Playing Fields*, by Paul D. Sachs, John Wiley & Sons, January 2004.

5) *Water Management Stretches Irrigation Water*, E. K. Chandler. http://www.txplant-soillab.com/page32.htm
6) *Park Irrigation and Water Conservation,* Texas Agricultural Extension Service. http://soilcrop.tamu.edu/publications/pubs/b6088.pdf
7) *Irrigation System Design and Management Courses*, Irrigation Technology Center, Texas A&M, http://irrigation.tamu.edu/courses.php

5.5 Residential Landscape Irrigation Evaluations

Applicability

The Residential Landscape Irrigation Best Management Practice is intended for use by a municipal water user or water utility with a large majority of customers utilizing automatic in-ground irrigation systems. Outdoor irrigation constitutes about 60 percent or more of water used by households during the summer months, and much of that water is wasted due to overwatering and broken or maladjusted components. Helping customers identify these issues can amount to large water savings and a positive customer service image for the utility.

Description

Landscape irrigation evaluation training is an effective way to utilize existing staff to reduce summertime water usage and effect positive behavior change through face-to-face site visits and information sessions with individual customers. Automatic landscape irrigation systems typically operate in the early morning or late evening hours, leaving broken and maladjusted components, resulting in irrigation water run-off that goes unnoticed by the home resident. Having in-house staff to address customer complaints regarding a variety of irrigation issues such as high water bill complaints, watering schedule violations, complaints regarding broken irrigation components, or overwatering causing run off and/or ponding, is a valuable asset to the utility in terms of both water savings and customer service. This best management practice is designed to provide assistance and methods for a utility to gain the expertise to perform irrigation evaluations. Implementation can be accomplished by performing one or a combination of the approaches listed.

1. Off-Site Classroom Training
   Several training opportunities are available through accredited irrigation education providers around the state. The Texas Commission on Environmental Quality is the licensing agency for irrigators, technicians, and inspectors, and approves continuing education credits to maintain these licenses. To find a list of approved trainers and courses in your area of the state, visit http://www.tceq.texas.gov/licensing/training/trainers/li_cont_train. One does not need to be a licensed irrigator, technician, or inspector, or seeking one of the specified licenses, to attend courses. Many of the irrigation education service providers teach a variety of topics related to irrigation and water conservation.

   Texas Commission on Environmental Quality licensing regulations require that individuals who consult on the design, construction, or maintenance of irrigation systems hold irrigation licenses. The license ensures that any person giving advice regarding an irrigation system fully understands the function and regulations associated with the system. Individuals who are employees of water utilities may provide advice on irrigation scheduling and comment on irrigation maintenance challenges without a

license. However, obtaining an irrigation license is still desirable for utility employees to provide a higher level of service to customers.

Water providers seeking to utilize current staff should consider having staff attend a landscape irrigation auditing or evaluation course to gain a basic understanding of what landscape irrigation auditing involves and what tools and knowledge will be necessary to perform audits or evaluations. These courses can provide an understanding of basic irrigation principals to help with program development and potential troubleshooting while on-site performing an irrigation evaluation.

Training opportunities are also available through a number of different resources such as the Irrigation Association and Texas Agrilife Extension Service. Courses are available in many different areas around the state and will range from one to two days in length, depending on the course.

2. On-Site Training
   There are many water providers around the state with individuals on staff performing irrigation evaluations in a variety of methods. It may be possible to enlist the assistance of a landscape irrigation evaluation trained staff person from a nearby water provider to walk through their processes and procedures as well as offer advice and technical assistance for starting an irrigation evaluation program.

   The most beneficial opportunity would be a chance to “shadow” an experienced irrigation evaluator while evaluating properties within the water providers service area. The utility interested in starting the program would need to identify and schedule several properties to be evaluated. Setting up one or two city council or city official properties would be helpful to observe the process and see results first hand.

   Shadowing would require having scheduled staff time to accompany the evaluator, at least five properties lined up for evaluations over a two or three day period, and depending on the size of the properties to be evaluated, any materials necessary to provide evaluation results as well as other information for the property owner. Some additional tools would be necessary such as a stopwatch for reading and recording the flow rate from the meter and manuals for operating and programing various irrigation controllers. Shadowing an experienced evaluator, interacting with customers, seeing the variety of irrigation system components and problems typically encountered, and adjusting irrigation schedules firsthand provides the greatest level of education for beginning evaluators. Shadowing can provide a firsthand perspective of what to expect before scheduling those first evaluations.

Implementation

Water providers utilizing this best management practice should offer the program to customers with permanently installed in-ground landscape irrigation systems as a means of reducing wasteful irrigation practices and educating homeowners regarding proper maintenance and

operation of irrigation systems. This program should be targeted to water customers who use over a certain amount of water or as a response to high water usage or bill complaint. As an example focusing on high-use customers, such as the top 10 percent of water users, will provide a more manageable program while still achieving a large volume of water savings. Program marketing can be directed at customers through bill inserts or direct mailing of letters, post cards, or similar materials. The water provider can also approach homeowner associations of targeted high water use neighborhoods with articles regarding the program for publication in newsletters, or offer to give a presentation regarding program specifics, such as procedures and goals.

To incentivize the program a water provider could offer some type of rebate or giveaway to customers for participating. Some water providers offer, or have offered, free rain sensors to customers that did not have one. Others require an irrigation system evaluation as a prequalification to participate in irrigation equipment rebate programs. A utility that has imposed outdoor watering restrictions as a water use reduction measure, permanently or temporarily, could offer to waive a customer violation if they agree to an irrigation landscape evaluation where both the customer and utility benefit. The customer doesn't have to pay a fine and learns about their water use. The utility saves water and has had a positive impact on a customer.

Keeping detailed accounts of each site visited and the water use pre- and post-evaluation will help track water savings associated with the program. However, a follow-up survey with customers who participated in the program can show the effectiveness of the program and the overall satisfaction of the service.

Before the landscape irrigation evaluation program can be developed, it is important to establish defined goals. While the ultimate goal is to save water, the water provider will want to achieve several things along the way, such as a behavior change in how customers use water outdoors, provide a quality service that customers will recommend, and build a positive relationship between the water provider and the customer or end user.

Basic materials should be developed prior to conducting irrigation evaluations to provide results and information of the evaluation to the customer as well as tracking and monitoring evaluations and water use. This includes:

1. Irrigation evaluation forms that list elements of each irrigation station, such as plant type, soil, emitter, and light conditions. Also, this form should have sections for tracking water use per station, basic information recorded from the controller, and issues encountered in each station.
2. Manuals or access to manuals for various types of irrigation controllers which aids in programing and troubleshooting.
3. Irrigation schedule card to be affixed to the controller which current irrigation schedule.
4. Educational information for the customer regarding proper irrigation maintenance and scheduling.

5. Irrigation evaluator contact information for questions or comments regarding the evaluation.

Scope and Schedule

In the first 12 months the water provider should do the following for implementation of the Best Management Practice:

1. Obtain staff training and complete all necessary additional education, documents, and testing required to receive certifications.
2. Develop materials necessary for conduction, scheduling, and tracking irrigation system evaluations.
3. Develop materials and processes to promote program.
4. Look at historic and current water use of the utility and begin identifying target areas with high water use as potential areas for irrigation evaluations.

To accomplish this Best Management Practice, the water provider should do the following after the first year of implementation:

1. Look at water savings per irrigation evaluation and determine effectiveness of the program.
2. Develop and distribute a follow-up survey to customers who participated in the program and gauge the overall public perception of the program.
3. Identify aspects of the program that worked well and not too well. Look for opportunities to expand on what worked and change or remove aspects that did not.
4. Identify additional customers to target and expand the reach of the program through continued outreach and promotions.

Measuring Implementation and Determining Water Savings

Water savings associated with landscape irrigation system evaluations are estimated to last approximately three years. Beyond the three years it is assumed that the landscape needs or scheduling will have changed from what was originally observed and programmed as a direct result of the irrigation evaluation.

To measure savings of irrigation evaluations, exact documentation must be kept for each evaluation performed which must include flow rate measurements and specific run-times associated with each irrigation station. Calculations for each station and total water use must be included on the irrigation evaluation form that is provided to the customer and kept by the water provider as a record. Savings will be represented on each individual evaluation and can be averaged for an overall savings estimate.

Cost-Effectiveness Considerations

Landscape irrigation evaluation training courses can cost approximately $400.00, depending on the source and if an exam for certification is offered. Courses, typically referred to as Irrigation

System Auditing courses, are available several times annually around the state through the Texas Agrilife Extension Service and the Irrigation Association. Other irrigation education organizations may also offer similar courses as well.

It is also highly recommended the irrigation evaluator become a Texas Licensed Irrigator to ensure compliance with all state rules regarding landscape irrigation systems, and develop a greater awareness of the rules and regulations governing the irrigation industry in Texas.

To become a licensed irrigator in Texas a 40-hour course and examination is required. The course fee is around $500.00 and the exam fee another $100.00. Once licensed, the irrigator must complete 24 hours of continuing education credits every three years and pay a license renewal fee to maintain a current status.

Other cost considerations may include the purchase of tools and supplies for conducting irrigation evaluations; for example: soil probe to assess soil type and depth; utility key to access meters; irrigation controller remote controls to operate irrigation systems from various areas of the property; and water proof boots to keep feet dry.

References

1. Texas Commission on Environmental Quality. http://www.tceq.texas.gov/licensing/training/trainers/li_cont_train
2. Irrigation Association. Certified Landscape Irrigation Auditor. http://www.irrigation.org/clia/
3. Texas AgriLife Extension Service. http://itc.tamu.edu/
4. Lower Colorado River Authority. http://www.lcra.org/water/save/irrigation/index.html
5. San Antonio Water System. http://www.saws.org/conservation/
6. City of Austin, Austin Water Utility. http://www.ci.austin.tx.us/water/water_portal2.htm
7. City of Austin Grow Green. http://www.ci.austin.tx.us/growgreen/
8. Dobbs, Steve, *The Perfect Texas Lawn, Attaining and Maintaining the Lawn You Want,* Thomas Nelson, August 2002.

6.1 Public Information

Applicability

Any Municipal Water User Group ("utility") can adopt this BMP. A program for providing water conservation information to the public is an effective means of both promoting specific water conservation programs and practices and educating the public about the importance of using water efficiently. A utility may have already accomplished this BMP if it has a current public information program that meets the criteria of this BMP.

Once a utility decides to adopt this BMP, the utility should follow the BMP closely in order to achieve the maximum water efficiency benefit from this BMP.

Description

Public information programs, even though they may not be directly related to any equipment or operational change, can result in both short and long-term water savings. Behavioral changes by customers will only occur if a reasonable yet compelling case can be presented with sufficient frequency to be recognized and absorbed by customers. There are many resources that can be consulted to provide insight into implementing effective public information programs. Like any marketing or public information program, to be effective, water conservation public information should be planned out and implemented in a consistent and continual manner.

The goal is education of customers about the overall picture of water resources in the community and how conservation is important for meeting the goals of managing and sustaining existing water supplies and avoiding or delaying building of new facilities. An equally important part of the program is to provide data and information on specific actions and measures the customers should take to implement these community goals. Showing customers that the results of those actions have made a difference encourages greater participation in conservation efforts.

There are a variety of tools that can be effectively used to communicate water conservation public education. These include use of print, radio, and television media; billboards; direct distribution of materials; special events such as exhibits and facilities tours; and maintenance of an informative website.

Print media activities can include press conferences, articles and news releases. Regular columns and contributions to gardening and environmental reports are also good ways to reach a wide audience. Electronic media efforts include talk shows, news conferences, press releases, public service announcements, and even paid commercials.

Besides media, utilities can use direct distribution of materials such as inserts or messages on the utility bill, a newsletter, flyers, direct mail, and door hangers. Direct distribution allows targeting of specific messages to specific target audiences.

Special events provide excellent opportunities for direct interaction with the public. These events include facility tours, exhibits, participation in community events, trade shows, presentations to groups, water efficient landscape judging and competitions, and classes and seminars. Development of demonstration gardens and permanent exhibits are also effective.

Websites are now an essential element of public information. Much of the same printed material made available to the media and through direct distribution can be put on a website. Electronically delivered newsletters should include links to the utility's website.

An early step in development of the public information program is to identify the target audiences and what messages need to be conveyed. Themes should be selected that both convey the importance of water conservation and provide customers an opportunity to act. Thematic messages that stress the importance of water as a natural resource can be linked with specific tips or water conserving activities. The most successful public information campaigns also promote or "market" opportunities for customers to participate in utility sponsored conservation programs such as rebate and/or retrofit programs described in other BMPs.

Each public information program should be tailored to the utility and the community. The types of communication methods most effective for the target audience should be identified. Certain media outlets will be more effective than others. For example, television may be effective for large city utilities where it would not be for suburban or rural utilities. In those areas, a local newspaper or direct distribution of materials would likely be better choices.

There are many publications, brochures, videos, DVDs, etc. already available on water conservation that can be used as published or modified to meet the goals of the utility. The TWDB has brochures and guidebooks available at cost as well as TV and radio public service announcements. A statewide public awareness program is an additional resource anticipated for future years.

Some of the most effective education initiatives involve the participation of customers in the planning process. Creation of stakeholders committees, task forces, or advisory groups have proven effective for utilities in both defining the message and in recruiting allies in the community for promotion of water conservation. Such participatory programs should be well planned and may require an extensive process with numerous meetings or could be a relatively shorter process with representatives of key community organizations. The representative approach could involve neighborhood associations, business groups (i.e. nursery/landscape or other water-related businesses), academic institutions, not-for-profit agencies and environmental organizations among the mix of groups invited to participate. This process will be most successful if public input is sought not only for the public information plan but also for the entire Conservation Plan.

Partnership programs are another effective means of expanding the utility's public information efforts. Numerous not-for-profit agencies include environmental education among their goals. Integrating the utility's public information efforts with programs of other local agencies expands the impact of utility efforts. Other State agencies with offices around the state that include water conservation among their information programs include Texas Cooperative Extension offices, Texas Parks & Wildlife, Texas Soil & Water Conservation Board, Texas Commission on Environmental Quality, and Texas Forest Service.

Some business associations, neighborhood associations or not-for-profit groups may also provide partnering opportunities for the overall utility conservation program or specific BMPs. Together with these partners utility staff may be able to develop a speaker's bureau to offer adult education about specific water efficiency related topics such as Water Wise landscaping, irrigation system management, and retrofit and behavioral changes available to reduce water bills.

Another important marketing tool for successful conservation programs is public recognition of water-conserving customers. This is often used to focus attention on commercial customers as an incentive to promote greater efficiency by providing positive coverage of company conservation efforts. Awards or certification programs exist in a number of utility programs in Texas and across the nation[1]. These programs have also been used to recognize water-saving landscape designs.

For utilities that are pursuing a number of BMPs, it is important that the public information efforts be integrated with the promotion of implementation of the other conservation BMPs. Promotional efforts or "marketing" of rebates, retrofits, surveys, or educational events should be tied together in the Public Information Plan, much like commercial entities develop a marketing plan.

Implementation

The first step in implementation is to develop a Public Information Plan with goals and objectives and a schedule of activities for the first year and a tentative second year schedule. Forming a committee composed of customers and community leaders can help with the development of an effective plan. Committee members may be directly involved in implementing the plan, such as partnership programs with other agencies promoting water conservation, businesses or residents which implement BMPs and receive public recognition, or providing non-utility volunteers to promote conservation through a speakers bureau. Utilities should take advantage of and coordinate their efforts with State programs on conservation[2]. Another option is using firms that specialize in marketing and public information to develop a public information program.

The goal should be, at a minimum, to provide information to each customer at least four times each year on each action that the utility would like the customer to take. The plan should be updated every year continuing with a two-year time horizon. Every other year, the utility should

survey a sample of customers or consider the use of focus groups to determine if the utility messages are reaching customers and how effective the messages are in terms of customer actions.

The Public Information Plan should be a substantial part of the utility's overall Conservation Plan. Implementation of the Public Information program should be integrated with the implementation of specific BMPs included in the Conservation Plan. A successful public information effort will promote participation in other BMPs

Schedule

1) Utilities pursuing this BMP should begin implementing this BMP according to the following schedule: The utility should complete the Public Information Plan within six (6) months of adopting this BMP.
2) In the second year and each year thereafter, the utility should complete a revised Public Information Plan.
3) In the second year and every other year thereafter, the utility should conduct and complete a survey of customers to determine the effectiveness of its message and actions that customers have taken.
4) Every other year, the utility should survey customers or convene focus groups to assist in determining the effectiveness of materials used or to be used in the public information campaign.

Scope

The Public Information Plan should provide conservation information on each BMP being implemented to customers at least four times per year. For utilities focused on reducing summertime peak usage, themes and scheduling of message should be repeated numerous times during the late spring and early summer, rather than being spaced evenly throughout the year.

Documentation

To track the progress of this BMP, the utility should gather and have available the following documentation:

1) Number of activities and pieces of information and how many customers were at that activity or received each piece of information;
2) Number and schedule of activities or information pieces related to promoting specific BMPs adopted by the utility;
3) Number of news programs or advertisements that featured the utility message and how many customers had the opportunity to receive each message;
4) Total population in the utility service area;

5) Total budget by category for public information; and
6) Results of annual or biannual customer survey and/or focus groups to determine the reach and impact of the program.

Determination of Water Savings

Water savings due to public information efforts are difficult to quantify. If the public information effort was for a specific action such as a showerhead distribution, the savings can be calculated under this BMP if the utility did not implement the BMP containing the product or action. Water savings for other public information programs that result in specific actions by customers such as changes in irrigation scheduling or reduction in water waste occurrences could also be quantified through surveys or analysis of water waste reporting.

Cost-effectiveness Considerations

The costs for implementing this BMP depend on the scope of the public information effort. There may be costs for administration and materials. A comprehensive program would range in costs starting at $0.50 to $3.00 per customer per year depending on the size of the utility. Larger utilities should have lower unit costs due to economies of scale. The public information program can be developed and managed by utility staff or outside contractors. Media purchases with TV, radio and print media may be done directly by utility staff.

References for Additional Information

1) Texas Award Program Examples
   a. City of Austin Excellence in Conservation Award Program. http://www.cityofaustin.org/water/wwwssd_iw_award10.htm
   b. San Antonio Water System Annual Water Saver Awards for ICI Customers and Water Saver Landscapes. http://www.saws.org/conservation/
2) Texas Water Smart Program. http://www.watersmart.org
3) Educational Material on Outdoor Water Conservation, *Does Print Material Translate into Water Conservation Savings?* Kate Soroczan, Canadian Mortgage and Housing Corporation, AWWA Water Sources Conference, 2004.
4) *If They Help Write it, They'll Help Underwrite It*, Haring, T., AWWA Conserv 99, 1999.
5) *People are Watching – Public Participation in a Reuse Project*, Richardson, A.W., Janga, R.G., AWWA Water Sources Conference, 2002.
6) *Providing Incentives for Environmental Performance*, Brown, C., AWWA Water Sources Conference, 2004.
7) *Public Participation Methods to Increase Non-Residential Conservation*, Brown, C., AWWA Conserv 99, 1999.

8) *Stretching Your Marketing Dollar*, Mark Wieland, AWWA Water Sources Conference, 2004.
9) *Tuna Cans, Rain Gauges, and Soil Probes: High-Visibility Campaigns to Reduce Water Use*, DelForge and Platt, AWWA Water Sources Conference, 2002. http://www.awwa.org/waterwiser/references/abstract.cfm?id=53276&start=1&kw=public%20information
10) *Water Wise Awards: Incentive Based Conservation*, Bracciano, D., Holland, N., and Brown, S.P., AWWA Conserv 99, 1999.
11) *TWDB Education and Public Awareness Page.* http://www.twdb.state.tx.us/assistance/conservation/Education.htm
12) *A Consumer's Guide to Water Conservation (video and DVD),* AWWA, 1999. http://www.awwa.org
13) *Conserve Everyday Video,* AWWA, 2001. http://www.awwa.org
14) *H2O House Water Saving Home*, California Urban Water Conservation Council and EPA. http://www.h2ouse.org/

6.2 School Education

Applicability

This BMP is intended for a Municipal Water User Group ("utility") that serves schools as a part of its customer base. Lessons learned by students about good water use habits are often shared with the whole family. A utility may have already accomplished this BMP if it has a current school education program that meets the criteria of this BMP. Before deciding whether this BMP is necessary, review existing curriculum to see if the local school district is already offering a water conservation related curriculum.

Once a utility decides to adopt this BMP, the utility should follow the BMP closely in order to achieve the maximum water efficiency benefit from this BMP.

Description

School education programs, while not directly related to an equipment change, may result in both short and long-term water savings. Behavioral changes by the students based upon greater knowledge are often shared with parents and implemented at home. To be effective, a school education program should provide curriculum material appropriate to the grade level of the student, increasing in complexity from elementary school through high school. If such a curriculum does not already exist, local curriculum experts may be willing to help develop the desired materials.

A complementary aspect can be to include a water audit unit as part of the curriculum where the students take flow measurements of showerheads and faucet aerators at their homes. If the showerheads and faucet aerators are higher than the current standard, the students would receive efficient showerheads and faucet aerators to install with the assistance of their parents. This unit can be successfully implemented in grade 5 or higher and can meet the requirements of this BMP without additional curriculum development.

The circumstances and challenges of the local water resources should be considered in choosing or developing a conservation curriculum. Grade level appropriate material is important in ensuring that the students understand the information. When possible, curriculum material used in the classroom should address the Texas Essential Knowledge and Skills[6] ("TEKS") for the grade level and subject area. Texas state education guidelines for testing of skills are an important consideration as well. A quality water conservation program for schools provides teachers with materials that contribute to learning mathematics, science, social studies and history while educating the students about water conservation and local water resources. Already developed curriculum is available from the Texas Water Development Board, EPA, other public agencies, nonprofit organizations and private companies.

Another option beyond offering a supplemental curriculum is to offer an education entertainment show for grades 1 to 4. These shows can be very popular with teachers and often do not have the same requirement for the material to meet TEKS. In addition, the percentage of students that can be reached is often higher than for adoption of a curriculum.

To evaluate the effectiveness of the education materials, presentation or show, the utility should use an evaluation tool such as a pre- and posttest or survey.

Implementation

Implementation should consist of at least the following actions:

1) Evaluate local, regional, state or national resources available to determine applicability to the utility's local water conditions. Consider creating an advisory committee of local educators to assist in choosing or creating the curriculum;
2) Implement a school education program to promote water conservation and water conservation related benefits.

   Programs include working with school districts and private schools in the water suppliers' service area to provide instructional assistance, educational materials, and classroom presentations that identify urban, agricultural, and environmental issues and conditions in the local watershed and water service area. When possible, educational materials should meet the TEKS guidelines.

   A water oriented curriculum that is focused on conservation and resource issues should be made available for all grades.

   a. Grade appropriate programs and/or materials should be implemented for grade levels 1 to 6 initially. Alternatively, a presentation or educational show can be offered for some or all of these grade levels.
   b. For grades 7 to 8 and for high school students, the utility should do one of the following: distribute grade appropriate materials for high school science, political science, or other appropriate classes; present assembly type programs to high schools; sponsor science fairs with emphasis on conservation; or implement education programs with community groups like Scouts, 4-H clubs, etc.

The utility can elect to meet this BMP by focusing only on grades 1 to 6 or 7 to 12 and achieving higher participation rates.

In conjunction with the Showerhead and Aerator BMP, consider providing a water audit unit as part of the curriculum where the students take flow measurements of showerheads and faucet aerators at their homes. If the showerheads and faucet aerators are higher than the current

standard, the students would receive efficient showerheads and faucet aerators to install with the assistance of their parents. This unit can be successfully implemented in grade 5.

Schedule

Depending on the program option(s) selected, the following schedule should be followed:

1) Utility should adopt or develop the program in the first year and start implementation in the second year for grades 1 to 4.
2) Utility should adopt or develop the program in the second year and start implementation in the third year for grades 5 to 6.
3) Utility should adopt or develop the program in the third year and start implementation in the fourth year for grades 7 to 8.
4) Utility should adopt or develop the program in the fourth year and start implementation in the fifth year for grades 9 to 12.

Scope

Select items 1 and 2 or item 3.

1) The utility should strive to reach 10 percent of students in grades 1 to 6 with a presentation or curriculum each year by the third year of implementation, following the schedule above, and
2) The utility should strive to reach at least 10 percent of students in grades 7 to 12 with a presentation or curriculum each year by the third year of implementation following the schedule above. Or,

3) Alternatively this BMP will be met if the utility only focuses on grades 1 to 6 or 7 to 12. The program would be developed in the first year and implemented in the second year for either alternative. The utility should strive to reach either 15 percent of students in grades 1 to 6 each year by the third year of implementation or 15 percent of students in grades 7 to 12 by the third year of implementation.
4) The utility can count as participants students reached through clubs and educational events; and students impacted by utility sponsored program outside the utility service area.
5) For smaller utilities, or those in which service area boundaries overlap school district boundaries with another water utility, jointly operated or funded programs should be considered.

Documentation

To track the progress of this BMP, the utility should gather and have available the following documentation:

1) Number of school presentations made during reporting period;
2) Number and type of curriculum materials developed and/or provided by water supplier, including confirmation that curriculum materials meet state education framework requirements and are grade-level appropriate;
3) Number and percent of students reached by presentations and by curriculum;
4) Number of students reached outside the utility service area;
5) Number of in-service presentations or teacher's workshops conducted during reporting period;
6) Results of evaluation tools used, such as pre- and posttests, student surveys, teacher surveys;
7) Copies of program marketing and educational materials; and
8) Annual budget for school education programs related to conservation.

Determination of Water Savings

Water savings for school education programs are difficult to quantify and therefore estimated savings are not included in this BMP. If the retrofit kit is distributed, water savings can be calculated as described in the Residential Retrofit BMP**.** A 1991 study conducted for The Harris Galveston Coastal Subsidence District found an average savings of 18 percent or 1,400 gallons per month[1] in homes where the student and parent had installed efficient showerheads and aerators on bathroom and kitchen sinks.

Cost-effectiveness Considerations

A true cost-effectiveness analysis cannot be determined without a measure of water savings. By implementing this BMP, the utility will enhance its public image, increase customer goodwill, and increase the viability of its overall water conservation efforts.

School education costs vary widely due to the varying types of programs. Curriculum units can be developed and implemented for $1 to $3 per student. Educational entertainment programs can be developed or contracted out for $2 to $5 per student. There are prepackaged contractor programs with extensive features that cost up to $35 per student. Most programs will require utility staff oversight and outreach efforts to schools and students.

If showerhead and faucet aerator kits are distributed as part of this BMP, the costs for the kits will be similar to those described in the Residential Retrofit BMP.

References for Additional Information

1) *Effectiveness of Retrofit in Single Family Residences,* Prepared for Harris Galveston Coastal Subsidence District, Roger Durand, University of Houston , 1992.
2) *Water Savings and Beyond: A Multi-Resource Conservation Collaboration in the Seattle School District,* Broustis, D., et al*,* Water Sources Conference Proceedings, AWWA, January 2002.
3) *'Water in our World' and 'Down the Drain' Programs Close the Water Curriculum Gap for 5th and 6th Graders*, Jefferson, C., et al*,* Water Sources Conference Proceedings, AWWA, January 2002.
4) *Water Sourcebook,* Tennessee Valley Authority, Environmental Education Section, Knoxville, Tennessee, May 1994.
5) *Effectiveness of Retrofit in Single Family Residences and Multi-Family Projects,* Texas Water Development Board**,** Roger Durand, University of Houston-Clear Lake, 1993.
6) *Texas Essential Knowledge and Skills.* http://www.tea.state.tx.us/teks/
7) *Major Rivers,* Texas Water Development Board & Lower Colorado River Authority.
8) *Learning to be WaterWise.* http://www.getwise.org/wwise/
9) *Project Wet.* http://www.water-ed.org/projectwet.asp
10) *Conservation Curriculum Resources,* EPA*.* http://www.epa.gov/teachers/curriculumconservation.htm
11) *Gulf Coast Curriculum Resources,* EPA. http://www.epa.gov/gmpo/edresrc.html
12) *National Project for Excellence in Environmental Education***,** North American Association for Environmental Education (NAAEE). http://www.naaee.org/npeee/
13) *H2O House Water Saving Home,* California Urban Water Conservation Council and EPA*.* http://www.h2ouse.org/
14) *TWDB Education and Public Awareness Page.* http://www.twdb.state.tx.us/assistance/conservation/Education.htm
15) *What Education Program is Right for your Community,* Vogel, C., Water Sources Conference Proceedings, AWWA, January 2002.

6.3 Small Utility Outreach and Education

Applicability

Any small Municipal Water User Group ("utility") that is initiating a water conservation program can adopt this Best Management Practice. A program for providing water conservation information to the public is an effective means of both promoting specific water conservation programs and practices and educating the public about the importance of using water efficiently.

Once a utility decides to adopt this Best Management Practice, the utility should follow the practice closely in order to achieve the maximum water efficiency benefit.

Description

Public outreach and education programs, though not directly related to equipment or operational change, can result in short- and long-term water savings. Behavioral changes by customers will only occur if a reasonable yet compelling case is presented with sufficient frequency to be recognized and absorbed by customers. There are many low-cost or free resources available that can be utilized to implement effective public outreach and education programs. To be effective, water conservation education and outreach should be planned and implemented in a consistent and continual manner.

The goal is customer education about the overall picture of water resources in the community. This includes how conservation is important for meeting the goals of managing and sustaining existing water supplies and avoiding or delaying building of new facilities. Equally important, the program will provide information on specific actions and measures the customers should take to implement these community goals. Showing customers the results of those actions can encourage greater participation in conservation efforts.

An early step in developing of the public information program is to identify target audiences and what messages need to be conveyed. Themes should be selected that convey the importance of water conservation and provide customers an opportunity to act (for example, replacing an old toilet with a high efficiency toilet for substantial daily water savings). Thematic messages that stress the importance of water as a natural resource can be linked with specific tips or water conserving activities. The most successful public information campaigns also promote opportunities for customers to participate in utility programs such as retrofit or rebate programs.

There are a variety of tools that can be effectively used to communicate water conservation to the public. When starting a program within a small utility, there is often limited budget to work with but low-cost effective resources are available. They include print and electronic media; community events such as spring clean-up days, public library events; the school district;

collaboration with community groups such as Master Gardeners, Master Naturalists, gardening clubs, and staff within the utility or municipality; and state or federal agencies.

Print media activities can include articles on internal publications such as utility bill stuffers, the actual water bill, and employee newsletters; or externally by submitting articles to homeowner association newsletters or other local group newsletters. Printed material, specifically door hangers, can be left by meter readers to target specific neighborhoods. The Texas Water Development Board and the Texas Commission on Environmental Quality are good resources for low cost, pre-printed brochures, landscaping guides, and handouts.

An internet presence is crucial, as more and more residents turn to electronic media to locate information. A comprehensive website with dedicated pages to water conservation, broken down into various subsections such as indoor use, outdoor use, rainwater harvesting, irrigation, appliances, graywater, landscaping, and other relevant topics is an invaluable tool that is relatively easy to maintain, edit, and expand on as needed. Websites offer an easy means to direct residents to other resources regarding water conservation such as the Texas Water Development Board, Texas Commission on Environmental Quality, Texas AgriLife Extension, Water IQ: Know Your Water, and the WaterSense program. Creating an electronic newsletter to send out seasonal water conservation facts or reminders is possible to do with email addresses collected from the billing department. Social media applications, such as Facebook and Twitter, are another avenue to reach residents. Short educational messages and news stories can be relayed quickly and frequently with no real cost and reach far more customers than a direct mail out.

Community events are good opportunities to directly interact with customers and supply more specific topical information to them. These events could include staffing a booth, presenting special topics to groups as requested, Homeowner Association meetings, and presenting to schools.

Partnering with other utility departments, municipal staff, and local groups that are promoting the same message you are such as master gardeners, master naturalists, gardening clubs, the County Texas AgriLife Extension Agent, river authorities, conservation or environmental groups are all tremendous resources in distributing the water conservation message to larger audience than a singular effort from any one source. Collaborating with other utilities in the area or utilities that share a similar water situation is another way to expand the water conservation program by working together on messages that will target all groups of customers. Joint mail outs, advertising, and products can be paid for by several groups to expand the audience and cost-effectiveness. Creating an environmental or conservation committee that incorporates staff from various departments within the utility or municipality will ensure that all messages are promoted during community events which could include staff from parks departments, watershed protection, storm water management or drainage, forestry, recycling, water treatment departments, development and planning, and energy conservation staff.

Creating a recognition program for water conservation efforts is another successful outreach tool. This can be focused on the commercial customers that perform a water saving measure such as water reuse at a laundry, native landscaping, or efficient irrigation. The positive attention focused on those customers promotes water efficiency to their customers and among their peers or competitors. The award could be a sign on the property, recognition at a city council meeting, or a picture and article on the utility's website. A positive image benefits the company as well as reiterates the importance of water conservation among all customer classes.

Implementation

The first step in implementation is to develop a Conservation Promotion Plan and calendar for the first year. It should focus on what the message will be, when it will be promoted, and what form(s) it will be in. At a minimum conservation messages should be promoted at each season change or quarterly. Collaborate with internal staff in the public information or communications department so that messages will be coordinated with other utility or municipal promotional activities that may be happening. Outreach can also be planned around other national water conservation events such as "Fix-a-Leak" week or "Smart Irrigation" month. The plan should be updated each year thereafter to integrate new ideas and means of conveying the messages. Work with the public information or communication staff to determine if messages are effective in reaching customers; this may involve taking a survey of residents. Revise the Conservation Promotion Plan as needed.

The Conservation Promotion Plan should be a substantial part of the utility's overall Water Conservation Plan. The implementation of the plan should be integrated with the implementation of specific Best Management Practices included in the Water Conservation Plan. A successful public education effort will promote participation in other practices.

Scope and Schedule

Utilities pursuing this Best Management Practice should begin implementing it according to the following schedule:

1. Complete the Conservation Promotion Plan within six months of adopting this practice.
2. In the second year and each year thereafter, complete a revised Conservation Promotion Plan.
3. In the second year and every three years thereafter, conduct and complete a survey of the customers to determine the effectiveness of the message and actions the customers have taken.

The Conservation Promotion Plan should provide conservation information on the Best Management Practices implemented at least four times per year. For utilities focused on reducing summertime peak usage, themes and scheduling of messages should be repeated numerous times during the spring and summer months, rather than spaced evenly throughout the year.

Measuring Implementation and Determining Water Savings

To track progress of this Best Management Practice, the utility should gather and have available the following documentation on an annual basis. This can be completed as part of the Water Conservation annual report that is conducted and submitted to the Texas Water Development Board.

1. Monthly water production;
2. Total population in the utility service area;
3. Number and schedule of activities or information pieces related to promoting specific Best Management Practices adopted by the utility;
4. Number of pieces of information that were conveyed and what form they took (i.e. number of direct mailers, articles in newspaper);
5. Number of activities (presentations, booths, etc.) conducted that year and participants at each activity;
6. Results of customer survey to determine the reach and impact of the program; and
7. Total budget for conservation program and budget specifically for public education information, if applicable.

Water savings due to public information efforts are difficult to quantify. If the public information effort was for a specific action, such as showerhead distribution, the savings can be calculated under this Best Management Practice if the utility did not implement the practice containing the product or action. Water savings for other public information programs that result in specific actions by customers, such as changes in irrigation scheduling or reduction in water waste occurrences could also be quantified through surveys or analysis of water waste reporting.

Cost-effectiveness Considerations

The cost for implementing this Best Management Practice depends on the scope of the public information effort. There may be costs for administration and materials. Within a small utility, the costs will be in the lower range, as the majority of the education efforts will be managed by utility staff. The largest cost will be printing of materials for mail outs, door hangers, or signs along with postage costs for direct mail outs. Internet outreach, collaboration with other groups, and community activities are virtually free from supplemental expenses, as staff time is the largest cost. Purchasing of promotional or give-away materials, such as showerheads, aerators, and dye tablets, is an additional expense that is not necessary to have effective water conservation outreach, though it can enhance a water conservation education program. A comprehensive program would range in costs starting at $0.25 per customer per year, to several dollars per customer, depending on the budget and utility size.

References for Additional Information

1) *Texas Water Development Board: www.twdb.texas.gov/conservation/outreach/doc/Public_Awareness_UtilityGuide.pdf*

2) *Texas Water Development Board:* www.twdb.texas.gov/publications/brochures/conservation/index.asp

Texas Water Development Board: www.wateriq.org

6.4 Partnerships with Nonprofit Organizations

Applicability

The use of volunteers to provide conservation information and techniques to their fellow citizens allows the water purveyor access to large numbers of water users across a spectrum of economic, ethnic, social, and geographic groups.

Description

Organizations such as the Master Gardeners, Master Naturalists, Botanical Gardens, and environmental entities with water conservation sympathies are enlisted to use their volunteers to deliver water conservation education to their typical and expanded audiences. The volunteers are provided special training and the organization may be subsidized based on audiences reached. The delivery vehicles are speaker bureaus, neighborhood events, school projects, and demonstration gardens but the volunteers may also respond to audit requests, rebate inspections, and conduct research.

Volunteer organizations can be selected that have membership recruited from diverse ethnic, age, geographic, or economic groups. It is also effective to utilize organizations that are willing and capable to expand their membership to targeted audiences.

In some cases social organizations that do not normally have water conservation goals can be recruited to the conservation cause. Their targeted audience such as low income households or senior citizens will benefit by the services (for example, high efficiency toilets and leak repairs) that are available related to water conservation.

To evaluate the effectiveness of the education materials, presentation or show, the utility should use an evaluation tool such as a pre- and post-test or survey.

Implementation

Contact is made with organizations with volunteers encouraging them to deliver a packaged program. In many cases it may be more effective, however, to communicate with the entity with a goal in mind and work with the organization and volunteers to develop a package to meet the desired goal. Volunteers often know the target audience's capabilities and are invaluable in developing a program that will work to meet the goal. Training should be developed to complement the volunteer's skills.

The financial arrangement may only involve expenses and training materials. To ensure administrative attention from understaffed, cash-strapped groups, providing funds upfront and linked to audience contacts and progress may accelerate progress. Simple contracts can be developed to encourage a more efficient process.

Scope and Schedule

If the volunteer organization partner is organized and operating with educational goals already in place, it is reasonable to expect that recruitment, negotiations, contracting, training, and program results can be accomplished in 12 months. A packaged "high efficiency toilet" giveaway program could be organized, and toilets distributed through churches and social service entities in a targeted section of a city in the year's period.

For example, a Master Gardener Chapter provided special one-day training to 20 of their volunteers from 10 different neighborhoods on low water landscapes. The trained volunteers then conducted a total of 10 neighborhood sessions and were able to reach a combined audience of 200 interested neighbors within one year.

Measuring Implementation and Determining Water Savings

Evaluation of this Best Management Practice can be very simple or more complex with volunteers or water purveyor staff used to do the necessary evaluation. Various measures are audience contacts, toilets delivered, newsletter sign-ups, and landscape conversions. In some cases, such as the high efficiency toilet conversions and landscape conversions, water usage changes are effective measures of program impact. For a volunteer program to be judged effective it should show measurable results in behavioral or technological changes that reduce water use.

Cost-effectiveness Considerations

Partnerships with volunteer organizations have political advantages in expanding the water conservation team; however, the major advantage involves cost effectiveness. Every person in the field trained in conservation techniques and who believes in water conservation can be expected to reach several hundred other individuals with varying degrees of effectiveness. The cost of using volunteers is very low compared to the cost of paid staff and can be nearly as effective when volunteers are well trained and working in a framework of an organized program.

References for Additional Information

1. Finch, C. (1997) – Profile of an Active Master Gardener Chapter, HortTechnology October-December Vol. 7 No. 4 371-376.

2. Bohne, D. (1996), Water Saver Rebate – San Antonio Water System, San Antonio, Texas.

Determination of the Impact on Other Resources

The advantage of using well organized volunteers to staff conservation outreach programs saves staff time. A poorly organized volunteer effort can be a negative force in the relationship between a water purveyor's ratepayers, local elected officials, and media along with little achievement in water conservation efforts.

7.1 Conservation Programs for Industrial, Commercial, and Institutional Accounts

Applicability

This BMP is intended for all Municipal Water User Groups ("utility") which serve industrial, commercial, and institutional ("ICI") customers. Conservation programs for ICI accounts are essential for increasing water efficiency among ICI users. For many utilities, consumption in the ICI sector is a significant proportion of total consumption, and average water use by ICI customers is higher than average water use by residential customers. In these circumstances significant overall reductions in water demand can be more rapidly achieved by developing a Conservation Program for ICI Accounts. Additional information regarding specific processes is found in the industrial section of the BMP guide.

Description

Under this BMP, the utility identifies ICI customers and sorts them according to water usage. The utility should focus its ICI Conservation Program toward the higher use customers and those sectors with the highest conservation potential. In addition to domestic water use by employees and customers, many industry-specific processes are captured in this BMP. Differences in this industry-specific category of water use result in unique opportunities for significant water savings within each utility service area. Similarities in overall water use by ICI customers create the opportunities for an ICI Water Conservation Program which is the subject of this BMP.

Utilities wishing to pursue efficiency among their ICI customers should consider programs which offer incentives for specific activities such as: retrofits of inefficient water cooled equipment with air cooled equipment (*See,* Cooling Systems BMP), cooling tower upgrades (*See,* Cooling Tower's BMP), installation and operation of internal recycling equipment, or conversion to reclaimed water from the local water treatment plant in processes where nonpotable water can be used (*See,* Industrial Alternative Sources and Reuse of Process Water BMP). In addition to process changes and cooling tower upgrades, incentives can be offered for condensate collection and reuse, using water quality ponds for permanent storage for irrigation or use of process water for irrigation. Efficient landscape water use should be evaluated and implemented by using appropriate elements of the Landscape Irrigation Conservation and Incentives BMP and the Rainwater Harvesting and Condensate Reuse BMP. For clothes washers in common area laundry rooms in apartment communities and for self-service laundromats, a clothes washer incentive program could be offered.

The incentive programs should start with direct communications through newsletters or direct mail to introduce the program and give examples of successful efficiency efforts (*See* Industrial BMP for Management and Employee Programs).

While a significant portion of conservation savings for industrial customers comes from modifications to water using equipment and processes, additional savings for the commercial and institutional customers comes from water used for domestic purposes. Programs and incentives for plumbing fixture retrofits and reduction in water wasting practices should be considered. Several municipal BMPs such as Prohibition of Wasting Water; Showerhead, Aerator, and Toilet Flapper Retrofit; and Residential Toilet Replacement Programs provide good guidance for the development of programs for ICI customers in these areas.

A water use survey program (*See,* Industrial Water Audit for guidance) is another program that can educate ICI customers about potential water savings. To accurately track water usage by ICI accounts, the utility should develop and market an ICI water-use survey. Water-use surveys should include a site visit; an evaluation of all water-using equipment and processes; a report identifying recommended conservation measures and their expected payback; and available agency incentives. The utility should conduct periodic follow-up visits to evaluate the status of recommended water-saving improvements.

In lieu of customer incentives programs and water-use surveys, the utility may choose to implement other efforts to reduce water usage in the ICI sector. All ICI customers should be encouraged to become familiar with BMPs that may be appropriate to their facilities including those related to fixture retrofits, landscape management, submetering, employee education, and reuse. The utility can also set goals for the ICI sector in relation to the utility's own gallons per capita per day ("GPCD") targets and goals from its overall conservation plan.

Implementation

Implementation should consist of at least the following actions:

1) Identify ICI Accounts

   Identify and rank commercial, industrial, and institutional accounts (or customers if the agency chooses to aggregate accounts) according to water use and highest conservation potential. For purposes of this BMP, ICI accounts are defined as follows:

   a. Commercial Accounts: any water user that provides or distributes a product or service, such as hotels, restaurants, office buildings, commercial businesses or other places of commerce. These do not include multi-family residences, agricultural users, or customers that fall within the industrial or institutional classifications.

   b. Industrial Accounts: any water users that are primarily manufacturers or processors of materials as defined by the Standard Industrial Classifications (SIC) Code numbers 2000 through 3999 or the North American Industry Classification System.

   c. Institutional Accounts: any water-using establishment dedicated to public service. This includes schools, courts, churches, hospitals, and government facilities. All facilities serving these functions are to be considered institutions regardless of ownership.

After ranking ICI accounts by water use, identify priority customers for incentives based upon cost-effectiveness or ease of program implementation.

2) 5-Year ICI Ultra Low Flush Toilet ("ULFT") Program

Implementation should consist of at least the following actions:

a. A retrofit program to replace 50 percent of existing high-water-using toilets with ultra-low-flush (1.6 gallons or less) toilets in commercial, industrial, and institutional facilities within 5 years.
b. Other programs that may be at least as effective as facilitating toilet replacements over a 10-year implementation period sufficient to produce cumulative water savings to 5 percent of total water savings potential per year for ULFT retrofits by the ICI sector.

3) ICI Customer Incentives Program and Water-Use Surveys

Implement an ICI and Customer Incentives Program. Develop a customer targeting and marketing strategy to provide customer incentives to ICI accounts such that each ICI sector's average annual water demand, after considering growth in demand that may occur from new ICI customers, is reduced 10 percent within 10 years of the date implementation is to commence. Directly contact (via letter, telephone, or personal visit) and offer water use surveys and customer incentives to at least 10 percent of each ICI sector on a recurring basis.

Financial incentives can be offered on a dollar amount per piece of equipment retrofitted such as toilets, clothes washers or cooling tower conductivity meters. Another option for determining the amount of potential incentives is offering an open-ended incentive per gallon per day saved so that facility managers propose the projects. This approach places utility staff in the role of evaluating such proposals.

For utilities which choose to offer water-use surveys, the surveys include a site visit, an evaluation of all water-using apparatus and processes, a customer report identifying recommended efficiency measures with their expected payback period, and available agency incentives. The Industrial Water Audit BMP can provide good guidance for development of the survey.

Within one year of a completed survey, there should be follow-up via phone or site visits with customers regarding facility water use and water-saving improvements. The utility should track customer contacts, accounts (or customers) receiving surveys, follow-ups, and measures implemented. Develop a customer targeting and marketing strategy to provide water-use surveys to ICI accounts such that 10 percent of each ICI sector's accounts are surveyed within 10 years of the date implementation is to commence. Directly contact (via letter,

telephone, or personal visit) and offer water use surveys and customer incentives to at least 10 percent of each ICI sector on a repeating basis.

4) ICI Conservation Performance Targets
Utilities may choose an alternative approach based upon local customer base and specific circumstances. To be effective as a BMP, they should implement programs designed to achieve annual water-use savings by ICI accounts of an amount equal to or exceeding 10 percent of the baseline use of ICI accounts in the utility's service area over a ten-year period, accounting for growth. The target amount of annual water-use reduction in ICI accounts is a static value calculated from the baseline amount of annual use. Baseline use is defined as the average annual use by ICI accounts in the five years prior to implementing the BMP.

Schedule

1) Within the first twelve (12) months of implementing this BMP, identify industrial, commercial, and institutional accounts and sort them by water use;
2) Replace at least 10 percent of existing high-water-using toilets with ultra-low-flush (1.6 gallons or less) toilets each year for 5 years;
3) By the end of year 5 contact and offer water-use surveys and customer incentives to 100 percent of ICI accounts;
4) By the end of year 10 complete water-use surveys for 10 percent of ICI accounts; and
5) If utilizing other programs in lieu of the water-use survey and customer incentives program: by the end of year 10, reduce ICI water usage by 10 percent of baseline ICI usage.

Scope

To accomplish this BMP, the utility should adopt ICI conservation policies, programs or ordinances consistent with the provisions for this BMP specified in Section C.

Documentation

To track this BMP, the utility should provide the following documentation:

1) The number of customers and amount of water used within the commercial, industrial, and institutional customer classes;
2) Number of toilets replaced each year;
3) A description of the plan to market water-use surveys to ICI accounts;
4) The number of ICI customers offered water-use surveys during the reporting period and the number of water-use surveys completed during the reporting period;
5) The number of follow-ups completed during the reporting period;
6) The type and number of water-saving recommendations implemented; and

7) If utilizing other programs in lieu of the water-use survey and customer incentives program, a description of the programs and estimated water-use reductions achieved through these programs. The utility should document how savings were realized and the method and calculations for estimating savings.

Determination of Water Savings

Calculate water savings as follows:

Using historical records and manufacturer data as appropriate, calculate water savings due to implemented operating procedures, equipment changes or alternative water sources.

Specific water savings calculations for cooling tower efficiency improvements can be found in the Cooling Tower BMP for industrial users.

For Water Surveys
Water Savings = Number of Surveys x Estimated Savings x Water Used

Where: Estimated Savings = 20 percent or percentage determined through survey results
Water Used = Average (5 year) annual water use by ICI customers receiving the survey

Source: A&N Technical Services, Inc. (1999)

Cost-Effectiveness Considerations

1) Toilet Rebates

If the rebate cost for the toilet is set too low, only those customers planning to retrofit will do so. If the rebate is set too high, the utility will be overpaying for customers to retrofit. Most utilities have found a rebate to work effectively if set between $75 and $130 for the toilet and flush valve.

Some utilities find it is more cost effective to provide toilets free of charge to their customers. Flush valve bowls and the flush valves can be purchased in bulk for approximately $50 to 60 and $35 to 40 respectively. Administration of the program can be conducted by utility staff or contracted out. There will be labor costs for application processing and inspections to verify installation. Labor costs range from $10 to $20 per toilet. Marketing and outreach costs range from $5 to $10 per toilet. Administrative and overhead costs range from 10 to 20 percent of labor costs. To calculate the total cost per unit, total all costs and divide by the number of units being retrofitted.

2) General ICI Rebate

The rebate can be based on a set amount such as $1 per gallon per day reduction up to a certain percentage of the actual customer costs of implementing the

project. Often the cap for the rebate is 50 percent of the actual costs of the project.

References for Additional Information

1) *A Water Conservation Guide for Commercial, Institutional and Industrial Water Users*, New Mexico Office of the State Engineer, July 1999. (http://www.seo.state.nm.us/water-info/conservation/pdf-manuals/cii-users-guide.pdf)
2) *Commercial and Institutional End Uses of Water*, AWWA Research Foundation, Summer 2000.
3) *Commercial Conservation Rebates & Audits*, San Antonio Water System. http://www.saws.org/conservation/commercial/
4) *Commercial/Industrial Rebate Program,* Metropolitan Water District of Southern California. http://www.mwd.dst.ca.us/mwdh2o/pages/conserv/program02.html
5) *Handbook of Water Use and Conservation*, Amy Vickers, Waterplow Press, May 2001.
6) *Waste Not, Want Not: The Potential for Urban Water Conservation in California,* Pacific Institute, November 2003.
7) http://www.pacinst.org/reports/urban_usage/waste_not_want_not_full_report.pdf
8) *Water Efficiency Guide for Business Managers and Facility Engineers*, State of California Department of Water Resources, October 1994.

7.2 Residential Clothes Washer Incentive Program

Applicability

This Best Management Practice can be implemented by any Municipal Water User Group ("utility") that has residential customers. Once a utility decides to adopt this Best Management Practice, the utility should follow it closely in order to achieve the maximum water efficiency benefit. Many utilities have initiated some of the program elements listed below and can provide documentation of previous clothes washer incentive programs and can serve as a mentor and point of contact.

There is no question that newer efficient washing machines use less water than older models. However, due to stricter efficiency standards and the increase in market penetration of these higher efficient machines, utilities must acknowledge that consumers have started to accept these machines and may not need an incentive/rebate. If a utility chooses to implement this Best Management Practice, there is a risk of the program becoming a "Free Rider," which translates into a program that provides an incentive/rebate to a customer that would purchase the equipment regardless of the incentive. This risk should be taken into account when doing analyzing of the option and designing the program.

It is important to note when drafting the municipal water demand projections, Texas Water Development Board staff included automatic reductions of water use due to assumed replacement of clothes washers from older to new models over time. Applied to projected populations, staff assumed that future populations between 2010 and 2020 will have per-person water savings of 5.56 gallons per person per day for top-loading washers (40 percent of new washers), as compared to the 2010 base water use, and 6.67 gallons per person per day for front-loading washers (60 percent of new washers).

After 2020, the anticipated difference in savings between top- and front-loading washer narrows and future populations are projected to have a composite savings of 6.45 gallons for both types of washers. The 2010 utility customers are assumed to replace their washers with a replacement rate of 12 years. This rate of savings should be considered prior to implementing a clothes washer incentive program. For more information regarding the population and water demand projections in the regional and state water plans, please go to www.twdb.texas.gov/waterplanning/data/index.asp.

Description

Under this Best Management Practice, the utility would develop and implement an incentive based program to encourage residential customers to purchase high-efficiency clothes washers. Water efficiency for clothes washers is best described by using water factor terminology. Water factor is calculated by dividing the volume of water used to wash a full load of clothes in gallons by the capacity of the washer tub in cubic feet. For example, a washer using 27 gallons for a full

load of clothes and a 3 cubic foot tub would have a water factor of 9 gallons per cubic foot. A lower water factor results in a more water efficient machine.

Conventional top-loading clothes washers use 41 gallons per load on average while high-efficient clothes washers use 11 to 25 gallons per load. The typical household washes an average of just more than one load per day. Manufacturers started producing efficient clothes washer models in the late 1990s in anticipation of rules adopted by the U.S. Department of Energy setting higher efficiency standards. The agency adopted the first set of rules in 2001 and continues to revise the minimum efficiency standards improving the water efficiency of qualified machines.

A clothes washer incentive program is most effective when offered in conjunction with local gas and/or electric utilities as the incentive can be increased along with the marketing. The energy savings are a result of more efficient motors, less energy required for heating hot water as less hot water is used, and shorter drying time because the spin cycle on efficient washers is faster. Many water utilities in Texas and other parts of the country have already successfully partnered with local energy companies.

Incentives should be given only to those customers who install washers that qualify as water efficient. A list of efficient washers is maintained and regularly updated by the Consortium for Energy Efficiency, a nonprofit public benefits corporation that develops national initiatives to promote the manufacture and purchase of energy-efficient products and services. The U.S. Department of Energy and U.S. Environmental Protection Agency both support the consortium through active participation as well as funding. The Consortium for Energy Efficiency Residential Clothes Washer Program has tiers for both water and energy efficiency. The group's list has been used by many utilities as the source of qualifying washers to receive an incentive.

Efficient washing machine sale trends:

- In 2001, the Texas Legislature passed legislation requiring washing machine manufacturers to report on the efficiency of clothes washers sold in Texas.
    - 2002 showed that 4.4 percent of washers sold in Texas had a Consortium for Energy Efficiency water factor equal to or less than 9.5.
    - 2003 showed that 9.4 percent of washers sold in Texas had a Consortium for Energy Efficiency water factor equal to or less than 9.5.
    - According to the tiers recommended by the Consortium for Energy Efficiency in 2011, a high-efficient clothes washer would need to have a water factor equal to or less than 6.0 to be considered a high-efficient washing machine.[1] This represents a 36 percent efficiency increase since the 2001 program requirements.
    - 2006, showed that 38 percent of all washers sold were ENERGY STAR, an international standard for energy efficient appliances created by the Environmental Protection Agency and the Department of Energy, up from 27 percent in 2004, when new criteria took effect.

- In 2009, more than half (56 percent) of all clothes washer models available for sale in the United States were ENERGY STAR qualified.
- According to 2009 ENERGY STAR Qualified Appliance Retail Sales Data, 45 percent of all washing machine sales in Texas were ENERGY STAR rated.
- The national market share of ENERGY STAR qualified clothes washers quadrupled between 2000 and 2007, growing from 9 percent to 42 percent.

Implementation

The program should be offered to customers in single-family homes (including duplexes and triplexes) and in multi-family units that have in-unit washer connections. Approach the local gas and/or electric utility to join in a partnership to implement the program, organize stakeholder meetings, develop a marketing plan for educating customers, appliance stores, and realtors about this program, and initiate the program.

In an effort to eliminate the potential of the program becoming a "Free Rider," the utility needs to analyze several factors periodically including but not limited to:

- What machines are for sale at local vendors?
- What is the local vendor inventory?
- What are the local market sales?
- What are the state market sales?
- How do customers determine what machines to purchase?

If at any point the utility discovers the program has become ineffective, even if the number of rebates processed is high, the rebate program guidelines must be adjusted or eliminated to ensure proper water savings investment. The fundamental question to determine is whether the rebate can be designed to have most of the payments result in an effective incentive and not a free-rider reward.

Scope and Schedule

The following schedule should be considered:

1. Analyze the market and customer acceptance of efficient washing machines to determine if a rebate is needed.
2. Determine if a pilot effort or permanent program option is desired.
3. Plan, implement, and market an efficient clothes washer incentive program within six months of adopting this Best Management Practice. Water purveyors who have implemented this type of program have the following suggestions to include in planning steps:
    a. Include retail centers where washing machines are sold in program outreach. It may not be necessary to expend funds on advertising if retail locations use the program to promote the more efficient machines.

b. Consider potential fraud when designing application materials. Allowing copies of receipts as rebate documentation may lead to multiple applications processed by several individuals for one purchase. Create an option for customers who may need their receipts returned or who may be reluctant to mail an original receipt.
c. Retail centers often have different coding on their receipts than models listed on the Consortium for Energy Efficiency lists. It is a good idea to check major retail centers and request that they be clear in receipt documentation or that they provide a list to allow staff to determine model number based on their coding system.
d. Consider web-based lists of eligible machines that can be linked to source material such as the Consortium for Energy Efficiency. This provides automatic updates as lists change. Clarify how eligibility will be assessed on the customer application.
e. Determine before offering program if households replacing efficient machines are eligible for the rebate and if individuals may apply for more than one rebate over time. Clarify this policy on the application.

Measuring Implementation and Determining Water Savings

The program is evaluated based on a formula taken from the American Water Works Association Residential End Uses of Water study which takes into consideration the difference in the average water use between the standard and high-efficient machine and the number of loads washed each year. Water savings formula may need to be adjusted in accordance to any changes made to the efficiency specifications set forth by Consortium for Energy Efficiency.

Annual water savings calculations per machine or per rebate

- Standard washing machine water factor = 13.3 gallons per cubic feet
- Average Cubic foot of laundry per Machine = 2.77 cubic feet
- Average Loads Washed per Year = 392
- Annual Consumption = 13.3*2.77*392 = 14,442 gallons

- Tier 3 High Efficiency Washing Machine Water Factor = 4.0 gallons per cubic feet
- Average volume of laundry per Machine = 2.77 cubic feet
- Average Loads Washed per Year = 392
- Annual Consumption = 4.0*2.77*392 = 4,343 gallons

Total Savings per Year = 10,099 gallons

Annual Water Savings Formula

(#rebates)(7.5loads/week)(52weeks)(25.8 gallons saved per load) = total water savings

Cost Effectiveness Considerations

Rebates to customers for installation of water efficient clothes washers are the most significant cost of this program. If the rebate for the clothes washer is set too low, only those customers already planning to buy an efficient washer will do so. If the rebate is set too high, the utility will be overpaying for customers to retrofit.

To be effective, the incentive offered should bridge at least one-half of the gap in the price difference between the high-efficient machines and conventional ones. Fully-featured inefficient machines cost approximately $400 while the least expensive high-efficient machines cost from $600 to more than $1,000. For the least expensive machines, the price difference is $200 and is the most important part of the buying decision for low-income customers. Most utilities that implement this Best Management Practice have found a rebate may be effective if set between $50 and $100 per high-efficient clothes washer. If partnering with an energy utility, the gas or electric utility rebate may add an additional $50 to $100.

Some utilities have started offering tiered rebates based on the efficiency of the washer with higher rebates offered for washers in the lowest water factor tier. With the acknowledgement of market sales, budget constraints must be considered if a tiered rebate system is implemented. Utilities may want to consider doing a pilot program at first to assess the level of interest and market. A pilot may be more easily capped and ended depending on results. A survey of pilot program participants could determine if the rebate was an effective incentive or simply an appreciated reward for customers who would already have purchased the efficient machines. A key survey question would be to assess if customers replaced a less efficient machine or if the recent purchase was to replace a machine that already met efficiency criteria.

Administration of the program can be conducted by utility or contracted staff. Washer inspections are sometimes performed in order to verify installation and discourage fraud. Labor costs range from $15 to $35 per clothes washer. Marketing and outreach costs range from $5 to $15 per clothes washer. Administrative and overhead costs range from 10 to 20 percent of labor costs. To calculate the total cost per unit, total all costs and divide by the number of units being retrofitted.

Program Cost Analysis

- Total Savings per Year = 10,099 gallons
- Total Savings over Equipment Life (10 yrs) = 100,990 gallons or 0.31 acre-feet
- Rebate = $100.00 per qualified machine
- Cost per Acre-foot of Water Saved - $322.58

Note

- This analysis is based on a program that rebates $100 for current Tier 3 machines with a water factor of 4.0.
- This calculation also assumes and “effective rebate incentive.” If the rebate is a free-rider, there are no associated water savings.

References for Additional Information

1) Consortium for Energy Efficiency Clothes Washer Page http://www.cee1.org/resid/seha/rwsh/rwsh-main.php3
2) *Waste Not, Want Not: The Potential for Urban Water Conservation in California*, Pacific Institute, November 2003. http://www.pacinst.org/reports/urban_usage/waste_not_want_not_full_report.pdf
3) *Residential End Uses of Water*, AWWA Research Foundation, 1999.
4) *US DOE Volume Purchase Program*, Sandi Edgemon, Pacific NW National Laboratory, 1997.
5) Impacts of Demand Reduction on Water Utilities, AWWA Research Foundation,1996.
6) Alliance for Water Efficiency Resource Library website: http://www.allianceforwaterefficiency.org/resource-library/default.aspx
7) *BMP Cost Savings and Guide*, California Urban Water Conservation Council, July 2000.
8) Seattle Home Water Conservation Survey, Aquacraft, Inc., 2001. http://www.aquacraft.com/
9) *Handbook of Water Use and Conservation*, Amy Vickers, Waterplow Press, May 2001.
10) California Energy Commission http://www.energy.ca.gov/appliances/clothes_washers/notices/2003-09-17_Washer_Final.PDF
11) Energy Star, http://www.energystar.gov/index.cfm?c=clotheswash.pr_clothes_washers
12) Austin WashWise Program, http://www.ci.austin.tx.us/watercon/sfwasher.htm
13) *Seattle Home Water Conservation Study*, Aquacraft Inc., 1999 http://www.aquacraft.com

7.3 Residential Toilet Replacement Programs

Applicability

This BMP is intended for a Municipal Water User Group ("utility") that has at least 20 percent of its homes and apartment units in its service area constructed prior to 1995 and for which there has not been an active retrofit program to replace high flush volume toilets with 1.6 gallons per flush toilets ("ULFT"). A utility that has initiated some of the program elements listed below prior to adopting the BMP can provide documentation of a previous retrofit program or voluntary retrofits by customers as described in Section E. This BMP is often implemented in conjunction with the Showerhead, Aerator, and Toilet Flapper Retrofit and/or the Water Survey for Single-Family and Multi-Family Customers BMPs. Once a utility decides to adopt this BMP, the utility should follow the BMP closely in order to achieve the maximum water efficiency benefit from this BMP.

Description

ULFT replacement programs are an effective method of achieving water efficiency in the residential sector[1,2,3]. ULFTs are toilets that use 1.6 gpf or less including dual flush toilets that can flush at either 1.6 gpf or 0.8 to 1.0 gpf. State and federal requirements prohibit installation of new toilets using more than 1.6 gpf. Under this BMP, the utility would develop and implement a program to replace existing toilets using 3.5 gpf or more in single-family and multi-family residences. To accomplish this BMP, the utility first identifies single-family and multi-family residences constructed during or prior to 1995.

Implementation

Implementation should consist of at least one of the following:

1) A program for replacing existing pre-1995 high water-use toilets with efficient (1.6 gpf or less) toilets in single-family and multi-family residences. The Showerhead, Aerator, and Toilet Flapper Retrofit BMP outlines a method for determining the number of homes and apartments constructed before 1995.
   a. ULFT models that are used in retrofit programs should maintain 2.0 gpf or less regardless of what replacement flapper is used[11]
   b. ULFT replacement programs should offer free toilets or rebates for toilet replacement. Incentives and promotion of the program should be sufficient to retrofit at least 5 percent of eligible homes each year.
2) A retrofit ordinance triggered when ownership of the property changes. The ordinance would require all plumbing fixtures in the house or multi-family unit to meet current plumbing standards when the ownership of the property changes. For example, the Lower Colorado River Authority ("LCRA") requires homes that are being enlarged to be retrofitted with 1.6 gallon per flush toilets as part of its septic regulations[4]. The LCRA requires verification inspections. Several cities in California have implemented ordinances requiring retrofit upon change in

ownership. The buyer and seller certify that the plumbing fixtures meet the efficiency standards[5]. In these cities, no inspection is required.

3) A retrofit ordinance by date certain no later than five years after adoption of the BMP. The ordinance would require all plumbing fixtures in the house or multi-family unit to meet current plumbing standards by a specific date.

Schedule

Based on the program(s) selected, use the appropriate schedule**:**

1) Toilet Retrofit Program

In the first twelve (12) months: Plan a program including stakeholder meetings as needed. Locate plumbing contractors or retrofit companies who may be interested in bidding on this program. Develop 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 third party to verify installation. In order to effectively implement this program, each year 5 percent of eligible single-family homes and 5 percent of eligible multi-family units should be retrofitted.

In the 2nd year and after: Each year 5 percent of identified eligible single-family homes and multi-family units are to be retrofitted. The program should be continued until 50 percent of eligible single-family homes and multi-family units are retrofitted in order to achieve a reasonable water efficiency benefit. Or,

2) Ordinance Approach: Upon Change of Ownership of Property

Consider offering rebates for all or a portion of the time this program will be in place. For example, offer rebates for five years and publicize this so customers can take advantage of rebates and retrofit early in the program.

In the first twelve (12) months: Plan a program including stakeholder meetings as needed. Develop a plan for educating realtors and title companies about this requirement. Determine how change of ownership can be obtained from County Appraisal Districts. Plan follow up inspection program or buyer/seller certification program to assure compliance[5] after retrofit. Develop and pass ordinance. Implement ordinance and tracking plan for number of units retrofitted.

In the 2nd year and after: Continue implementation and outreach program for realtors and title companies. Continue verification inspections or buyer/seller certification program to assure compliance as needed. Or,

3) Ordinance Approach: By Date Certain

Consider offering rebates for all or a portion of the time this program will be in place. For example, offer rebates up to Year 4 and publicize this so customers can take advantage of rebates and reduce the enforcement required in Year 5.

In the first twelve (12) months: Plan a program including stakeholder meetings as needed. Determine a plan for educating homeowners, multi-unit owners and managers, plumbers, and realtors about this requirement. Plan follow-up inspections or buyer/seller certification program to assure compliance after retrofits are completed. Develop and pass ordinance. Implement ordinance and tracking plan for number of units retrofitted.

Years 2, 3, and 4: Continue implementation. Continue educating homeowners, multi-unit owners and managers, plumbers, and realtors about this ordinance.

Year 5: If 50 percent of eligible homes and units have not been retrofitted, prepare education campaign about upcoming deadline and fines that may occur if retrofit does not take place by deadline. Prepare compliance program. After deadline, issue penalties for those not complying.

Scope

Annually, the ULFT replacement program should replace at least 5 percent of the estimated number of eligible toilets within the service area.

In order to accomplish this BMP, the utility should perform the following:

1) Develop and implement a plan to distribute or directly install high quality ULFTs to eligible single-family and multi-family units;
2) Implement the distribution or installation programs so as to achieve ULFT retrofits on at least 5 percent of eligible single-family units and 5 percent of eligible multi-family units each year. Utilities with more than 200,000 eligible connections should retrofit at least 20,000 eligible homes and units each year.
3) Within ten years of implementing this program, retrofit at least 50 percent of eligible single-family homes and multi-family units with ULFTs. For utilities with more than 200,000 eligible connections, at least 100,000 eligible homes and units should be retrofitted within ten years. Or,
4) Adopt an enforceable ordinance or rules requiring replacement of ULFTs greater than 1.6 gallons per flush, when ownership of the property transfers or by date certain no later than five years from adoption of the BMP, and implement the ordinance or rules with a verifiable inspection program for each property.

Documentation

To track this BMP, the utility should gather the following documentation:

1) The eligible number of single-family residences and multi-family units in the service area;
2) The average number of toilets per single-family residence; the average number of toilets per multi-family unit;
3) The average persons per household for single-family residences; the average persons per household for multi-family units;
4) The housing resale rate for single-family residences in service area; the housing resale rate for multi-family units in service area;
5) The number of ULFT installations credited to the program participant's replacement program, by year, including brand and model of toilets installed;
6) Description of ULFT replacement program, if applicable;
7) Estimated cost per ULFT replacement, if applicable;
8) Estimated water savings per ULFT replacement; and
9) Description of retrofit upon resale inspection and enforcement program, if applicable.

Determination of Water Savings

(*See,* Section I. References for Additional Information, 2 and 9*)*

Average Daily Savings = SF x (10.5 x Hs) / Ts + MF x (10.5 x Hm) / Tm

Where SF = Number of SF Toilets Retrofitted
MF = Number of MF Toilets Retrofitted
Hs = Number of people in average single family household
Hm = Number of people in average multi-family household
Ts = Average number of toilets per SF house
Tm = Average number of toilet per MF unit

For **Single Family Homes:**
10.5 = gallons saved per capita per day if all toilets replaced in each household[5]
Dual Flush ULFTs increase savings by 25 percent.

For **Multi-Family Units:**
10.5 = gallons saved per capita per day if all toilets replaced in each unit[8]
Dual flush ULFTs increase savings by 25 percent

Cost-effectiveness Considerations

The rebates to the customers for installation of ULFT toilets are the most significant costs of this program. If the rebate cost for the toilet is set too low, only those customers planning to retrofit will do so. If the rebate is set too high, the utility will be overpaying for customers to retrofit. Most utilities have found a rebate to work effectively if set between $70 and $100 per toilet.

Some utilities find it is more cost effective to provide toilets free of charge to their customers. Toilets can be purchased from wholesalers by the truckload for $50 to $70. There may be additional costs for storage and distribution of the toilets.

Administration of the program can be conducted by utility staff or contracted out. There will be labor costs for application processing and inspections to verify installation, determine if the water level in the tank is properly set, and discourage fraud. Inspection costs will be lower per toilet for multi-family retrofits due to the higher volume of toilets per application, but generally, labor costs range from $10 to $40 per toilet. Marketing and outreach costs range from $5 to $20 per toilet. Administrative and overhead costs range from 10 to 20 percent of labor costs. If this program is combined with the Showerhead, Aerator, and Flapper Retrofit BMP, there will be efficiencies in these costs.

To calculate the total cost per unit, total all costs and divide by the number of units being retrofitted.

References for Additional Information

1) *Handbook of Water Use and Conservation*, Amy Vickers, Waterplow Press, May 2001.
2) *Residential End Uses of Water,* AWWA Research Foundation, 1999.
3) *Jordan Valley (Utah) Study of ULF Toilet Fixture,* Paula Mohadjer. http://www.cuwcc.org/Uploads/product/Jordan_Valley_ULFT_study.pdf
4) *Lower Colorado River Authority Frequently Asked Questions about its On-Sewage Rules.* http://www.lcra.org/water/faq_septic.html
5) *Summary of Residential End Use Study.* http://www.aquacraft.com/Publications/resident.htm
6) *Impacts of Demand Reduction on Water Utilities,* AWWA Research Foundation, 1996.
7) *BMP Cost Savings and Guide,* California Urban Water Conservation Council, July 2000.
8) *Quantifying the Effectiveness of Various Water Conservation Techniques in Texas,* Texas Water Development Board, May 2002.
9) *Dual-flush Toilet Project,* Canada Mortgage and Housing Corporation, September 2002. http://www.cmhc.ca/publications/en/rh-pr/tech/02-124-e.pdf
10) *Dual Flush Toilet Fixtures,* John Koeller and Company, December 2003. http://www.cuwcc.org/Uploads/product/Dual_Flush_Fixture_Studies.pdf
11) *Water Closet Performance Testing,* National Association of Home Builders, September 2002. http://www.cuwcc.org/Uploads/product/NAHB_ToiletReport.pdf
12) *Maximum Performance Testing of Popular Toilet Models,* William Gauley and John Koeller, December 2003. http://www.cuwcc.org/Uploads/product/MaP_Final_Report.pdf

13) Performance Testing of Wall Mount Siphon Jet Toilets at the University of Washington, Roger van Gelder, June 2003. http://www.cuwcc.org/Uploads/product/MaP_Final_Report.pdf

14) *Marin Municipal Water District Plumbing Fixture Certificate.* http://www.marinwater.org/TOSforms.pdf

15) *Waste Not, Want Not: The Potential for Urban Water Conservation in Calofornia*, Pacific Institute, November 2003.

7.4 Showerhead, Aerator, and Toilet Flapper Retrofit

Applicability

This BMP is intended for a Municipal Water User Group ("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 faucet aerators. This BMP is often implemented in conjunction with Residential ULFT Replacement BMP and/or the Water Survey for Single-Family and Multi-Family Customers BMP. Once a utility decides to adopt this BMP, the utility should follow the BMP closely in order to achieve the maximum water efficiency benefit from this BMP.

Description

Plumbing retrofits have usually included showerheads and kitchen and bathroom faucet aerators. Recent studies have shown that replacing toilet flappers[1] is also an effective method of conserving water in the residential sector. Four types of high quality, low flow plumbing devices are to be installed under this program: showerheads rated at 2.0 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 toilet flappers that flush the toilet at the design 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 1.6 gpf toilets are installed, the flush volume should be checked and, if needed, the water level in the tank should be adjusted to restore the flush volume to 1.6 gpf. If after the water level in the tank is adjusted, the flush volume is still well above 1.6 gpf, it is likely that the toilet originally had an early closure flapper. Using the model number, usually located on the inside of the tank and the research on compatibility of flappers[2] the flapper required to restore the flush volume to 1.6 gpf can often be determined. If the flapper is one of several early models of closure flappers, the flapper could be replaced during the survey and/or the information on the correct replacement flapper should be provided to the customer.

The utility may meet the requirements of this BMP through enforceable ordinances and inspection programs requiring replacement of inefficient plumbing when ownership of the property transfers or by date certain no later than five years.

Implementation

Under this BMP, the utility should:

1) Identify single-family ("SF") and multi-family ("MF") residences constructed prior to 1995. The utility may have data showing the number of SF homes existing at the end of 1994 or census data can be used. The 2000 Census data can be used to determine the total number of housing units constructed prior to 1995. The only drawback is that the construction data cannot be separated into SF and MF

units. Another approach would be to use the Census data from 1990 and 2000, which includes the number of housing units by type for 1990 and 2000. This data can be used to estimate SF Units (detached units in the Census data) at the end of 1994. A linear growth assumption yields the following approach. Take the difference (2000 detached units-1990 detached units) and multiply by 40 percent (4 years) and add this to the 1990 detached units. This produces an estimate of SF units at the end of 1994. A similar calculation can be done for MF units.

2) Develop a plan to directly install plumbing devices in single-family homes and multi-family residential facilities or, alternatively, provide kits for installation with follow up inspections; and
3) If feasible, include a program to restore the flush volume of 1.6 gpf toilets to the design flush volume.

After determining the potential number of participants, select at least one of these approaches:

1) Direct Install and Kit Distribution Program
2) Ordinance Approach: Upon Change of Ownership of Property
3) Ordinance Approach: By Date Certain

Schedule

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

1) <u>Direct Install and Kit Distribution Approach</u>
In the first twelve (12) months: Plan a program including stakeholder meetings as needed. Locate plumbing contractors or retrofit companies who may be interested in bidding on this program. Determine 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 third party to verify plumbing device 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 program until 50 percent of eligible single-family houses and multi-family units are retrofitted.

2) <u>Ordinance Approach: Upon Change of Ownership of Property</u>
In the first twelve (12) months: Plan a program including stakeholder meetings as needed. Consider offering rebates for all or a portion of the time this program will be in place. For example, offer rebates for five years and publicize this so customers can take advantage of rebates and retrofit in the early stages of the program. Develop a plan for educating realtors and title companies about this requirement. Determine how change of ownership can be obtained from County Appraisal Districts. Plan follow up inspection program or buyer/seller

certification program to assure compliance. Develop and pass ordinance. Implement ordinance and tracking plan for number of units retrofitted. In the second year of the program, continue implementation and outreach program for realtors and title companies. As long as the program is in place, continue compliance program.

3) Ordinance Approach By Date Certain
In the first twelve (12) months: Plan a program including stakeholder meetings as needed. Consider offering rebates for all or a portion of the time this program will be in place. For example, offer rebates up to Year 4 and publicize this so customers can take advantage of rebates and reduce the enforcement required in Year 5. Determine plan for educating homeowners, apartment owners and managers, plumbers, and realtors about this requirement. Plan follow up inspection program or buyer/seller certification program to assure compliance. Develop and pass ordinance. Implement ordinance and tracking plan for number of units retrofitted.

Years 2, 3, and 4: Continue implementation. Continue educating homeowners, apartment owners and managers, plumbers, and realtors about this ordinance.

Year 5: If 50 percent of eligible households have not been retrofitted, prepare education campaign about upcoming deadline and fines that may occur if retrofit does not take place by said deadline. Prepare compliance program. After deadline, issue citations for those not complying.

Scope

To accomplish this BMP, the utility should do the following:

1) 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.
2) 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.
3) 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. Or,

Adopt an enforceable ordinance or rules requiring replacement of inefficient plumbing fixtures, including toilets greater than 1.6 gallons per flush, when ownership of the property transfers or by date certain no later than five years

from adoption of the BMP, and implement the ordinance or rules including a compliance program.

Documentation

To track the progress of this BMP, the utility should gather and have available the following documentation:

1) An inventory of the number of single-family and multi-family buildings completed prior to 1995, which are targeted by this BMP;
2) If applicable, certified copies of adopted ordinances and rules requiring retrofit of plumbing fixtures upon transfer of property ownership or by date certain for each utility that has selected this program option;
3) 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.

Determination of Water Savings

Calculate water savings as follows:

Water Savings = *Number of Devices Retrofitted* x *Device Savings*
Where Device Savings may be found in the Retrofit Device Savings Table, and
Number of Devices Retrofitted = *1.0* x *Number Devices installed* (when using Ordinance Approach or Direct Installation Approach), or
Number of Devices Retrofitted = *0.3* x *Number Devices installed* (when using Kit Distribution Approach)

Retrofit Device Savings Table

Device	Initial Savings (gpd per device)	Device Life Span (Savings)
Showerheads and Faucet Aerators	5.5 gpd	Permanent*
Toilet Flapper	Up to 12.8 gpd **	5 years

Notes: (*) The actual device life span is 5 to 15 years; the savings are permanent because inefficient equipment can no longer be purchased. The Texas Performance Standards for Plumbing Fixtures[3] forbids importation or sale of inefficient fixtures into Texas. Plumbing standard provisions of the Energy Policy Act took effect in 1994 thereby ensuring that inefficient fixtures would not be manufactured in neighboring states[4].

(**) 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. (9.5gpcd x 2.7) / 2=12.8 gpd per toilet

Cost-Effectiveness Considerations

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. There will be labor costs for utility staff to bid the project, oversee the contractor and conduct spot inspections of the contractor's work. Utility staff often run programs where customers pick up kits. Labor costs range from $10 to $30 per SF customer for showerhead and aerator installation and an additional $5 to $20 per toilet for replacement. MF customers will usually use 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 equipment should be compared with the benefits to the utility in order that the maximum water efficiency benefit can be developed.

Administration of the program can be conducted by utility staff or contracted out. If a utility chooses to implement the ordinance approach there may be costs for inspections in order to verify installation and discourage fraud. Marketing and outreach costs may range from $5 to $10 per SF customer. Administrative and overhead costs range from 10 to 20 percent of labor costs. If this program is combined with the Residential ULFT Replacement BMP, there should be efficiencies in these costs.

To calculate the total cost per unit, total all costs and divide by the number of units being retrofitted.

References for Additional Information

1) Department of Energy 1998 Plumbing Product Rules http://www.eere.energy.gov/buildings/appliance_standards/residential/pdfs/plmrul.pdf

2) *Maximum Performance Testing of Popular Toilet Models,* William Gauley and John Koeller, May 2004. http://www.cuwcc.org/Uploads/product/Map_Update_No_1_June_2004.pdf

3) *BMP Cost Savings and Guide,* California Urban Water Conservation Council, July 2000.

4) Texas Performance Standards for Plumbing Fixtures http://www.capitol.state.tx.us/statutes/docs/HS/content/word/hs.005.00.000372.00.doc

5) *Residential End Uses of Water*, AWWA Research Foundation, 1999.

6) *Handbook of Water Use and Conservation*, Amy Vickers, Waterplow Press, May 2001.
7) *Impacts of Demand Reduction on Water Utilities,* AWWA Research Foundation, 1996.
8) *Residential End Uses of Water,* AWWA Research Foundation, 1999.
9) *Quantifying the Effectiveness of Various Water Conservation Techniques in Texas,* Texas Water Development Board, May 2002.
10) *Waste Not, Want Not: The Potential for Urban Water Conservation in California,* Pacific Institute, November 2003. http://www.pacinst.org/reports/urban_usage/waste_not_want_not_full_report.pdf
11) *Lower Colorado River Authority Frequently Asked Questions about its On-Sewage Rules* http://www.lcra.org/water/faq_septic.html
12) *Marin Municipal Water District Plumbing Fixture Certificate* http://www.marinwater.org/TOSforms.pdf
13) *Summary of Residential End Use Study* http://www.aquacraft.com/Publications/resident.htm
14) *Toilet Flappers: A Weak Link in Conservation,* John Koeller, P.E. , CUWCC, March 2002. http://www.cuwcc.com/Uploads/product/Flappers_Weak_Link.pdf

7.5 Water Wise Landscape Design and Conversion Programs

Applicability

This BMP is intended for a Municipal Water User Group ("utility") that has 20 percent or more residential customers that have landscapes consisting of high water use landscape materials that consume more than 20,000 gallon per month or use more than twice as much water in the summer as in the winter. Under this BMP, the utility would offer financial assistance as an incentive to customers to convert to a water wise landscape. Utilities impacted by repeated drought may also consider this BMP as a means of reducing outdoor water demand overall in their service area as a step toward long-term change of water use patterns. Once a utility decides to adopt this BMP, the utility should follow the BMP closely in order to achieve the maximum water efficiency benefit from this BMP.

Description

The utility offers financial incentives for landscape conversion to a water wise landscape or requires by ordinance that all new landscapes incorporate water wise principles. Water wise landscaping involves not only plant selection but also follows optimum landscaping principles listed below. Financial incentive programs that promote water wise landscaping contain an educational component involving the seven principles of water wise landscaping. Water wise landscaping material often consumes whatever quantity of water the customer supplies, so careful follow up is necessary to ensure that excess irrigation does not take place. Incentives should be designed to be rescinded if water use returns to previous levels or exceeds the projected water budget for the new landscape.

For new customers and change-of-service customer accounts, the utility should provide information on water wise landscape design and efficient irrigation equipment and management (*See* the Landscape Irrigation Systems Conservation and Incentives BMP for more detail on efficient irrigation equipment and management). The utility should install water wise landscaping at water agency facilities. Encouraging the use of rainwater capture and limiting irrigation to the quantity of water captured are also included.

Some cities with ordinance-making powers have adopted ordinances to define water-conserving landscapes to be installed in buffer areas, new commercial buildings, new homes, and apartment complexes. Any ordinance for new homes should incorporate requirements for water wise principles, specifically requiring only water efficient landscaping materials to be used. Irrigated turf areas can be reduced or eliminated in this BMP. Limiting turf areas can be accomplished by any number of means including reducing turf as a percent of total landscaped area, restricting irrigation systems to a portion of the landscaped area, encouraging shade tolerant species under trees, or encouraging the use of turfgrasses which have low water use rates.

In the typical landscape, turfgrass occupies the largest area and, when managed incorrectly, receives the largest amount of irrigation. Installing practical turf areas and irrigating only the turf in high impact, highly visible areas of the landscape, achieve water savings. Practical turf areas mean locating turfgrass in areas of the landscape where it provides the most functional benefit, such as recreational areas or on slopes to prevent erosion. In the case of irrigation of sloped turf grass areas adjacent to a sidewalk and needed for erosion control, the use of drip or subsurface irrigation and not sprinklers is recommended.

Grasses available for use in Texas lawns vary significantly in water requirements. This BMP may require limiting irrigated turf area within the landscape and/or requiring the lowest water use turfgrass adapted to the region and use in the landscape. Shrub beds, low water use groundcover, or hardscape in the landscape design should replace irrigated turfgrass in areas that are long and narrow or small and odd-shaped. Turfgrass requirements for new construction should include specifications for soil depth.

Soil improvement is an effective method for reducing irrigation water usage while maintaining healthy soils. Soil improvement programs on high visibility areas can demonstrate to the public the effectiveness of this method. For most landscapes, compost applications of 1/4 to 1/2 inch annually on turf areas, and one inch annually on flower beds are recommended. Compost is most beneficial when applied in the fall.

Water Wise Landscape programs follow the seven principles of Xeriscape™, from the Texas A&M Horticulture Website (*See*, Section I, References for Additional Information, 2), listed below and explained in greater detail in resources listed in the reference section:

- Planning and design
- Soil analysis and improvement
- Appropriate plant selection
- Practical turf areas
- Efficient irrigation
- Use of mulches
- Appropriate maintenance.

Implementation

Initially, the utility should consider offering the Water Wise Landscape Design and Conversion Program to customers with educational missions such as schools, universities, botanical gardens, and museums with large public landscapes. A focus on buffer areas and small landscaped areas that are inefficient to irrigate has also proven effective in some communities. The utility should consider also approaching local weather announcers, radio gardening show hosts and newspaper columnists for assistance in notifying the public about the program. Public-private partnerships should be pursued with gardening clubs, Cooperative Extension offices, landscape designers, maintenance companies and nurseries.

Calculation of rebates for landscape conversion or as incentives for new landscape installation should be based on careful consideration of the net present value of the water saved versus the size of rebate that helps motivate customers to install such a landscape. For new construction, another type of incentive would be a discount on the water capital recovery fee.

Careful design of the program is necessary to prevent overwatering after the water wise landscape is installed. Signed agreements with customers receiving rebates can assist the utility in recovering funds if water use does not decline after installation of the water wise landscape. Incentives including rebates should be rescinded if water use returns to previous levels within two years.

Awards programs can both reward the customer who has converted the landscape and help motivate others in the community to convert to low water use landscaping materials.

Schedule

1) The scope of this BMP, should be realized within ten years of the date implementation commences.
2) Develop and implement a plan to target and market landscape conversions to Industrial/Commercial/Institutional ("ICI") & Residential accounts with dedicated meters by the end of the first year from the date implementation commences.
3) Develop and implement a plan to target and market landscape conversions to all accounts by the end of the second year from the date implementation commences.
4) Develop and implement a customer incentive program by the end of the first year from the date implementation commences.

Scope

1) <u>Rebate and Incentive Approach</u>
   a. Within one year of implementation date, develop and implement a plan to market low-water requiring landscape design and conversion program;
   b. Within one year of implementation date, develop and implement a customer incentive program.
   c. Rescind incentives, including rebates, if water use returns to previous levels within two years.

2) <u>Ordinance Approach</u>
   In the first twelve (12) months: Plan a program including stakeholder meetings as needed. Consider offering rebates for all or a portion of the time this program is in place. For example, offer rebates for five years and publicize this so customers will take advantage of rebates and retrofit early in the program. Develop a plan for educating realtors and landscape companies about this requirement. Plan a follow up inspection program after retrofit. Develop and

pass ordinance. Implement ordinance and tracking plan for number of units retrofitted.

In the second year and after: Continue implementation and outreach program for realtors and landscape companies. Continue verification inspections.

Documentation

To track this BMP, the utility should gather the following documentation:

1) Number of dedicated irrigation meter accounts;
2) Number, type, and dollar value of incentives, rebates, and loans offered to and awarded to customers;
3) Estimated water savings based on customer surveys; and
4) Estimated landscape area converted and water savings achieved through low water landscape design and conversion program.
5) Customer water use records prior to and after conversion of the landscape. This data is best compared in years of similar rainfall and after sufficient time has passed for the landscape to establish itself.

Determination of Water Savings

Provide estimates of water savings from landscape conversions based upon actual metered data.

Cost-Effectiveness Considerations

The primary costs to implement this BMP are the incentives or rebates to customers for conversion to water wise landscape. Current incentives for landscape conversion range from $0.05 to $1.00 per square foot in Texas. Depending on program design and whether pre and postconversion inspections are required, staff labor cost should range from $50 to $100 per conversion.

Marketing and outreach costs range from $20 to $50 per conversion. Administrative and overhead costs range from 10 to 20 percent of labor costs.

References for Additional Information

1) *EARTHKIND™ Environmental Landscape Management*, http://aggie-horticulture.tamu.edu/earthknd/earthknd.html 2004.
2) *Handbook of Water Use and Conservation*, Amy Vickers, Waterplow Press, May 2001.
3) *Water Savings from a Turf Rebate Program in the Chihuahuan Desert*, El Paso Water Utilities, City of El Paso Water Utility, 2003.
4) *Waste Not, Want Not: The Potential for Urban Water Conservation in California,* Pacific Institute, November 2003.

http://www.pacinst.org/reports/urban_usage/waste_not_want_not_full_report.pdf

5) *Xeriscape Handbook*, American Waterworks Association, Denver, 1999.
6) *Xeriscape Plant Guide*, American Waterworks Association, Denver, 1996.
7) *Xeriscape Color Guide - 100 Water-wise Plants for Gardens and Landscapes,* American Waterworks Association, Denver, 1998.
8) *City of Austin Landscape Regulations.* http://www.amlegal.com/austin_nxt/gateway.dll/Texas/Austin/code00000.htm/volume00157.htm/title00158.htm/chapter00160.htm?f=templates$fn=altmain-nf.htm$3.0#JD_25-2-981
9) *City of Austin Environmental Criteria Manual: Section 2 Landscape.* http://www.amlegal.com/austin_nxt2/gateway.dll?f=templates&fn=default.htm&vid=alp:austin_environment
10) *California Model Landscape Ordinance 1993*.http://www.owue.water.ca.gov/docs/WaterOrdIndex.cfm
11) *Austin Green Gardening Program* (http://www.ci.austin.tx.us/greengarden/)
12) *City of Corpus Christi Xeriscape Landscaping.* http://www.cctexas.com/?fuseaction=main.view&page=1047
13) *San Antonio Water System Conservation Program.* http://www.saws.org/conservation/h2ome/landscape/
14) *Texas Cooperative Extension for El Paso County.* http://elpasotaex.tamu.edu/horticulture/xeriscape.html
15) *WaterWise Council of Texas.* http://www.waterwisetexas.org/

8.1 New Construction Graywater

Applicability

This BMPis intended for a Municipal Water User Group ("utility") that has new development in its service area where use of graywater can be an option for an additional water supply. This BMP does not include on-site wastewater treatment and reuse. Once a utility decides to adopt this BMP, the utility should follow the BMP closely in order to achieve the maximum water efficiency benefit from this BMP.

Description

Graywater has always been used in Texas. The most common example is using washing machine water for lawn or garden irrigation. Until 2003, Texas statutes contained very restrictive provisions for using graywater, primarily due to concerns about public health. In 2003, the Texas Legislature adopted House Bill ("HB") 2661 which provides a more comprehensive definition of graywater and provisions for facilitating the use of graywater in a safe manner.

Graywater is defined in Texas as wastewater from clothes washers, showers, bathtubs, hand washing lavatories and sinks not used for the disposal of hazardous or toxic ingredients. Graywater cannot include water from clothes washers used for washing diapers, sinks used for food preparation, toilets, nor urinals.

HB 2661, passed by the 78th Legislature Regular Session, added a provision that allows graywater use without treatment of up to 400 gallons per day at a private house for landscape irrigation, gardening or composting as long as the graywater:

1) Is used by the occupants of the residence for gardening, composting, or landscaping;
2) Is collected using a system that overflows into a sewage collection system or on-site wastewater treatment and disposal system;
3) Is stored in tanks that are clearly labeled and that have restricted access;
4) Uses purple pipe or purple tape around the pipe;
5) Is not allowed to pond or run off across property lines; and
6) Is distributed by a surface or subsurface system that does not spray into the air unless the graywater receives additional treatment.

HB 2661 also encourages builders of new homes to install dual piping that provides the capacity to collect graywater from allowable sources and to install subsurface graywater systems around the foundation of new houses to minimize foundation movement and cracking. This approach can also provide irrigation for landscaping planted up to four feet from the foundation.

New duplexes, triplexes, fourplexes, town homes, condo units and apartments can all be designed for utilization of graywater. Graywater generated from office buildings and other commercial buildings, primarily through faucet use, can be used for landscape irrigation. HB 2661 requires the Texas Commission on Environmental Quality to adopt rules for graywater use for commercial purposes as well as for industrial purposes and these rules are expected to be released for public comment sometime in 2004.

In many cases the quantity of water available as graywater is declining due to water efficiency gains from water conserving showerheads, faucet aerators and clothes washers. In a new home, which would have efficient plumbing fixtures, the amount of graywater produced will range from 22 to 30 gallons per person per day[1]. For an average size household of 2.7 persons that would be sufficient in most cases for both foundation stabilization and landscape irrigation in a four-foot strip around a 2,500 square foot house.

The suitability of graywater for irrigation will vary, and if graywater is the primary source for irrigation, a low water use landscape should be used. Irrigation systems should consider soil depth, soil permeability and flooding characteristics. Application options include drip, flood and subsurface irrigation. It is not appropriate to use spray irrigation unless the graywater is highly treated. Pumps may be required for pressure dosing and uniformity of flow.

Implementation

Implementation of this BMP includes following rules pertaining to graywater adopted by TCEQ (expected 2004) as well as any local City or County Health Department rules. To promote this BMP, stakeholder meetings should be held with builders, developers, realtors and other impacted groups.

Due to the high cost of retrofitting existing homes and buildings for collection and use of graywater, that option is not included in this BMP. A utility choosing to support such retrofits should include design standards as a component of its public information programs.
Under this BMP, the utility should:

1) Implement an incentive plan to encourage builders and owners of new homes and/or multi-unit properties to install plumbing that separately collects graywater from all eligible sources and distributes the graywater through a subsurface irrigation system around the foundation of the residence or building or for other landscape use. It may be effective for this BMP to be part of a Green Builder type rating system that also includes WaterWise landscaping, adequate soil depth and rainwater harvesting; or
2) Adopt regulations requiring all new homes and/or multi-unit properties to install plumbing that separately collects graywater from all eligible sources and distributes the graywater through a subsurface irrigation system either around the foundation of the residence or building or for other landscape use; or
3) Adopt regulations and/or incentives requiring new commercial properties to reuse graywater.

Schedule

The schedule for accomplishing this BMP depends upon the utility's choice of approach:

1) Incentive Approach: In the first six months, plan the program including stakeholder meetings as needed. Develop a plan for educating and training potential homebuyers, developers, plumbers, landscape professionals and realtors about this program. After six months, implement the program.
2) Ordinance Approach: In the first six months, hold stakeholder meetings to develop the ordinance. Consider offering incentives for the first year of implementation. Propose the ordinance or rules to local City Council or Board for approval. Develop plan for educating potential homebuyers, developers, plumbers, and realtors about this program. After six months, implement the program.

Scope

To accomplish this BMP, the utility should do the following:

1) Develop and implement an incentive program to encourage graywater use in new homes and/or multi-unit properties and/or certain new commercial developments such as office parks; Or,

2) Adopt an enforceable ordinance or rules requiring use of graywater on all new homes and/or multi-unit properties and/or certain new commercial developments such as office parks.

Documentation

To track the progress of this BMP, the utility should gather and have available the following documentation for each year of implementation:

1) Depending on which sectors the utility has decided to focus on, the number of new homes and/or multi-unit properties and/or certain new commercial developments such as office parks, started and completed after adoption of this BMP;
2) The number and type of graywater installations completed each year; and
3) The estimated graywater use in each graywater installation.

Determination of Water Savings

Water savings will vary depending on the type of installation and will likely be unique to each customer installing a graywater system. There may also be some cases where graywater use will provide more water for a purpose than is currently being met with potable water. Only the

reduction in potable water use should be calculated as the actual savings. In general, calculate water savings as follows:

- For single-family units, calculate gallons of potable water use replaced by graywater and multiply this estimated potable water savings per house times the number of houses installing a graywater system.
- For commercial and other properties, calculate gallons of potable water use replaced by graywater. In some cases, water savings for commercial developments can be calculated based on the number of employees and graywater discharge per employee.

Cost-Effectiveness Considerations

The costs to the utility will center around the administrative costs of working with existing and potential graywater projects, including review of plans and inspection of construction. Utilities may also consider offering incentives. Depending on program design and whether project inspections are required, staff labor cost should range from $50 to $100 per project. Marketing and outreach costs range from $20 to $50 per project. Administrative and overhead costs range from 10 to 20 percent of labor costs.

References for Additional Information

1) *Graywater System Guidelines, Green Building Program Sustainable Building Sourcebook.* http://greenbuilder.com
2) *Impacts of Demand Reduction on Water Utilities,* AWWA Research Foundation, 1996.
3) *Residential End Uses of Water,* AWWA Research Foundation, 1999.
4) *Quantifying the Effectiveness of Various Water Conservation Techniques in Texas,* Texas Water Development Board, May 2002.
5) *Waste Not, Want Not: The Potential for Urban Water Conservation in California,* Pacific Institute, November 2003. http://www.pacinst.org/reports/urban_usage/waste_not_want_not_full_report.pdf
6) *Texas HB 2661.* http://www.capitol.state.tx.us/tlo/78R/billtext/HB02661F.HTM
7) *City of Austin Green Builder Program.* http://www.ci.austin.tx.us/greenbuilder/

8.2 Rainwater Harvesting and Condensate Reuse

Applicability

This BMP is intended for use by a municipal water user group ("utility") concerned with reducing outdoor irrigation demands on the potable water system. Calculation of potential savings will depend upon regional climate patterns. Rainwater harvesting and condensate reuse are applicable to ICI buildings, while private homes can benefit from rainwater harvesting. Utilities may benefit by targeting this BMP to help shave peak demand through customer education. For maximum water-use efficiency benefit, the utility should adhere closely to the measures described below.

Description

Rainwater harvesting and condensate reuse ("RWH/CR") conservation programs are an effective method of reducing potable water usage while maintaining healthy landscapes and avoiding problems due to excessive run-off. Using this BMP, the utility provides customers with support, education, incentives, and assistance in proper installation and use of RWH/CR systems. RWH/CR systems will be most effective if implemented in conjunction with other water efficiency measures including water-saving equipment and practices. Rainwater harvesting is based on ancient practices of collecting – usually from rooftops – and storing rainwater close to its source, in cisterns or surface impoundments, and using it for nearby needs. Industrial, Commercial, and Institutional ("ICI") users have found it to be cost effective to collect the condensate from large cooling systems by returning it into their cisterns as well. Facilities with large cooling demands will be in the best position to take advantage of condensate reuse, which due to its quality can potentially be used in landscape irrigation, as cooling tower makeup water, or in some industrial processes. The variability in rate and occurrence of precipitation events requires that rainwater or condensate be used with maximum efficiency. Incentives may include rebates for purchase and installation of water-efficient equipment.

Several factors should be considered in the design of rainwater harvesting and condensate reuse systems. System components include the collection area, a first flush device, a roof washer, an opaque storage structure with the capacity to meet anticipated demand, and a distribution system. Design consideration should be given to maintaining the highest elevations feasible for collection and storage systems for the benefit of gravity flow to storage or distribution. When using drip irrigation systems, filters are necessary to prevent particulates from clogging drip nozzles. For potable water uses, a higher degree of filtration and disinfection is needed to ensure water quality adequate for human consumption. Regular maintenance of RWH/CR systems includes changing filter media on a regular basis and cleaning the first flush filter. The utility should consider providing participants with reminders of regular maintenance requirements for their RWH/CR systems. Maximum expected daily demand, and knowledge of historical precipitation patterns, including amount, frequency and longest time between rainfall events, is important in designing the system. The Texas Water Development Board's *Texas*

Manual on Rainwater Harvesting, 2004, should be used as a resource, as well as technical assistance from professional installers and manufacturers of RWH/CR equipment for proper design and implementation of RWH/CR program guidelines.

In some parts of the state of Texas, RWH/CR has been used as a private water supply for both potable as well as nonpotable uses. Using rainwater for potable supply creates a responsibility on the part of the owner/operator of the system to operate and maintain the system to a higher level than nonpotable use. For this reason most RWH/CR programs run by utilities are likely to focus on non-potable water uses. Successful implementation of this BMP is accomplished by performing one or a combination of the approaches outlined below.

While residential cooling systems are unlikely to provide significant flows of condensate, Industrial/Commercial/Institutional ("ICI") installations with large cooling demands can produce significant amounts of condensate and should be evaluated for the dual RWH/CR system. Large ICI installations can implement rainwater harvesting (from roofs) as well as capture of stormwater for irrigation or other non-potable uses. New commercial developments are often required to have either stormwater detention ponds or water quality treatment structures. In either case, permanent storage can be added beyond that required and this storage can be used to retain runoff for later irrigation use. Large buildings that have or need French drain systems for foundation drain water should evaluate the potential for recovery of this resource as well.

The utility should consider sponsoring one or more demonstration sites. Potential partners include customers with educational missions such as schools, universities, botanical gardens, and museums with large public landscapes.

Although rainwater is recommended for all irrigation uses, it is most appropriate for use with drip or micro irrigation systems. Utilities implementing this BMP should consider offering a landscape water-use survey (*See*, the related BMP) to help customers ensure that RWH/CR systems are properly designed and sized.

The water-use surveys, at a minimum, include: measurement of the total irrigated area; irrigation system checks, review of irrigation schedules or development of schedules as appropriate; provision of a customer survey report and information packet. The utility should provide information on climate-appropriate landscape design and efficient irrigation equipment and management for new customers and change-of-service customer accounts (*See*, the Water Wise Landscape Design and Conversion Programs BMP for more detail).

Implementation

Programs should consider the following elements:

1) <u>Retrofit or Rain Barrel Program</u>
   Marketing the program to the customer via bill inserts will allow the utility to target the largest summer peak users first. The utility should consider also

approaching local weather announcers, radio gardening show hosts, and newspaper columnists for assistance in notifying the public about the program. Public/private partnerships with non-profits such as gardening clubs, neighborhood associations, Cooperative Extension offices and/or with green industry businesses such as rainwater harvesting companies and local sustainable building groups are potential avenues to market the program and leverage resources.

Incentives can include rebates for RWH/CR systems, recognition for RWH/CR systems through signage, award programs, and certification of trained landscape company employees and volunteer representatives to promote the program. Utility staff can also be trained to provide irrigation audits, which can include resetting irrigation controllers with an efficient schedule.

The initial step in assisting customers with landscape irrigation systems is a thorough evaluation of the potential water capture of a RWH/CR system.

The water customers who participate in this program will need to maintain and operate their irrigation systems in a water-efficient manner. The utility should consider implementing a notification program to remind customers of the need for maintenance and adjustments in irrigation schedules and to system filters as the seasons change.

The utility needs to ensure that RWH/CR system specifications are coordinated with local building and plumbing codes.

The American Rainwater Catchment Systems Association lists evaluation training for RWH/CR programs. ICI customers may want to consider performance contracting as an option for financing retrofitted RWH/CR systems.

2) <u>New Construction</u>

a. In addition to retrofitting existing homes and buildings with RWH/CR systems a utility may also choose to support implementation focused on new construction. Under this approach, the utility could:

b. Adopt regulations requiring all new ICI properties to install a RWH/CR system that collects and stores rainwater and condensate from all eligible sources and distributes it to irrigation and/or a cooling tower make-up system or

c. Implement an incentive program to encourage builders and owners of new ICI properties to install a RWH/CR system that collects and stores rainwater and condensate from all eligible sources and distributes it to irrigation and/or a cooling tower make-up system. In large ICI buildings requiring cooling towers, design consideration should be given to returning condensate flows from air conditioning coils to cooling tower

make-up. It may be effective for this BMP to be part of a Green Builder type rating system that also includes WaterWise landscaping and adequate soil depth;

d. Implement an incentive program to encourage homebuilders and homeowners to install a RWH system for landscape use to reduce potable water consumption from the utility in the summer season or

e. Adopt regulations requiring all new homes and/or multi-unit properties to install plumbing that separately collects and stores rainwater from all eligible sources and distributes the rainwater through a subsurface irrigation system either around the foundation of the residence or building or for other landscape use.

Such programs would need to be carefully coordinated with stormwater collection programs and meet all applicable regulations for stormwater collection and reuse.

Schedule

Depending on the option(s) selected, the corresponding schedule should be followed.

1) Incentive Approach
In the first six months, plan the program including stakeholder meetings as needed. Develop a plan for educating potential homebuyers, developers, plumbers, green industry trade groups, landscape architects and realtors about this program. After six months, implement the program.

2) Ordinance Approach
In the first six months, hold stakeholder meetings to develop the ordinance. Consider offering incentives for the first year of implementation. Propose the ordinance or rules to local City Council or Board for approval. Develop a plan for educating potential homebuyers, developers, plumbers, and realtors about this program. After six months, implement the program.

Scope

To accomplish the goals of this BMP, the utility should do one or more of the following:

1) Develop and implement an incentive program to encourage RWH/CR in new multi-unit properties and certain new commercial developments such as office parks. Or,

2) Develop and implement an incentive program to encourage RWH/CR in existing multi-unit properties and certain existing commercial developments such as office parks. Or,

3) Develop and implement an incentive program to encourage residential customers to install rainwater systems and rain barrels. Or.

4) Develop and implement an ordinance requiring condensate recovery in new non-residential construction as applicable.

Documentation

To track this BMP, the utility should gather and have available the following documentation for each year of operation:

1) The number of new RWH/CR developments for which design planning started after adoption of this BMP;
2) The number and type of RWH/CR installations completed each year;
3) The estimated rainwater and condensate use in each RWH/CR installation;
4) Aggregate water capacity of RWH/CR sites;
5) Number, type, and dollar value of incentives, rebates, or loans offered to and accepted by customers; and
6) Estimated water savings achieved through customer surveys.

Determination of Water Savings

Water savings from a RWH/CR program is determined by water volume harvested and used to replace other water sources. In programs which target new construction, the water savings should be estimated based upon known water consumptions for the proposed end use. A number of sources, including other BMPs, can be helpful in estimating potential water savings. A method for estimating potential water catchment and a monthly water balance equation for estimating water storage capacity are:

1) Catchment Potential (gals) = Area x 0.62 x 0.8 x Rainfall
Where Area = total area of catchment surface in square feet
0.62 = coefficient for converting inches per ft^2 to gallons (unit conversion from 7.48 gallons per ft^3)
0.8 = collection efficiency factor
Rainfall = average rainfall in inches.
Note: median and lowest recorded rainfall can also be calculated in order to develop a range of expected values.

2) Storage Capacity
A simple assumption is that up to three months may elapse without significant rainfall. So a storage capacity to provide for a three-month period of water demand may be desired.

More precise methods of estimating needed storage capacity or additional information for estimating water balance of RWH/CR systems and of accounting

for the variability in seasonal rainfall pattern is available in the *Texas Manual on Rainwater Harvesting.*

For condensate recovery, storage should be based on the anticipated maximum holding time before the condensate is reused for irrigation or other purposes.

Cost-Effectiveness Considerations

The costs of this BMP to the utility will include both administrative program management costs and incentives to customers for implementing rainwater harvesting or condensate reuse projects. Depending on program design and whether project inspections are required, staff labor cost should range from $50 to $100 per project. Current incentives provided by the City of Austin for complete rainwater harvesting system are up to $500 per SF home and for commercial customers, the incentive for condensate reuse is up to $1 per gallon per day recovered. Marketing and outreach costs range from $20 to $50 per project. Administrative and overhead costs range from 10 to 20 percent of labor costs.

The incentive for bulk purchase rain barrels in Austin is a $20 discount from the actual costs of the rain barrel. Labor costs range from $8 to $12 per rain barrel and warehouse storage costs may be an additional consideration.

References for Additional Information

1) American Rainwater Catchment Systems Association. http://www.arsca-usa.org/
2) City of Austin Water Conservation Program. http://www.ci.austin.tx.us/watercon/rainwaterharvesting.htm
3) *First American Rainwater Harvesting Conference Proceedings*, Gerston, J. and Krishna, H., editors, ARCSA, August 2003.
4) *Rainwater Harvesting Design and Installation,* Save the Rain. saverain@gvtc.com
5) *Texas Guide to Rainwater Harvesting*, Texas Water Development Board and Center for Maximum Potential Building Systems, 2nd Edition, 1997.
6) *Waste Not, Want Not: The Potential for Urban Water Conservation in California,* Pacific Institute, November 2003. http://www.pacinst.org/reports/urban_usage/waste_not_want_not_full_report.pdf

8.3 Water Reuse

Applicability

This BMP is intended for Municipal Water User Groups ("utility") that may have potential applications for reusing water within its system. The utility may be a producer of reclaimed water or may work to bring in reclaimed water from outside sources. Reuse can be direct with reclaimed water substituted in end uses to replace potable water or raw water. Another method of reuse is indirect water reuse which involves the intentional planned use of system return flows.

Both direct and/or indirect reuse should be implemented as a supplement to other methods of reducing per capita water use or increasing the efficient use of water.

Upon review, utilities may find that they are already implementing one or more elements of this BMP and may want to adopt additional elements outlined below. Once a utility decides to adopt this BMP, the utility should follow the BMP closely in order to achieve the maximum benefit from this BMP.

Description

1) Direct Reuse

The direct use of reclaimed water is an effective method of reducing potable water usage. Reclaimed water is defined inTexas Administrative Code ("TAC") §210.3(24) as "Domestic or municipal wastewater which has been treated to a quality suitable for a beneficial use, pursuant to the provisions of this chapter and other applicable rules and permits." Direct use of reclaimed water is appropriate for a number of domestic, industrial and irrigation needs where the potential for human contact is limited. Some possible uses for reclaimed water are landscape irrigation, non-contact recreational use, cooling tower make up water, toilet or urinal flushing water, or manufacturing process water. Although differences in water quality between potable and non-potable water may change the quantity needed for a particular task, users of reclaimed water should view it as a valuable water resource and use it as efficiently as possible. Direct use of reclaimed water is regulated by the Texas Commission on Environmental Quality ("TCEQ") under Chapter 210 of the TAC (2) and Safe Drinking Water Act standards. Included in these rules are provisions that require permission from that agency before providing reclaimed water for beneficial use and design guidelines for reclaimed water systems.

Under this BMP, the utility should identify and rank industrial, commercial, and institutional ("ICI") customers according to volume of water use and investigate the feasibility of replacing some of potable water uses with reclaimed water. Municipalities should investigate reclaimed water opportunities within their own

accounts or with third parties outside their service area. The utility provides a description of effluent treatment facilities and distribution systems including the amounts and quality of effluent expected to be available for reuse. The utility should implement programs to provide as much reclaimed water to approved non-potable uses as is available and cost-effective to the utility.

2) Indirect Reuse

Indirect reuse can provide substantial water conservation by replacing or delaying the development of additional raw water resources for water supply. Indirect reuse can be for potable or non-potable uses. Indirect potable reuse is defined as follows by the Water Reuse Association[1] "A particular application where the recycled water (generally having received a substantial degree of treatment) is blended into a community's water supply (via groundwater recharge or surface water augmentation) prior to final treatment and distribution to the customer in the existing water distribution system."

The use of reclaimed water for augmentation of potable supplies as a BMP involves the intentional planned use of the reclaimed water for this purpose. Use of reclaimed water for augmentation of potable supplies must take into consideration the following:

- TCEQ Surface Water Quality Standards for the receiving water body.
- State laws and regulations directly applicable to authorizing water reuse, including those that consider the impact of reuse on instream uses, freshwater inflows to the bays and estuaries, and existing water rights under circumstances that the regulatory agency deems appropriate.

A water rights permit is required to withdraw reclaimed water that has been discharged to the waters of the state.

Implementation

Implementation should consist of at least the following actions:

1) Direct Reuse

a. Identify Potential Reuse Accounts

b. Identify and rank ICI accounts according to water use. Proximity to a reclaimed water distribution system, an existing wastewater treatment plant, or possible locations for new wastewater treatment plants should be considered in ranking potential reuse customers. A wastewater interceptor could be designed to divert wastewater flows from a wastewater line for treatment and use in the nearby area. Careful consideration should be given to the water quality needs of the end user. For purposes of this BMP, potential direct reuse accounts are defined as:

1. Irrigation Accounts: any water user that uses potable water to irrigate large turf, shrubs, trees or other landscaped area. Care should be taken to ensure that such irrigation is in compliance with the human contact standards in TAC Chapter 210 and that the plant material can tolerate the water quality of available reclaimed water
2. ICI Accounts: any water users that are defined as ICI in the Conservation Programs for Industrial, Commercial, and Institutional Accounts BMP. Care should be taken to ensure that identified potential uses are in compliance with the human contact standards in TAC Chapter 210.
3. New Construction: Reclaimed water can be used for toilet and urinal flushing if it meets TCEQ standards. This would only be feasible in new construction of an office building or adult residential facility such as a dormitory. For new subdivisions, dual distribution systems could be installed to use reclaimed water to irrigate common areas, medians, parks and home landscapes. The utility could also adopt an ordinance and regulations requiring all or specific customers to use reclaimed water for irrigation and other suitable purposes if reuse water is available.

c. Implement a Reclaimed Water Customer Incentives Program. Financial incentives can be offered on a dollar amount per acre-foot of potable water use replaced. Another potential incentive is to offer discount rates or grants to assist a reuse end user in connecting to the reclaimed water system and replumbing facilities from potable to non-potable water use. Purple pipe is required for all reuse water to prevent cross connections. Proper backflow prevention measures must be implemented when a facility has both potable and non-potable water uses or has an irrigation system installed.

2) Indirect Reuse

a. Identify indirect reuse opportunities for augmentation of potable supply.
b. Identify the source of reclaimed water that could be used to augment the potable raw water supply.
c. Identify the potential water body that would receive the reclaimed water. Careful consideration should be given to the water quality requirements for the augmented water supply to be suitable for potable use. The augmentation of a potable supply should involve multiple barriers to ensure compliance with applicable regulatory standards, including high levels of treatment of the reclaimed water, blending with substantial amount of natural water, retaining the reclaimed water in the receiving water body for significant amounts of time, high degree of treatment of the potable water, and monitoring (sampling and testing) to ensure compliance with applicable regulations.

d. Determine potential impacts on instream uses, freshwater inflows to bays and estuaries, and existing water rights with regulatory agency input.

Schedule

Utilities pursuing this BMP should begin implementing this BMP within twelve (12) months of adoption of the official resolution to initiate the program.

Scope

In order to accomplish this BMP, the utility should perform the following:

1) Direct Reuse

To the extent that reclaimed water is available for reuse, replace the use of potable water on golf courses, in large cooling plants, and in other industrial or landscape processes identified by the municipal utility.

2) Indirect Reuse

To the extent that reclaimed water is available, that a receiving water body is available, and a water rights permit is obtained from the TCEQ, augment the potable water supply sources with reclaimed water in a manner determined by the utility to be financially and technically feasible.

Documentation

To track this BMP, the utility should gather the following documentation based on whether direct and/or indirect reuse is selected:

1) Direct Reuse

a. Description of wastewater treatment facilities and reclaimed water distribution systems.
b. Documentation of its efforts to find reuse opportunities within its customer base, including lists of potential users.
c. Number of gallons or acre-feet of water use replaced by reclaimed water or new water demands served by reclaimed water since implementation of this BMP.

2) Indirect Reuse

a. Description of indirect reuse project(s).
b. Number of gallons or acre-feet of previous potable water use replaced by reuse water or new water demands served by reuse since implementation of this BMP.

Determination of Water Savings

Water savings are estimated at up to 100 percent of total amount of water replaced by reuse. Changes in operating parameters or water balance calculations which depend upon water quality parameters, such as the impact of TDS in irrigation water, may require different quantities of reuse water to be applied for the same end uses.

Cost-Effectiveness Considerations

The costs for direct or indirect reuse include capital costs of facilities, engineering, regulatory costs, and operations costs. There will also be outreach costs to gain public acceptance. The benefits will be the avoided costs for water supply acquisition and additional potable water treatment capacity.

These benefits of direct reuse can be taken into account when setting the reclaimed water rate. If a utility can adopt a regulation requiring reclaimed water use for certain purposes within the proximity of a reclaimed water supply line, more customers will tie on to the reclaimed water system and the utility will be able to charge a rate that recovers its costs.

References for Additional Information

1) *Water Reuse Association: Fact Sheets and Studies.* http://www.watereuse.org/Pages/information.html
2) *Recycled Water Users' Handbook, San Antonio Water System.* http://www.saws.org/our_water/recycling/handbook/recycle_water_hb.pdf
3) *Chapter 210 Rules, Texas Commission on Environmental Quality.* http://www.tnrcc.state.tx.us/oprd/rules/pdflib/210a.pdf through 210e.pdf
4) *AWWA M24 Manual: Dual Water Systems.* http://www.awwa.org/bookstore/product.cfm?id=30024
5) *Using Reclaimed Water to Augment Potable Water Resources,* Water Environment Federation and American Water Works Association, 1998. (2.16c)

9.1 Prohibition on Wasting Water

Applicability

This BMP is intended for all Municipal Water User Groups ("utility"). This BMP should be considered by utilities that have customers who continue to waste water despite the efforts of the utility to educate customers to reduce waste of water. Many customers who are cooperating with conservation efforts may lose their inclination to conserve water if other water customers are ignoring efficient water management practices and continuing to irrigate the streets and parking lots or allow outside leaks to run visibly for long periods. In these circumstances, the utility's efforts in limiting water waste should find acceptance by the general public. The specific measures listed as part of this BMP can be implemented individually or as a group. Upon review, a utility may find that it is already implementing one or more these elements and it may want to adopt additional elements outlined below.

Once a utility decides to adopt this BMP, the utility should follow the BMP closely in order to achieve the maximum water efficiency benefit from this BMP.

Description

Water waste prohibition measures are enforceable actions and measures that prohibit specific wasteful activities. Under this BMP, the utility enacts and enforces ordinances to prohibit wasteful activities including: water waste during irrigation, failure to fix outside faucet leaks, service line leaks (on the customer side of the meter), sprinkler system leaks; once-through use of water in commercial equipment, non-recirculation systems in all new conveyer and in-bay automatic car washes and commercial laundry systems; non-recycling decorative water fountains; and installation of water softeners that do not meet certain regeneration efficiency and waste discharge standards.

Water waste during irrigation includes: water running along the curb of the street, irrigation heads or sprinklers spraying directly on paved surfaces such as driveways, parking lots and sidewalks in public right of ways; operation of automatic irrigation systems without a functioning rain shut off device or soil moisture sensor; a wind sensor and/or freeze sensors in some areas of the State; operation of an irrigation system with misting heads caused by water pressure higher than recommended design pressure for the heads, or broken heads; and spray irrigation during summer months between the hours of 10 a.m. and 6 p.m. Summer months are generally considered June 1 through September 30, but utilities may select a longer or shorter timeframe. Utilities may want to consider not allowing spray irrigation until as late as 8 pm in summer months. An exemption for these watering hours should be included for newly installed landscapes for a limited period of time.

Implementation

The utility should consider stakeholder group information meetings, especially for those affected by the landscape component of this BMP. Working with stakeholder groups is important to achieving "buy in" from the landscape industry and water customers.

Utilities with ordinance making powers may want to consider amending landscaping or irrigation ordinances that may have provisions that could be changed to increase water efficiency. For example, Corpus Christi has irrigation system regulations[1] requiring drip irrigation in landscaped areas between the sidewalk and the street. Plan customer follow-up compliance and education after ordinance passage. Implement ordinance and tracking plan for violations, compliance notifications, and enforcement.

Utilities that lack ordinance making powers may want to develop a plan for educating customers, especially those directly affected, about the requirements of a water waste prohibition program; plan a program including stakeholder meetings as needed; plan a follow-up compliance and education program; and implement a water waste program and tracking plan for violations and compliance notifications.

Schedule

Utilities pursuing this BMP should begin implementing this BMP according to one of the following approaches:

1) <u>For utilities with ordinance making powers</u>
   a. In the first twelve (12) months: Plan, develop, and pass an ordinance, including stakeholder meetings as needed. Develop a plan for educating customers, especially those directly affected by the requirements that are enforced as a result of the ordinance.
   b. After Ordinance Passage (In the 2nd year and on): Continue implementation and an outreach program for customers. Continue compliance education and initiate enforcement programs. Enforcement can include citations with fines and service interruption for repeat offenders. Or,

2) <u>For tilities that lack ordinance-making powers</u>
   In the first twelve (12) months: Plan a program including stakeholder meetings as needed. Implement a water waste program and tracking plan for violations and compliance notifications.

Scope

To accomplish this BMP, the utility should adopt water waste prohibitions policies, programs or ordinances consistent with the provisions for this BMP specified in Section C.

Documentation

To track the progress of this BMP, the utility should gather and have available the following documentation:

1) Copy of water waste prohibition ordinances enacted in the service area;
2) Copy of compliance or enforcement procedures implemented by utility; and
3) Records of enforcement actions including public complaints of violations and utility responses.

Determination of Water Savings

Total water savings for this BMP can be estimated from each water wasting measure eliminated through the actions taken under this BMP. For the replacement of inefficient equipment, the water savings are the difference in use between the new or upgraded equipment and inefficient equipment (*See* Industrial Cooling Processes BMP for additional information). For landscape water waste, the savings can be calculated based on estimated savings from each water waste warning or enforcement. There will be additional savings from the education of customers who may change some of their inefficient water use practices. These savings could be determined by surveys.

Cost Effectiveness Considerations

The primary costs associated with implementing this BMP will be ongoing administrative and staff costs. There may some one time only costs associated with developing and adopting ordinances and enforcement structures. If a utility chooses to implement fines as part of its program, the revenues from those can be included in the cost effectiveness analysis.

References for Additional Information

1) *Corpus Christi Irrigation System Regulations* http://www.cctexas.com/
2) *A Water Conservation Guide for Public Utilities,* New Mexico Office of the State Engineer, March 2001.
3) *City of Wichita Falls Drought Emergency Ordinance,* http://www.cwftx.net/drought/ordinance.PDF
4) *El Paso Water Conservation Ordinance,* http://www.epwu.org/ordinance.html
5) *Handbook of Water Use and Conservation*, Amy Vickers, Waterplow Press, May 2001.

9.2 Conservation Ordinance Planning and Development

Applicability

This Best Management Practice is intended for use by municipalities as part of a comprehensive approach to water conservation.

Description

This Best Management Practice is designed to provide guidance in developing and implementing a successful conservation ordinance that addresses permanent year-round water savings. Short-term cut backs based on temporary drought conditions is not the focus of the practice but should be considered to address short term conditions.

Developing a Comprehensive Conservation Ordinance

The most successful conservation ordinances have support from a community with a knowledgeable and engaged customer base, whether through education and awareness or a voluntary conservation program. A community that is considering this Best Management Practice should first determine what goals they wish addressed, such as long-term resources, peak or seasonal demand, capacity issues, or reduced waste water flows and then analyze end uses to help identify what may have the greatest potential for water savings. Stakeholders associated with those end uses should be brought into the process as early as possible. A good source for additional information and approaches to identifying opportunities for water conservation is Texas Water Developments Board's "Guidance and Methodology for Reporting on Water Conservation and Water Use."

1. End Use Analysis
   An end use analysis is the first step in identifying conservation provisions that will have the greatest impact on water use reductions in a given community. Basic questions include:
   - How old is the predominant housing stock?
   - Is the community "built-out" or still growing?
   - Are there industrial or manufacturing operations that are served?
   - Is there only light commercial and office?
   - Is there extensive use of irrigation systems?
   - Are there a significant number of multi-family housing, schools, golf courses?

Use basic billing information and utility employee knowledge of your customer base to gather the information. For smaller communities enough information can be gathered this way. Other sources of information include economic development offices, chambers of commerce, builders associations, school districts, metropolitan transit authorities, city planning, and permitting offices.

2. Provision Mix
   Communities with a very homogeneous customer base may need only a few provisions to address in a conservation ordinance; however, communities with more varied customer bases should consider provisions that address more than one sector. As the stakeholder process moves forward it is beneficial for all sectors that use water to be included in the community effort to save water as everyone who uses water has a part to play.

3. Stakeholder Process
   To assist in identifying that best provisions for the community are determined, a stakeholder process should be developed. Besides the ongoing implementation and enforcement, this is the most time consuming step and should be as inclusive and extensive as possible. This is the time to organize the stakeholder process for general public input and end user sector input. Reasons the community has determined the need for this ordinance should be included in any presentations or communication. These stakeholders should become advocates for the provisions to their colleagues. Communication and defense of the provisions can be shared between staff and stakeholders when the package is presented to the public and entities such as city councils.
   a. General public input process
      Broad or homeowner related provisions need input from the general public, accomplished in several forms. Distribute a general survey asking for public comment for or against the provisions proposed collected through online survey tools, hard copy in utility bill materials, or distributed at public events. Presentations can be developed and offered to community service groups such as Rotary or Lions clubs, church groups, garden clubs, homeowners associations, or any number of groups unique to your community. If this is the first effort by the community to develop an ordinance addressing conservation, a citizens advisory group should be considered appointed for the duration of the process and continued through the implementation process.

   b. End use sector stakeholder: Business Community
      Parallel to the general public input effort, input should be sought from specific end use sector stakeholders dependent on the provision proposed. For example, if you are proposing that certain standards need to be implemented when installing new landscapes you will want to meet with landscape and irrigation professionals and homebuilders at a minimum. If proposing provisions that address cooling towers you will want to meet with building owners and managers as well as cooling tower management companies. If you include provisions on pool construction standards you will want to meet with pool companies. Local chambers of commerce, landscape and irrigation groups, apartment associations, the local school district, city parks, homeowner associations, and other business groups that have a

general interest should also be included. Do not overlook the Texas county extension service as well. All meetings and comments received should be documented as you move through this process.

Implementation

Each community will have a different process to adopt ordinances. Most cities adopt final provisions through their home rule authority to pass ordinances and include them in their city codes. There are a variety of enforcement mechanisms which often depend on the specific mix of provisions adopted. Many conservation ordinance provisions have elements that come up in the building process and may be best addressed and enforced through the permitting process used for new construction requirements. Other provisions may be associated with facility management that may affect billing and can be enforced through billing requirements. Other items may fit better into a fine or citation system. The implementation phase will be challenging and buy-in from those directly responsible for enforcement is essential. Those responsible for the enforcement mechanism should be considered a stakeholder as the effectiveness of the ordinance depends on it.

Scope and Schedule

The water provider should allow for approximately 12 to 24 months realizing the full scope of this Best Management Practice. A schedule for creating, implementing, and evaluating this Best Management Practice should look similar to this:

1. Creation and support of permanent or special citizen/stakeholder advisory groups to provide programming and enforcement input.
2. End use analysis conducted by staff and special stakeholder work groups to determine proposed provisions.
3. Incorporate input and finalize provisions for staff to present to governing body such as a city council.
4. Establish enforcement mechanism.
5. Establish buy-in from the enforcement sector.
6. Develop materials and processes to inform those directly affected of the new requirements.
7. Evaluate the effectiveness of provisions implemented as well as the enforcement mechanisms.
8. Make adjustments to the provisions or enforcement mechanisms as needed.

Measuring Implementation and Determining Water Savings

To accomplish this Best Management Practice, the water provider should do the following after the first year of implementation:

1. A general survey should be sent to those sectors specifically and directly affected by the provisions to assess the general level of awareness of the provision, how compliance is occurring, and what could improve the process in the actual provision to continue to conserve water. Include both the end use sector as well as the “enforcement” sector.

2. A second round of stakeholder outreach should be considered depending on the initial survey results.
3. Identify aspects of the program which may or may not have succeeded. Look for opportunities to expand on what worked well and change or remove aspects that did not work as well.
4. A general accounting of the number of warnings, citations, corrective actions, or other statistics should be collected and compared to the number of total associated activities to get a sense of compliance rates.

The ease of determining water savings will greatly depend on the mix of provisions selected. Provisions addressing water saving equipment will have specific savings that can be calculated by determining the number of pieces of equipment installed compared to the higher use alternative. High efficiency plumbing fixtures or air cooled equipment compared to their higher water using equipment is an example of a straightforward comparison.

Less straightforward are provisions associated with outdoor water use. In these cases, comparing use before and after the provision is implemented along with overall water use, incorporating weather and other variables may be necessary to get a true determination of water savings.

Though water savings from reduced outdoor end use is the most difficult to determine in many ways, it is often critical to the provision mix because many communities are trying to address peak demand.

Cost-Effectiveness Considerations

The cost-effective water conservation ordinance provisions will be determined by the provision mix and choice of enforcement mechanism. Elements include:

1. Choice and number of provisions included in the ordinance.
2. Enforcement mechanism chosen.
3. Current and projected water resource portfolio specific to the community.
4. Marginal cost and need of the next available water source.
5. Availability of voluntary conservation programs in the community.

References

1. San Antonio Water System. http://www.saws.org/conservation/
2. City of Austin, Austin Water Utility. http://www.ci.austin.tx.us/water/water_portal2.htm
3. Alliance For Water Efficiency. http://www.allianceforwaterefficiency.org
4. American Water Works Association. http://www.awwa.org
5. Texas Water Development Board. http://www.twdb.texas.gov/conservation

Determination of the Impact on Other Resources

Effective implementation of a comprehensive conservation ordinance can have significant positive impact on both economic and environmental resources.

1. Economic Resources
   A reduction in water use by either voluntary or mandatory methods including the adoption of a conservation ordinance can reduce the cost for both water and wastewater treatment capacity, energy use, and the need to secure additional sources of raw water. While some provisions may initially cost the implementing stakeholder more, in the current water resource environment as well as the significant and ever-increasing costs in treatment and energy costs, those upfront costs can be recouped with low rate increases or in some cases the ability to have enough water for the stakeholder will outweigh the initial costs of the provision.

2. Environmental Resources
   A reduction in water use by either voluntary or mandatory methods including the adoption of a conservation ordinance will allow more water resources for environmental flows that can also lead directly or indirectly to economic benefits for the fishing and shrimping industry. In the urban environment, provisions can lead to land use that is more beneficial to urban wildlife including birds that are protected under migratory bird act and indirectly to increase in environmental tourism such as bird watching that can account for a significant portion of tourism dollars in many Texas communities.