WATER EFFICIENCY POTENTIAL STUDY FOR WISCONSIN

Prepared for the

Public Service Commission of Wisconsin

and

Wisconsin Department of Natural Resources

Camp, Dresser & McKee, Inc.
Milwaukee, WI
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List of Acronyms

AMR	automated meter reading
AWWA	American Water Works Association
BCR	benefit-cost ratio
C	conserving
CII	commercial, industrial and institutional
Compact	St. Lawrence River Basin Water Resources Compact
DNR	Wisconsin Department of Natural Resources
ELL	economic leakage level
gpcd	gallons per capita per day
gpf	gallons per flush
gpl	gallons per load
gpr	gallons per rack
HET	high efficiency toilets
HEU	high efficiency urinals
ILI	infrastructure leakage index
IWA	International Water Association
MG	million gallons
NC	non-conserving
NPV	net present value
NRW	non-revenue water
PSC	Public Service Commission of Wisconsin
UARL	unavoidable annual real loss
UAW	unaccounted-for water
UC	ultra-conserving
ULF	ultra low flush
USEPA	United States Environmental Protection Agency
WLC	water loss control
WLCC	AWWA Water Loss Control Committee

Executive Summary

This report provides an objective, statewide analysis to estimate and quantify achievable economic water savings under various water conservation and efficiency options. Few states, if any, have undertaken such a novel and unique attempt to quantify statewide water savings in this manner. This study will inform the State's comprehensive water management efforts by providing PSC and DNR decision makers with cost-effectiveness data for various water conservation measures and technologies when setting water conservation program goals, priorities, and funding levels.

It is important to note that throughout this document, assumptions are made with the intent to be representative of statewide conditions. Such assumptions may not be representative of any single water utility, and are intended to provide a reasonable statewide assessment. It is highly recommended that information contained within this report be modified with individual utility information in order for the results and assessments to be relevant at the utility level. It is the intent of this effort, that an individual utility can follow the procedures detailed in this report to develop its own assessment of water efficiency potential.

Previously, the DNR and PSC convened a stakeholder group to discuss demand-side water conservation options available to public water utilities. Results of this process are documented in: *Water Conservation, A Menu of Demand Side Initiatives for Water Utilities, 2006* and provide the list of water efficiency measures evaluated in a customer satisfaction survey and the analysis of potential savings.

The survey of Wisconsin water utility managers and clerks was conducted as part of this study to gauge the likely effect of conservation measures on customer satisfaction. Respondents were asked to score nineteen water conservation measures as to the likely impact on customer satisfaction ranging from mostly positive to mostly negative.

Two common concerns were identified by respondents in the open comment section: (1) how to fund conservation programs and (2) the loss of revenue that may occur following the implementation of conservation measures. The first concern suggests that external funding from the state may be required to spur implementation of programs or to inform utilities about conservation programs that may be recovered with rates. The second concern suggests that utilities may need to re-design rate structures to be less sensitive to fluctuations in water consumption.

Results of this survey represent a statewide assessment of potential measures. It is recommended that individual utilities assess the appropriateness and customer acceptability of any program or measure within its service area prior to implementation.

Water efficiency costs and savings, as well as water loss control program costs and savings vary with the size of the utility. Therefore, three generic water utility systems were defined as average representative utilities in Wisconsin for this statewide analysis. PSC statistics were used to identify average performance indicators for all utilities statewide, **large** (class AB) utilities, **medium** (class C) utilities, and **small** (class D) utilities.

The analysis of water loss control efforts in Wisconsin is based upon a water system audit format and water loss metrics established by the International Water Association and adopted by the American Water Works Association. Based on the results of the statewide analysis of water loss, both real and apparent (billing) losses among utilities in Wisconsin provide a great opportunity for improving water efficiency statewide into the future. While the PSC has worked hard to implement water control standards for these utilities, a number of utilities are not currently in compliance. By enforcing compliance standards and bringing all utilities to the current water loss allowance, Wisconsin water utilities could potentially save over 5,000 million gallons of water statewide in one year. Furthermore, by implementing stricter standards for water loss control, utilities could potentially save over 15,000 million gallons of water per year.

The performance indicators and metrics were evaluated for three different potential implementation scenarios defined as:

The <u>technical</u> water efficiency potential scenario reflects the *theoretical maximum* amount of water savings from water efficiency measures *regardless of cost-effectiveness* and the elimination of all leaks and losses statewide, with the exception of UARL.

The <u>economic</u> water efficiency potential scenario is a subset of the technical potential scenario which assumes implementation of *only the most cost-effective* measures, and water loss control programs required for the reduction of water leaks and losses by all utilities to 10 percent.

The <u>achievable</u> water efficiency potential scenario is a subset of the economic potential scenario and reflects water savings that can be *realistically expected* based on the survey of customer satisfaction. What is achievable within a given community is dependent upon education, attitudes and understanding of the need to use water efficiently. This will vary from one community to the next. Similarly, more education regarding water efficiency can change attitudes and shift some measures from marginal to acceptable. For the water loss control programs, technical water efficiency potential is defined as the reduction of water leaks and losses by all utilities to 15 percent. For the water efficiency measures, the utilities would implement all measures with a benefit-cost ratio of 1.0 or greater and received positive ratings on the customer satisfaction impact survey.

Measures with marginal economic and satisfaction impact rankings are included in the economic and achievable scenarios, respectively. In addition, state funding of measures, or mandates such as rate increases and ordinances, can potentially provide incentives or requirements that would add potential measures to the list of measures in the achievable scenario.

The statewide total water savings from efficiency measures for the <u>technical water efficiency potential</u> scenario of 330.9 million gallons per day by 2030 are estimated to cost about $391 million dollars over the 20 year period, assuming that all the measures are implemented and can concurrently achieve their estimated savings. The estimated revenue impact suggests that water rates would need to be increased over time if utility revenues are to remain unaffected as savings occur in response to these measures. It is estimated that implementation of all these measures could potentially save customers about $732 million over the next 20 years in energy bills. However, it should be noted that it is unrealistic to assume implementation of all measures simultaneously, or that the estimated savings could be achieved without overlapping affects between measures.

The water savings in the year 2030 and the NPV of each water efficiency measure and water loss control program were estimated and formed the basis to determine which measures qualified for each of the three implementation scenarios. The total water savings and implementation costs from each scenario are summarized in **Table ES.1** by utility size and for the statewide total. The present value of program implementation costs are derived from the efficiency measures and water loss control program by implementation scenario.

Table ES.1 Summary of Savings and Costs of WLC Program and Efficiency Measures by Implementation Scenario

	Implementation Scenario					
	Technical		Economic		Achievable	
	Savings 2030 GPD	Present Value Costs + Incentives	Savings 2030 GPD	Present Value Costs + Incentives	Savings 2030 GPD	Present Value Costs + Incentives
Large Utility	4,048,116	$4,895,619	3,735,479	$2,858,542	1,906,999	$2,097,579
Medium Utility	500,021	$758,556	467,288	$437,287	247,072	$329,800
Small Utility	93,664	$163,364	84,927	$91,246	45,647	$68,670
Statewide Total	373,786,001	$477,890,889	343,512,155	$265,471,406	164,058,943	$176,042,807

The difference between the technical and economic implementation scenarios shows a small decrease in water savings and a rather significant decrease in implementation costs. This is because the non-cost-effective (i.e., higher cost per gallon saved) measures are dropped from the economic scenario.

The difference between the economic and achievable implementation scenarios shows a large decrease in water savings and a lesser decrease in implementation costs. This is because some of the more cost-effective measures were deemed to be unfavorable with respect to their impact on customer satisfaction with the utilities. Rate changes and ordinances mandating water efficient fixtures or behaviors are perceived as unpopular, yet provide significant water saving potential.

Table ES.2 and **Figure ES.1** present the unit costs in dollars per 1,000 gallons saved for the water loss control program and each measure. Note that these costs are based upon assumptions described in Sections 3 and 4 of this report, and will vary under actual implementation conditions. For most Wisconsin utilities of any size, a water loss control program is the most cost-effective and provides the most water savings for the utility's investment. The estimated cost of water saved from water loss control is less than half the cost of water saved through water efficiency measures, given the assumptions used in this analysis. Although water loss control is more cost-effective, there may be non-economic and social considerations that would lead a utility to implement water efficiency measures in addition to water loss control.

Methods for improving water loss control are readily available and offer an affordable alternative to aiming water conservation strategies solely at the end user. Both proactive and reactive control of water losses not only save large quantities of water, but also reduce lost revenues and wasted energy resources by water utilities. This study shows that statewide utilities could potentially save an estimated $6.8 to $19.6 million in avoided costs and recovered revenue per year. The costs of leak repair and detection to recover these costs range from $2.4 to $7.2 million statewide per year. As a result, utilities statewide could potentially realize a net savings of $4.4 to $12.4 million per year as a result of implementing water loss control practices.

While the water loss control programs offer the best return on investment, the water efficiency measures offer up to ten times the water savings.

The estimated energy savings for customers implementing the water efficiency measures range from about $428 to $733 million over the 20 year period of analysis.

Recommendations can be made for statewide initiatives to promote greater water efficiency, improve data gathering, and allow tracking of water use efficiency statewide. These recommendations include:

- Provide utilities with information on reporting practices for calculation and determination of water losses (i.e., apparent losses and real losses), such as the use of the AWWA water loss control software
- Require reporting of meter testing data, annual operating pressure, and other information in annual reports as required for calculation of water loss control performance indicators such as:
  - Apparent loss and real loss per day per connection
  - Real loss per day per mile of main
  - Real loss per day per connection per psi
  - Unavoidable annual real loss
  - Infrastructure leakage index
- Require utilities to utilize the best management practices appropriate for each utility's size and performance indicators as found in the AWWA Water Audits and Loss Control Programs, M36 Publication, to reduce leaks and losses
- Require counties and municipalities to implement stricter building codes that require WaterSense, Energy Star and CEE labels for toilets, urinals, showerheads, faucets, clothes washers, dishwashers, irrigation controllers and other water-using fixtures
- Require utilities to implement water use efficiency measures that are cost-effective within their service areas, such as:
  - Submetering of multi-unit properties
  - Residential and nonresidential property water audits
  - Pre-rinse spray valves for commercial kitchens
- Provide funding or statewide initiatives, particularly among smaller utilities, to promote water use efficiency for measures which may not be cost-effective for individual utilities yet result in significant water savings, such as:
  - Weather-controlled sprinkler system controllers

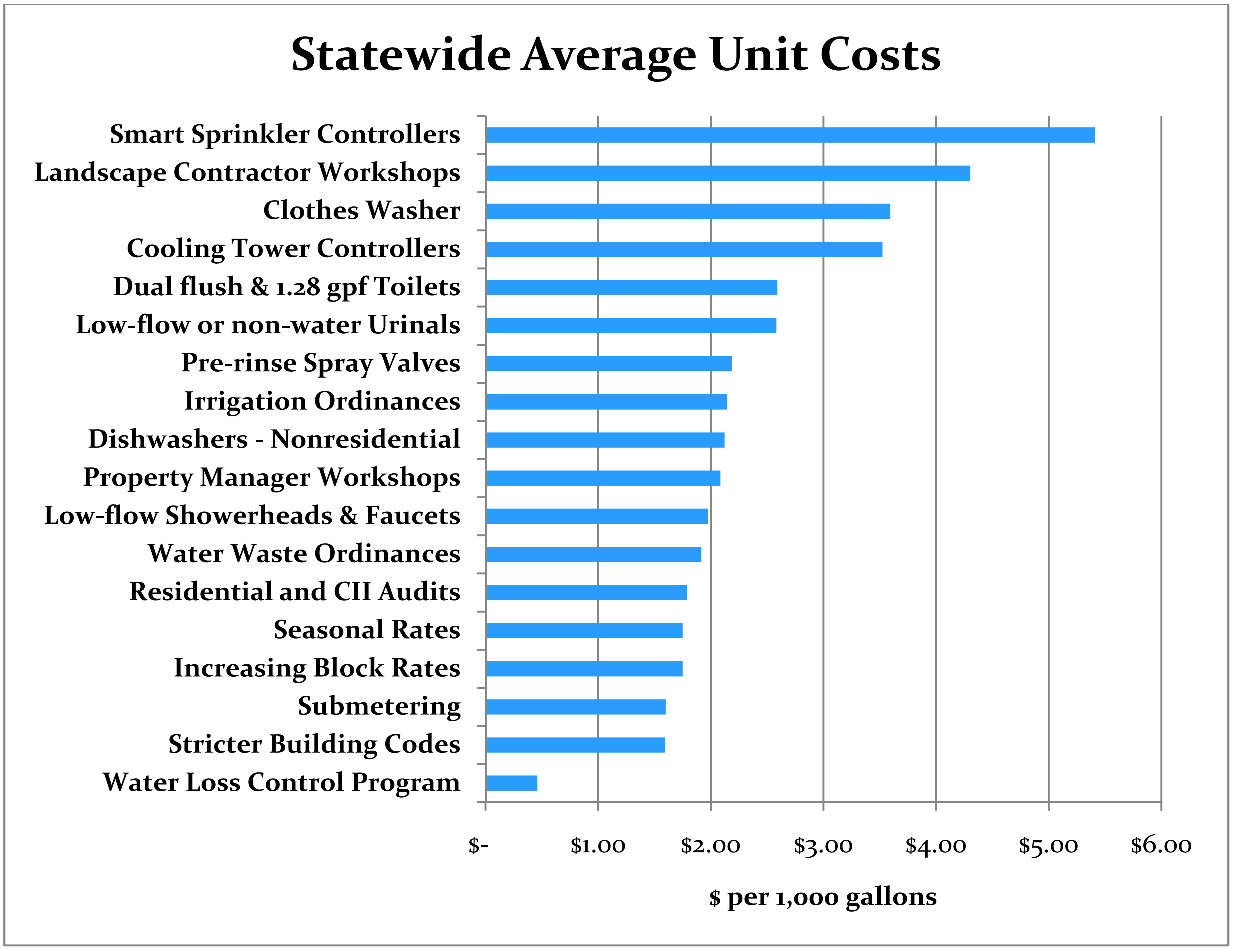
- Cooling tower conductivity controllers
- High-efficiency residential clothes washers
- High efficiency toilets and urinals
- Water efficiency workshops for property managers

- Provide guidance and assistance for utilities in designing and implementing water rates less sensitive to variations in water demand while maintaining a pricing incentive for efficient water use. For example:
  - Shifting a larger portion of revenue to fixed charges to increase revenue stability
  - Establish separate rates by user characteristics (e.g., residential, commercial, industrial)
  - Establish higher rates or surcharges by season or volume for users that drive peak water demand

Table ES.2 Unit Costs in Dollars per 1,000 Gallons

Measure	Large Utility Unit Cost $/kgal	Medium Utility Unit Cost $/kgal	Small Utility Unit Cost $/kgal	Statewide Utility Unit Cost (average) $/kgal
Dual flush & 1.28 gpf Toilets	$2.32	$2.44	$2.71	$2.59
Low-flow or non-water Urinals	$2.10	$2.37	$2.78	$2.58
Low-flow Showerheads & Faucets	$1.83	$1.86	$2.06	$1.98
Dishwashers - Residential	$18.46	$21.14	$24.77	$22.99
Dishwashers - Nonresidential	$1.86	$1.97	$2.25	$2.12
Pre-rinse Spray Valves	$1.88	$2.01	$2.33	$2.19
Clothes Washer	$3.09	$3.39	$3.79	$3.59
Smart Sprinkler Controllers	$4.48	$5.10	$5.74	$5.41
Cooling Tower Controllers	$2.60	$3.17	$3.88	$3.52
Irrigation Ordinances	$1.93	$2.03	$2.24	$2.15
Water Waste Ordinances	$1.76	$1.81	$1.99	$1.92
Stricter Building Codes	$1.52	$1.50	$1.65	$1.59
Submetering	$1.53	$1.51	$1.65	$1.60
Residential and CII Audits	$1.69	$1.69	$1.85	$1.79
Property Manager Workshops	$1.93	$1.97	$2.17	$2.09
Landscape Contractor Workshops	$3.36	$4.07	$4.61	$4.30
Increasing Block Rates	$1.66	$1.65	$1.81	$1.75
Seasonal Rates	$1.66	$1.65	$1.81	$1.75
Water Loss Control Program	$0.46	$0.46	$0.46	$0.46

Figure ES.1 Statewide Average Unit Cost in Dollars per 1,000 Gallons



Note that residential dishwashers ($22.99 per 1000 gallons) are excluded from this chart.

Section 1
Introduction

1.1 Project Overview and Purpose

The Wisconsin Department of Natural Resources (DNR) and the Public Service Commission of Wisconsin (PSC) are jointly developing a statewide water conservation and efficiency program to promote water efficiency and conservation across all water use sectors. This collaboration was initiated through the 2007 Wisconsin Act 227, which implements the Great Lakes—St. Lawrence River Basin Water Resources Compact (Compact). Due to the perceived abundance of water, water utilities have historically met demand growth through development of new surface or groundwater sources. However, reliance on these sources to meet future demand is increasingly risky due to climatological, environmental, regulatory, and demographic uncertainties. A diverse portfolio of water supply options—including water conservation and efficiency—could help address potential water scarcity and cost issues and reliably meet Wisconsin's future water demand while continuing to protect public health, support economic growth, and sustain aquatic resources.

In 2006, the DNR and PSC convened a stakeholder group to discuss demand-side water conservation options available to public water utilities. This effort led to a report that identified a menu of water conservation and efficiency options, including innovative water rates, water use accountability, customer incentives, and public education. Although the 2006 report identified the existing measures and technologies available to utilities, it did not quantify the costs of implementing these measures nor the potential water savings that could be achieved with each.

Additionally, the DNR has promulgated an administrative rule (Wis. Admin. Code NR 852) related to water conservation and water use efficiency that became effective January 1, 2011. NR 852 imposes mandatory water conservation and efficiency measures on new or increased withdrawals of 100,000 gallons per day or more from the waters of the Great Lakes basin and new and increased withdrawals statewide resulting in water loss of 2,000,000 gallons per day or more. Additionally, the rule promotes voluntary statewide water conservation through the identification of water conservation and efficiency measures.

This report provides an objective, statewide analysis to quantify achievable economic water savings under various water conservation and efficiency options. This study will inform the State's comprehensive water management efforts by providing PSC and DNR decision makers with cost effective data for various water conservation measures and technologies when setting water conservation program goals, priorities, and funding levels.

It is important to note that throughout this document, assumptions are made with the intent to be representative of statewide conditions. *The results of this report are estimates meant to be utilized for planning purposes to provide a relative evaluation of the conservation potential in Wisconsin.* Such assumptions may not be representative of any single water provider and are intended to provide a reasonable statewide assessment. It is highly recommended that information contained within this report be modified with individual utility information in order for the results and assessments to be relevant at the utility level.

1.2 Identification of Efficiency Measures to Be Evaluated

As noted, the DNR and PSC convened a stakeholder group to discuss demand-side water conservation options available to public water utilities. Results of this process are documented in: *Water Conservation, A Menu of Demand Side Initiatives for Water Utilities, 2006.* Although the water conservation menu is aimed at utilities, it provides useful information for all water consumers, even those on private wells. The comprehensive list of water conservation initiatives is designed to provide flexibility for Wisconsin water utilities as they work on their own individual water conservation strategies in the following areas:

- **Water Conservation Education** - The report points out that education alone won't maintain water conservation gains, but it is an integral part of any water conservation effort.

- **Water Use Accountability** - Measurement is a key to efficient use of water and Wisconsin utilities, unlike many other states' utilities, have been metering water sales since the early 1900s. The report illustrates the need for continued and new measurement methods that allow for benchmarking and assessment of conservation activities.

- **Water-Saving Hardware** - More efficient plumbing and water flow restrictors are the actions most frequently taken to conserve water because they do not usually rely on the consumer to curtail use on an ongoing basis.

- **Water Conservation Rates** - Pricing signals may be effective tools to help water utilities with water conservation goals and may encourage customers to purchase and use water-conserving appliances and fixtures. However, water utilities and environmental advocates both identified the ability of large industrial water consumers to "opt out" of the utility and build their own wells if water rates are too high as a major barrier to these types of pricing signals.

- **Water Reuse and Recycling** - Using a water supply that meets the minimum quality requirements for the intended purpose provides efficiency and preserves water resources. An example would be the higher quality standards for drinking water versus the standards required for landscape watering.

CDM reviewed the menu of potential water conservation measures in preparation for the statewide assessment of water efficiency and water loss control. The following adjustments were made from the 2006 menu to develop the list of measures for statewide analysis:

- Education programs, such as customer information, bill inserts, websites, media campaigns, speakers' bureaus, school programs, and educational materials are an integral component of any water efficiency program. Dissemination of information on how and why to conserve water sets the stage for participation in water efficiency programs offered by utilities. Education programs alone may result in modest voluntary water savings, although such savings are difficult to measure. For the purpose of this analysis, the costs of education programs are assumed to be included in the program administration costs of individual efficiency measures, and the benefits of education programs are assumed to contribute to the participation rates of measures.

- Water reuse and on-site water recycling are site specific applications. The potential for reducing the demand of potable water through reuse and recycling is dependent upon the availability of potential users of reclaimed and recycled water. An individual utility can assess water demands for irrigation, cooling, and industrial processes, and can conduct an assessment of potential users such as golf courses and local industries to determine the potential for offsetting potable water use. This analysis does not attempt to estimate the statewide potential for reclaimed water and recycled water use.

- Metering and meter testing, leak detection, line replacement, and water loss audits and benchmarks were identified separately in the 2006 menu of measures. These measures collectively are combined and evaluated in this analysis as a single measure of water loss control (WLC).

Some of the water use efficiency measures listed in the 2006 report were combined, or separated for the statewide analysis. In addition, a few measures not on the 2006 menu were added for evaluation. Measures are identified as targeting residential customers; commercial, industrial and institutional (CII) customers, or both. As noted below, some of these measures are evaluated in the assessment of customer satisfaction impacts, but not included in the quantification of costs and savings. This list does not include a description of WLC programs, which are described in detail later in this report.

Dual Flush and 1.28 gpf Toilet Retrofit and Replacement

Toilets are the main source of water use in the average home, accounting for nearly 30 percent of indoor water consumption. The most recent models are called high efficiency toilets, or HETs, and utilize only 1.28 gallons per flush (gpf), a 20 percent reduction from the standard 1.6 gpf version. Additionally, dual flush toilets use 1.6 gpf for solid waste and 0.9 gpf for liquid waste. Retrofit and replacement programs can range from rebates for the purchase of HETs to direct retrofit or replacement of older toilets with HETs in targeted areas. Toilet retrofit programs can target both residential and CII customers.

Low-flow or Non-water Urinal Replacement

Most urinals installed prior to 1994 utilized 1.5 to 5.0 gpf of water (Vickers 2001). Since 1994, all urinals installed in new and remodeled buildings must be 1.0 gpf or less, referred to as Ultra Low Flush (ULF) urinals. Recent developments include High Efficiency Urinals (HEUs) requiring 0.5 gpf or less, and non-water urinals which use a dry drainage system. While water savings from urinals generally apply only to CII settings, CII water use in Wisconsin accounts for approximately 44 percent of total metered water use, and restrooms can account from 5 to 51 percent of a facility’s water demand. Replacement programs can range from rebates for the purchase of HEUs to direct replacement of older fixtures with HEUs in targeted areas.

Low-flow Showerhead and Faucet Replacement

Water use by showerheads is the third largest source of indoor residential water use, averaging 11.6 gallons per capita per day (gpcd). Since 1994, all showerheads installed in new and remodeled homes and buildings have flow rates of 2.5 gpm or less. Recent advancements in water efficiency have resulted in showerheads with a flow rate as low as 1.5 gpm. Faucets installed prior to the Energy Act generally had flow rates of 3.0 gpm; however, the Energy Act mandated a flow rate of 2.5 gpm for all newly installed faucets. Recent high efficiency faucet models have reduced flow rates of 0.5 to 2.2 gpm.

Non-residential buildings can also benefit from replacement of showerheads and faucets. Schools, hotels, hospitals, and institutions with high numbers of these fixtures can see substantial monetary and water saving benefits from fixture replacement. Programs to replace older faucets and showerheads with low-flow models may range from rebates to free handouts of low-flow aerators and showerheads.

Dishwasher Replacement

Dishwashers manufactured from 1980 to 1990 used approximately 14 gallons per load (gpl), while models manufactured from 1990 to 1995 reduced this amount by 3 to 11 gpl. More efficient models continue to be developed with recent models using only 7.0 gpl, as much as a 50 percent reduction in water use from earlier models.

Non-residential dishwashers use significantly more water than residential versions, often using over two-thirds of overall water use in commercial kitchens (Alliance for Water Efficiency, 2010). Water usage among these units generally ranges from 0.33 gallons per rack (gpr) to over 20 gpr. Replacement programs include incentives for the purchase of Energy Star dishwasher models to replace older models that use more water.

Pre-rinse Spray Valves Retrofit and Replacement

Use of a pre-rinse apparatus to loosen food and debris from dishes in commercial kitchens often results in a total water use that is twice the amount of the water used by the dishwashing machine. Older, less efficient versions of pre-rinse spray valves utilize 2 to 5 gpm of water, while all pre-rinse spray valves installed since 1994 in new and remodeled commercial kitchens use 1.6 gpm or less of water. Programs to replace older spray valves with low-flow models may range from rebates to free handouts of new spray nozzles.

Clothes Washer Rebate Program

Early model clothes washing machines prior to 1980 used an average of 56 gpl, with those manufactured from 1980 to 1990 using approximately 51 gpl. Traditional top loading versions currently being produced still use approximately 43 gpl, while new high efficiency top loading versions use an average of 30 gpl. The most recent advancement in design allows customers to choose more efficient front loading models which use an average of only 27 gpl, a nearly 40 percent increase in efficiency over current top loading models.

Substantial savings can also be achieved by non-residential customers that use clothes washers, such as laundromats, hospitals, schools, and institutions. Rebate programs include incentives for the purchase of Energy Star clothes washer models to replace older models that use more water.

Rain Sensor and Weather-based Irrigation Controller Incentive Programs

Weather-based irrigation control technology uses local weather and landscape conditions to modify irrigation schedules to actual conditions on the site or historical weather data. Rain sensors and weather-based controllers allow irrigation to more closely match the water requirements of plants. This irrigation technology can be applied to residential yards, as well as the non-residential landscapes at businesses, golf courses, parks, and schools. Programs may include incentives for the purchase of rain sensors and weather-based irrigation controllers to replace older models that use more water or allow customers to exchange old controllers for new ones.

Incentive Program for Recirculating Cooling Towers with Conductivity Controllers

Many office buildings, hotels, and commercial facilities utilize cooling towers with their central cooling system. Industries with heat-generating industrial processes often use water as the medium to transfer heat away from the machinery. Older, less efficient systems utilize a single-pass system in which water passed through for cooling purposes is then disposed of into the sewer. Recirculating systems are substantially more water efficient than single-pass models leading to an overall reduction in both water and energy costs. In addition, conductivity controllers automatically monitor and control cooling systems, further increasing water efficiency. Recirculating cooling towers and conductivity controllers require a higher level of maintenance in order to best maintain the system and maximize water efficiency. Programs may include incentives for the retrofitting of cooling systems to be recirculating cooling towers with conductivity controllers.

Irrigation Ordinances

Inefficient irrigation practices can cause observed water loss of 20 to 50 percent of outdoor water use. Many cities, counties, and states have implemented irrigation ordinances establishing schedules for outdoor water use. These ordinances not only benefit customers by reducing water bills and eliminating excess water use, but also benefit water utilities by reducing peak demands and reducing the frequency and length of low water pressure in distribution systems. These regulations generally prohibit outdoor irrigation on certain days or during certain times of day (generally periods when risk of evaporation is highest). Ordinances can also prohibit inefficient practices such as watering of any non-growing surface, watering during periods of rain, or allowing runoff onto streets and gutters from excess watering. Irrigation ordinances affect both residential and non-residential customers.

Water Waste Ordinances

Water waste ordinances are a broad term used to identify any rules or regulations enacted to increase water conservation while prohibiting waste or unreasonable use of water. Examples include prohibitions on overwatering of landscapes and use of hoses without shut off valves, or restrictions on the amount of time allotted to repair a leak once a customer is notified of the problem. Water waste ordinances for the non-residential sector include requiring hotels to provide guests the option of having towels and linens washed daily and requiring restaurants to only serve water upon request. Water waste ordinances affect both residential and non-residential customers.

Stricter Building Codes and Enforcement

One way to ensure installation of water efficient fixtures on new construction is to regulate and enforce plumbing codes used to promote water efficiency. Building codes more stringent than national standards can be established and enforced by a building council or public works department and most often include regulations on maximum fixture flow rates and water heaters. Examples of these regulations would include requirements for insulation of hot water pipes, requiring maximum flow rates of 1.28 gpf for toilets, 0.8 gpm for faucets, and 1.5 gpm for showerheads. Reduction in maximum flow rates have the potential to save over 16 percent of indoor water use over standard fixtures required by current standards. Building codes could apply to both the residential and non-residential customers.

Submetering

Ordinances or utility regulations can require submeters for individual units in new and/or existing multi-family accounts. Tenants then receive a direct pricing signal and an incentive to reduce excess water use. A nationwide survey found that submetering of multi-family complexes can reduce water use by 15 percent compared to properties that include water use in the rent. Studies show that the costs can be recovered in 8 to 13 months given the significant decrease in water use among tenants. Incentive programs offered by utilities can offset the cost of installing submeters on existing properties.

Residential and CII Audits

Residential audits generally include measurement of fixture flow rates, evaluation of irrigation systems and landscape needs, and leak detection. Residential audits should be aimed at water users with the largest percent of water use, as well as any customers that report unusually high water bills or request an audit. Commercial and industrial audits are often related to engineering modifications of site-specific water uses such as process water use and cooling use, in addition to sanitary uses. Water efficiency improvements for institutions can include replacement of plumbing fixtures, evaluation of kitchens and irrigation systems, and leak reduction. Typical potential demand reduction estimates from audits range from 15 to 35 percent, if recommendations are implemented and maintained.

Education and Information Programs

Customer education is a critical component of any water conservation program and nearly all water conservation efforts are dependent on public awareness and an understanding of the need for conservation. Providing information which changes water use habits can result in water savings. EPA Conservation Plan Guidelines and other sources estimate a 3 to 5 percent reduction in water use as a result of information and education programs.

Education programs can be incorporated into school curriculums. Community-wide education can focus on a variety of topics including tips for indoor and outdoor water conservation, water-wise landscaping, and general water education. This information can be distributed by means of water bill inserts, brochures, media campaigns, school programs, conservation-based fairs and events, and speakers' bureaus which engage the audience and encourage discussion.

Property Managers Workshops

These workshops are designed to educate multi-family property managers on the importance of water conservation techniques, landscape irrigation efficiency, and the benefits of submetering. Workshops can also be used to introduce and promote any applicable water saving incentives established by the utility. Water savings can be assumed to be 10 to 25 percent among properties managed by those participating in a workshop.

Landscape Contractors Workshops

These workshops are intended for landscape architects and contractors, engineers, planners, parks and recreation staff, and land and resource managers. The workshops provide information on water efficient landscape design and installation, as well as efficient irrigation methods to reduce outdoor water consumption for residential, commercial, and public sectors. Savings of 20 percent of average outdoor use in properties managed by those in attendance can be assumed.

Appropriately Designed Increasing Block Rates

Increasing tiered rate structures are used to allocate costs by the quantity of water used and provide a conservation signal to larger water users. Some utilities use revenues from the highest tier to fund conservation programs. These rate structures also help utilities achieve an overall goal of reduced daily peak and seasonal peak usage. The USEPA Conservation Plan Guidelines estimates that an increasing block-rate structure can lead to a 5 percent overall reduction in water use. A properly designed rate structure can provide adequate revenues to the utility, social equity to low water users, and an incentive to conserve among large users. Increasing block rates can be applied to all residential and some non-residential accounts, although provisions must be made for large CII water users with essential water needs.

Seasonal Rates

Seasonal water rates are a pricing structure in which the cost of water per unit is higher during peak summer months and is intended to encourage efficient outdoor water use during peak seasonal periods. The rate is designed to send a price signal to customers to reduce excess water use and become more conscious of lawn and landscaping water use. The structure can be applied to all residential and non-residential accounts.

Automated Meter Reading Notifications

Automated meter reading (AMR) technologies, both mobile and fixed infrastructure, provide utilities with frequent meter read information. Customers can be notified when spikes or other abnormal patterns in water use occur. These notices alert customers to potential leaks on the customer side of the meter, thus reducing the duration of leaks. AMR notifications apply to all residential and non-residential accounts.

1.3 Organization of the Report

Section 2 of this report describes the methodologies used in this statewide assessment to: (1) evaluate impacts of these measures on customer satisfaction; (2) quantify and evaluate costs and savings associated with these measures; and (3) evaluate water loss control efforts. Section 3 provides details of the water loss control assessment, and Section 4 provides details of the water efficiency measures assessment.

This report uses a variety of metrics to score and rank the water efficiency measures and water loss control programs. These rankings are used to prioritize these measures and programs based upon selected criteria. The ranking and prioritization of measures and programs is presented in Section 5, along with estimates of statewide potential costs and savings.

Finally, Section 6 offers the conclusions of the analysis and a set of recommendations. Recommendations include ways for the State of Wisconsin to promote greater water use efficiency, refine information related to utilities and water conservation, and track water efficiency across the state. In addition, the recommendations offer ways in which individual utilities might customize the data and assumptions used in this analysis to evaluate WLC programs and water efficiency measures for their own service areas.

Appendices are included at the end of this report with detailed information and tables on the customer impact survey, water loss metrics, and water efficiency metrics.

Section 2
Methodology

This section of the report describes the methodologies used to assess customer satisfaction impacts of potential water efficiency measures, evaluate WLC, and evaluate efficiency measures. In addition, the analysis of WLC programs and efficiency measures is evaluated for different size utilities within the state, as well as three different implementation scenarios, as described below.

2.1 Approach for Assessing Customer Satisfaction

One objective of this analysis was to determine the impact to customer service and satisfaction of each measure for users served by public water utilities within specific customer classes. A survey form was developed that described each of the water use efficiency measures identified in Section 1. The survey was administered electronically in June 2011 with a link to the survey form sent by email to water utility managers and clerks. The PSC received 286 responses for a response rate of 50.3 percent.

Respondents were asked to score each measure's perceived impact on their customer service area satisfaction. A subjective evaluation was scored ranging from a positive impact (+2) to no negative impact (zero) to a significant adverse impact (-2). Some measures could target both residential and non-residential (commercial, industrial and institutional, or CII) customers. Therefore, respondents were asked to score potential impacts separately for the residential and CII sectors. Respondents were also asked to identify conservation measures that had already been implemented within their utility service area.

2.2 Approach to Evaluating Water Loss Control

Traditionally, the term "unaccounted-for water (UAW)" has been used to describe the difference between water produced into the system (input) and water delivered (output) to the users. However, this term has a variety of definitions and meanings. The International Water Association (IWA) proposed the term "non-revenue water (NRW)" with a clear definition, as shown in the lower right-hand portion of **Figure 2.1**. (See Alegre H. et al. 2000, *Manual of Best Practice: Performance Indicators for Water Supply Services*. IWA Publishing, London.)

The NRW definition and water audit format was developed by the IWA in 2000 and later adopted by the American Water Works Association (AWWA). The AWWA Water Loss Control Committee developed free software for calculating the NRW of a water system, along with other performance metrics defined by the IWA (see www.awwa.org, search for 'water loss software').

Figure 2.1 International Standard Water Audit Format

<table>
<tr><th colspan="7">International Standard Water Audit Format</th></tr>
<tr><td rowspan="7">Own water</td><td rowspan="10">System Input</td><td>Exported water</td><td rowspan="5">Authorized consumption</td><td rowspan="3">Billed consumption</td><td rowspan="3">Revenue water</td><td>Billed water exported</td></tr>
<tr><td rowspan="9">Water supplied</td><td>Billed metered consumption</td></tr>
<tr><td>Billed unmetered consumption</td></tr>
<tr><td rowspan="2">Unbilled consumption</td><td rowspan="7">Non-revenue water (NRW)</td><td>Unbilled metered consumption</td></tr>
<tr><td>Unbilled unmetered consumption</td></tr>
<tr><td rowspan="5">Water losses</td><td rowspan="2">Apparent losses</td><td>Unauthorized consumption</td></tr>
<tr><td>Meter inaccuracies and data errors</td></tr>
<tr><td rowspan="3">Imported water</td><td rowspan="3">Real losses</td><td>Leakage on mains</td></tr>
<tr><td>Leakage and overflow at storage</td></tr>
<tr><td>Leakage on service connections</td></tr>
</table>

Source: Alegre H. et. Al. IWA 2000 (columns not to scale)

Each column in **Figure 2.1** represents the same total volume of water (100 percent) in the system; the differences among the columns involve various ways to categorize the total volume for analysis. The right column includes detailed classifications of water volumes. The water volumes are not illustrated to scale. Ideally, revenue water should represent the majority of water in the system while NRW is minimized.

Components of NRW include unbilled consumption and water losses. Water loss is comprised of *apparent loss* and *real loss*. As defined by IWA, apparent loss consists of unauthorized consumption (including theft) and meter inaccuracies and data errors. Apparent losses can be reduced through better management practices, enforcement, and a program of meter testing and replacement. The reduction of apparent loss leads to increased revenues at minimal cost to the utility as this water becomes properly metered and billed. Thus, the value of reduced apparent loss is measured by the price at which the water would be billed to customers.

Real loss consists of leakage on mains, leakage and overflows at storage, and leakage at service connections. Real losses from leaks can be further categorized between reported, unreported, and background leaks. Reported leaks are visible leaks and broken mains that can be quickly repaired thus resulting in short duration loss. Unreported leaks are generally not visible at the surface and only detected through line surveys. These leaks are generally sustained loss and therefore larger volume losses before they are repaired. Background leaks are small leaks at joints and fittings and typically not cost-effective to repair.

Water use for firefighting, line flushing, and other authorized, but unbilled use is classified as neither real nor apparent loss, but is included in the computation of NRW as unbilled consumption.

The reduction of real loss does not directly increase revenue except that more water is available within the system, and operating costs may be reduced. Thus there are real savings in water volume and the value of reduced real loss is measured by the variable operating cost required to treat that volume of water.

Even a new or perfectly maintained pressurized distribution system will experience some leakage. The IWA identifies a theoretical minimum amount of water loss that may be expected from any water system. The *unavoidable annual real loss* (UARL) is a function of miles of pipe, number of service connections, average length from main to curb-stop, and average length from curb-stop to meter and system pressure. The AWWA Water Loss Control Committee has developed free software for calculating the UARL of a water system, along with other performance metrics defined by the IWA (see www.awwa.org , search for 'water loss software'). Utility information reported to PSC is used in this statewide analysis with the AWWA Water Audit Software v4.0 to calculate the UARL for utilities within the state as reported in Section 3.

The ratio of real loss to UARL, or the *infrastructure leakage index* (ILI) indicates the extent to which current real loss could be avoidable or resolvable. The appropriate target ILI range for a given utility depends upon financial, operational, and water resources considerations. The AWWA Water Loss Guidelines suggest that systems experiencing an ILI greater than 3.0 should begin to invest in increased leak detection and line replacement programs. The IWA defines the *economic leakage level* (ELL) as the point at which the cost of reducing real loss is equal to the cost of the water saved. That is, it is economical to address real loss as long as the cost of reducing real loss is less than the cost of the treated water being lost. For this statewide analysis, scenarios with different levels of acceptable leakage rates were defined, as described in Section 2.5.

2.3 Approach to Evaluating Water Efficiency Measures

In general, the reduction in water use from the installation of a more efficient fixture, or adoption of more efficient water use behavior and practice, is determined by: (a) the water savings of the new fixture relative to the replaced fixture, as well as (b) the number of replaced fixtures over time. The cost of the new fixture (and associated programs to encourage replacement, installation, etc.) is compared to the value of the water saved (and associated cost savings from reduced water use) to determine if the change is cost-effective.

Water conservation and water use efficiency occur at the end use level. That is, water savings involves either technological change (e.g., replacing a fixture) or a behavioral change (using the fixture less) related to a specific end use. Typical indoor and outdoor end uses of water for residential and nonresidential (CII) water users can be identified. Average rates of water use by end use can be estimated from (a) the average gallons per day per residential or nonresidential customer usage and (b) research on residential and nonresidential water use patterns. For example, the AWWARF Residential End Use Study (1999) provides information on the distribution of water use among single-family households, as shown in **Table 2.1**. Similar studies are available on CII water use.

Table 2.1 Average Residential Single-Family Water Use per Household

End Use	GPD	Distribution
Toilet	30.0	20.4%
Shower	18.9	12.8%
Bath	2.7	1.8%
Faucet	21.7	14.7%
Dishwasher	2.3	1.6%
Washing machine	28.1	19.1%
Urinal	0.0	0.0%
Evaporative cooler	0.1	0.0%
Boiler feed	0.0	0.0%
Processing	0.0	0.0%
Cooling/Condensing	0.0	0.0%
Other indoor	7.5	5.1%
Landscape irrigation	9.5	6.4%
Swimming pool	18.3	12.4%
Vehicle washing	0.9	0.6%
Other outdoor	7.5	5.1%
Total	147.3	100.0%
Indoor	111.19	75.5%
Outdoor	36.12	24.5%

Source: AWWARF 1999.

Once average gallon per day per end use estimates are established and calibrated to average customer usage rates in Wisconsin, the impacts of water efficiency measures can be estimated. CDM used the end use models within its proprietary software, the IWR-MAIN Conservation Manager (CDM proprietary software) to replicate residential and nonresidential average water use per day based upon information obtained from the PSC database and other sources.

The water conservation measures identified in Section 1 were input into the Conservation Manager including measure start and end years, number of participants per year, affected end uses, and the level of efficiency achieved. This information is used to compute shifts in the end use estimates over time resulting in estimated measure savings by sector and end use.

Results of the end use model are then used to develop the benefit-cost analysis of the measures. The IWR-MAIN Conservation Manager includes a module for the calculation of benefit-cost metrics for each measure. Costs associated with each measure, variable water and wastewater operating costs, and potentially deferred system expansion costs and delay rates (all listed below) are input into the model as applicable. A generic generalized capital expansion scenario and set of assumptions were created for the statewide analysis, as described in Section 4.

- Deferred Capacity Expansion:
    - New source of water supply
    - Capacity of water transmission facility
    - Capacity of water treatment plant
    - Capacity of water distribution
    - Capacity of sewage collectors
    - Capacity of sewage treatment
    - Capacity of sewage pumping

- Avoided Variable Costs:
    - Variable energy cost of water
    - Variable chemical cost of water
    - Variable purchased water cost
    - Other variable cost - water
    - Other environmental variable cost - water
    - Variable energy cost - wastewater
    - Variable chemical cost - wastewater
    - Other variable cost - wastewater
    - Other environmental variable cost - wastewater

- Measure Specific Benefits and Costs:
    - Incentives for participant
    - Local tax credit - participant
    - State tax credit - participant
    - Customer hardware and installation cost
    - Cost of program administration
    - Cost of field implementation
    - Other costs to participants
    - Other costs to utilities
    - Cost reduction for heating water

All future dollar values are discounted back to current (year 2010) dollars. The discounting of future dollar values of costs and benefits allows values accrued in different time periods to be evaluated on an equal basis in terms of their present value. The discount rate used to discount future dollar values is typically the cost of capital or the opportunity cost of money. That is, what the dollar amount could earn in its next best investment.

The discounted costs and benefits are used to calculate the net present value, benefit-cost ratio, payback period, and unit cost of water saved metrics for each measure. These metrics can then be used to rank and evaluate the potential measures.

- Net present value (NPV) is defined as all discounted benefits minus all discounted costs. The NPV measures the overall net return on the investment. A measure with a positive NPV is economically viable. The measure with the highest NPV is preferred.

- Benefit-cost ratio (BCR) is defined as all discounted benefits divided by all discounted costs. The BCR measures the magnitude of benefits relative to costs. A conservation measure with a BCR greater than 1.0 is economically viable and has a positive return on the investment. The measure with the highest BCR is preferred.

- The unit cost of water saved is the discounted cost of the measure divided by water savings over the life of the program. This unit cost (dollars per 1,000 gallons) allows water conservation programs to be compared with other sources of water, as well as WLC programs. Any measure that generates a unit cost of water saved less than the cost of alternative or new water supply is preferred.

These economic metrics are used to rank the water efficiency measures and allow comparison with the water loss control programs.

2.4 Development of Generic Large, Medium and Small Systems for Wisconsin

Water efficiency costs and savings, as well as WLC program costs and savings, vary with the size of the utility. Therefore, three generic water utility systems were defined as average utilities in Wisconsin for this statewide analysis. Information obtained from the PSC database and other sources was used to define average number of water customers, water usage and utility costs, and other utility-level information for these three generic utilities. Statistics were calculated to identify average performance indicators both statewide and by utility class (AB, C, and D).

CDM evaluated 2009 annual report responses from 582 water utilities in the State of Wisconsin from an electronic access database provided by Wisconsin PSC. Following analysis of data, outliers were removed in order to obtain a realistic statewide average. In cases where inaccurate data were found, data for utility with inaccuracies was completely removed from the analysis. CDM assumes the many of these inaccuracies are the result of individual utilities reporting values in incorrect units in the annual report. Utilities were removed from analysis based on the following criteria:

- Water Loss $\leq$ 0 (18 utilities)

- Estimated Real Losses $\leq$ 0 (31 utilities)

- Zero connections (1 utility)

- No reported retail costs (12 utilities)

As a result of this refinement, 56 utilities were removed from database. Utility data were separated by utility classes (AB, C, and D) and these summary statistics (totals or averages) were calculated for each class. Following refinement and data filtering, the total number of analyzed utilities was 520, with 72 utilities in class AB, 130 utilities in Class C, and 318 utilities in class D. Throughout the remainder of this report the utility class size is referred to as **Large** (class AB), **Medium** (class C) and **Small** (class D).

This analysis of water savings and costs by utility size provides decision makers with information that may help in determining the appropriateness of programs, measures, and policies for utilities. As noted in the introduction, individual utilities are urged to refine the analyses shown in this report to determine the applicability of measures and programs for their specific service areas.

2.5 Implementation Scenarios

The statewide analysis of WLC programs and efficiency measures is evaluated under three different implementation scenarios, as described below. The WLC programs by utility size are differentiated among the implementation scenarios on the basis of meeting various levels of compliance with non-revenue water benchmarks. The water efficiency measures are differentiated among the implementation scenarios on the basis of economic and acceptability metrics.

2.5.1 Technical Water Efficiency Potential

The technical water efficiency potential scenario reflects the theoretical maximum amount of water savings, assuming immediate implementation of all technologically feasible measures, regardless of cost-effectiveness. For the water loss control programs, technical water efficiency potential is defined as the elimination of all leaks and losses statewide, with the exception of UARL. That is, utilities would provide sufficient WLC programs to reduce losses to their individual UARL benchmark.

For the water efficiency measures, the utilities would implement all of the measures identified in Section 1 regardless of cost-effectiveness. Thus the maximum estimated water savings would be achieved.

2.5.2 Economic Water Efficiency Potential

The economic water efficiency potential scenario is a subset of the technical potential scenario which assumes implementation of only the most cost-effective measures and programs. For the WLC programs, technical water efficiency potential is defined as the reduction of water leaks and losses by all utilities to 10 percent. For the water efficiency measures, the utilities would implement all of the measures with a benefit-cost ratio of 1.0 or greater.

2.5.3 Achievable Water Efficiency Potential

The achievable water efficiency potential scenario is a subset of the economic potential scenario and reflects water savings that can be realistically expected. For the WLC programs, technical water efficiency potential is defined as the reduction of water leaks and losses by all utilities to 15 percent. For the water efficiency measures, the utilities would implement all of the measures with a benefit-cost ratio of 1.0 or greater and received positive ratings on the customer satisfaction impact survey.

Section 3
Water Loss Assumptions and Analysis

Water loss control measures are evaluated in this study in concert with water demand management measures to provide a comparison of the cost-effectiveness of the two different approaches to water use efficiency. While water conservation measures focus on water-efficient fixtures and customer education aimed at the end user, it is also important that emphasis be placed on water accounting and loss control by water suppliers. This analysis of water loss control provides the context through which utilities can compare water loss control with water conservation measures and determine where to best invest resources.

Reducing real loss recovers lost revenue and reduces water use; therefore, reducing real water loss is also a water conservation measure. This section analyzes potential water savings that could be achieved by reducing utility water loss (i.e., nonrevenue water, or NRW). The analyses follow a methodology that is recommended by the AWWA Water Loss Control Committee (WLCC). This methodology relies on strictly defined water use categories and water loss performance indicators and is becoming the international water loss accounting standard.

3.1 Data Sources and Assumptions

This section describes the analysis of the data submitted in the 2009 PSC Annual Reports. The reported data was used to calculate water loss performance statistics; compare water loss performance by utility size category; and make recommendations for improving the water audit reporting process.

Data were collected according to the inputs required for the AWWA Water Audit Software. Utility-level data was collected from an electronic access database provided by PSC. Data were queried and aggregated based on the requirements of the water audit software program. Queried data were exported to excel and formulas were added to a final excel spreadsheet to automate calculations of performance indicators for each utility. Data were refined and filtered as described in Section 2.4. Statistics were calculated on the refined data set to identify average performance indicators both statewide and by utility sizes - **Large** (Class AB), **Medium** (Class C), and **Small** (Class D). **Table 3.1**, summarizes the average system characteristics by utility size. **Table 3.2** provides the sources of data for this analysis.

Table 3.1 Average System Characteristics

	No. of Utilities	Production MGD[1]	Deliveries MGD[1]	% Loss[2]	No. of Accounts	Miles of Main
Average Wisconsin Large (AB) System	72	5.063	4.158	18%	17,487	176
Average Wisconsin Medium (C) System	130	0.613	0.507	17%	2,872	37
Average Wisconsin Small (D) System	318	0.113	0.090	20%	504	9
Average Wisconsin System	520	0.930	0.763	18%	3,470	40

1. Excludes wholesale and resale.
2. Weighted average among systems, weighted by production.

Table 3.2 Leaks and Losses Assessment Data Sources and Assumptions

Data Input	Source	Page	Notes
Volume pumped from own sources	2009 PSC Annual Report	W-13	Sum of monthly data for surface water and ground water
Water volume imported	2009 PSC Annual Report	W-13	Sum of monthly data for purchased water
Water volume exported	2009 PSC Annual Report	W-2	Sales for resale (466)
Total water volume supplied	AWWA WLCC Calculation		Volume from own sources + water imported - water exported
Billed metered	2009 PSC Annual Report	W-2	Sum of residential, commercial, industrial, and public authority: metered sales (461)
Billed unmetered	2009 PSC Annual Report	W-2	Sum of residential, commercial, industrial, and public authority: unmetered sales (460)
Unbilled metered	2009 PSC Annual Report	W-2	Interdepartmental Sales (467)
Unbilled unmetered	2009 PSC Annual Report	W-14	Gallons used to flush mains, prevent freezing of lines, fire protection, and other system uses
Apparent losses	2009 PSC Annual Report	W-15	Gallons for unauthorized usage such as vandalism and theft
Real losses	AWWA WLCC Calculation		Total Water Supplied - (Authorized consumption + Apparent Losses)
Water losses	AWWA WLCC Calculation		Apparent Losses + Real Losses
NRW	AWWA WLCC Calculation		Water Losses + Reported Unbilled Consumption
Length of mains	2009 PSC Annual Report	W-19	End of year total aggregation of all mains for each utility. Number of feet was converted to miles.
Number of active and inactive service connections	2009 PSC Annual Report	W-2	Total of No. Customers (column b)
Average length of customer service line	Assumptions per PSC		Assume 150 ft for rural customers (small utilities), 50ft for residential customers (large and medium utilities)
Average operating pressure	WI DNR Sanitary Survey Reports		Zone 1 high and low was averaged to determine average operating pressure. In cases where average psi was not given a statewide-average was applied.
Total annual cost of operating water system	2009 PSC Annual Report	W-1	Total operating Expenses
Customer retail unit cost	Wisconsin PSC		Tariff Data dated 03/16/2011
Variable production cost	2009 PSC Annual Report	W-1	Plant Operation and Maintenance Expenses (differing codes dependant on utility size)

3.2 Calculation of Water Loss Metrics

Analysis was completed to determine water loss performance indicators, as defined by the AWWA's WLCC Water Audit Software. Water loss performance indicators allow public utilities to assess their water loss performance in comparison to other utilities and to target their resources more efficiently to improve the areas of their system that will yield the greatest benefit. For this analysis, two principal types of water loss performance indicators were used, financial and operational, and are discussed below.

3.2.1 Operational Performance Indicators

Operational performance indicators reveal the efficiency of a utility's operations. Operational performance indicators include:

- Apparent loss per service connection per day
- Real loss per service connection per day
- Real loss per mile of main per day
- Real loss per service connection per day per psi pressure
- Unavoidable Annual Real Losses (UARL)
- Infrastructure Leakage Index (ILI)

Direct comparison of total water loss between utilities is not meaningful without taking into account the number of customers and the extent of the service area. To allow comparison between utilities, water loss should be normalized by the number of service connections and/or the miles of main. This is the purpose of performance indicators such as real loss per service connection per day, real loss per mile of main per day, and apparent loss per service connection per day.

For utilities that have a low density of service connections in relation to miles of main (fewer than 32 connections per mile), real losses are normalized by miles of main. These utilities tend to be more rural, with long stretches of main lines, and a majority of real loss generally originates from main breaks and leaks. For utilities that have a higher density of service connections in relation to miles of main (32 or more connections per mile), real losses are normalized by the number of service connections. These utilities tend to be more urban, and a majority of real loss generally originates from customer line breaks and leaks.

The ILI is the dimensionless ratio of total real loss to UARL. UARL is the theoretical minimum level of real water loss that would exist after successful implementation of water loss best management practices. A utility with a low ILI is experiencing a relatively low level of real losses compared to a utility with a high ILI.

The IWA recommends a formula to estimate UARL using miles of main, number of service connections, average length of service connections from curb-stop to meter, and average system water pressure. According to the AWWA, the ILI is the best indicator for comparison of real losses between systems. Unfortunately, two of these parameters (the average length of service connections from curb-stop to meter and the average system water pressure) are not reported on the PSC's Annual Report. Therefore, the UARL (and the ILI) for a given utility is estimated using assumed values for service connection length from curb-stop to meter (50 feet for large and medium utilities, 150 feet for small utilities). For average system water pressure, data was provided by the Wisconsin DNR, but the data set was incomplete. For utilities without average operating pressure data, a statewide average value was assigned (62.75 pounds per square inch). The resulting estimated infrastructure leakage index is not a precise measurement but may be a useful screening tool regarding the real loss performance of utilities and whether further investigation of the level of real losses is warranted.

The UARL formula is intended for utilities with more than 5,000 service connections, average pressure greater than 35 pounds per square inch, and a density of more than 32 service connections per mile. Based on analysis of the PSC database, only 83 of the 521 utilities analyzed currently have more than 5,000 service connections. Therefore, the ILI estimated for many Wisconsin utilities with fewer than 5,000 connections or fewer than 32 service connections per mile may not be an accurate representation of their current leakage index. The ILI values estimated in this analysis are for comparative purposes only. Individual utilities should determine if the ILI is an appropriate metric for their system.

3.2.2 Financial Performance Indicators

Financial performance indicators reveal a utility's efficiency in being compensated for the water it produces. Financial performance indicators include:

- Non-revenue water as percent by volume
- Non-revenue water as percent by cost
- Annual cost of apparent losses
- Annual cost of real losses
- Value of real loss per mile of main per day
- Value of real loss per service connection per day
- Value of apparent loss per service connection per day
- Value of apparent loss per mile of main per day

NRW as a percentage of volume shows the percentage of water entering the distribution system for which the utility does not receive any compensation. This indicator measures financial efficiency in terms of water produced. The value of non-revenue water as a percentage of the total annual cost of running the water system measures financial efficiency in dollar terms.

Table 3.3 and **Figure 3.1** provide a summary of these performance indicators for the State of Wisconsin. Results of baseline leaks and losses analysis show that the statewide annual percentage of overall water losses is 21 percent. For large utilities average losses are 17 percent of total water supplied, for medium utilities losses are estimated at 19 percent, and small utilities losses are 23 percent.

Water loss performance indicators allow public utilities to assess their water loss performance in comparison to other utilities and to target their resources more efficiently to improve the areas of their system that will yield the greatest benefit.

Financial performance indicators reveal a utility's efficiency in being compensated for the water it produces. Non-revenue water as a percentage of corrected input volume shows the percentage of water entering the distribution system for which the utility does not receive any compensation. This indicator measures financial efficiency in terms of water produced. The value of NRW as a percentage of the total annual cost of running the water system measures financial efficiency in dollar terms.

Operational performance indicators reveal the efficiency of a utility's operations. For large Wisconsin utilities the average ILI is only 2.1, for medium utilities the average screening level ILI is 1.78, and for small utilities the average ILI is 1.4 based on data from 2009 Wisconsin PSC Annual Reports. The average real loss for large, medium, and small Wisconsin utilities is 39.05 gallons per connection per day, 35.11 gallons per connection per day, and 39.38 gallons per connection per day, respectively based on data from 2009 Wisconsin PSC Annual Reports.

Compared to the AWWA guidelines for ILI goals (**Table 3.4**) and real loss performance by North American utilities, these statistics seem to indicate that more than half of reporting utilities have excellent real loss control. However, most utilities in Wisconsin practice real loss control in a reactive way (rather than a proactive way), so it is surprising that more than half of the reporting utilities have such excellent real loss performance, particularly in comparison to other North American utilities (see **Table 3.5** for utility comparison).

Because the actual large, medium, and small estimated ILI value is so low (somewhere between 1.4 and 2.1), it appears that most reporting utilities have underestimated actual real loss. Therefore, from comparison to AWWA guidelines and real loss performance by other North American utilities, it appears likely that the actual real loss is underestimated. It is expected that over time, as Wisconsin utilities become more familiar with the water audit process and reporting procedures, the reported values will more accurately represent their actual losses.

Table 3.3 Performance Indicators for Wisconsin Public Water Utilities
(Calculations based on data taken from 2009 PSC Annual Reports)

Large Utilities			
	Performance Indicator	Units	Average from Reported Data
Financial Indicators	Non-revenue water as percent by volume	%	17%
	Non-revenue water as percent by cost	%	26%
	Annual cost of Apparent Losses	$/year	$7,244.81
	Annual cost of Real Losses	$/year	$356,518.88
Operational Efficiency Indicators	Apparent Losses per service connection per day	gal/conn/day	0.55
	Real Losses per service connection per day	gal/conn/day	39.05
	Real Losses per length of main per day	gal/mile/day	3,554
	Real Losses per service connection per day per meter pressure	gal/conn/day/psi	0.6
	Unavoidable Annual Real Losses (UARL)	MG/year	117.31
	Infrastructure Leakage Index (ILI)	--	2.1
Medium Utilities			
	Performance Indicator	Units	Average from Reported Data
Financial Indicators	Non-revenue water as percent by volume	%	19%
	Non-revenue water as percent by cost	%	17%
	Annual cost of Apparent Losses	$/year	$41.51
	Annual cost of Real Losses	$/year	$39,329.22
Operational Efficiency Indicators	Apparent Losses per service connection per day	gal/conn/day	0.02
	Real Losses per service connection per day	gal/conn/day	35.11
	Real Losses per length of main per day	gal/mile/day	2,439
	Real Losses per service connection per day per meter pressure	gal/conn/day/psi	0.55
	Unavoidable Annual Real Losses (UARL)	MG/year	20.27
	Infrastructure Leakage Index (ILI)	--	1.8
Small Utilities			
	Performance Indicator	Units	Average from Reported Data
Financial Indicators	Non-revenue water as percent by volume	%	23%
	Non-revenue water as percent by cost	%	11%
	Annual cost of Apparent Losses	$/year	$10.11
	Annual cost of Real Losses	$/year	$11,568.48
Operational Efficiency Indicators	Apparent Losses per service connection per day	gal/conn/day	0.05
	Real Losses per service connection per day	gal/conn/day	39.38
	Real Losses per length of main per day	gal/mile/day	2,071
	Real Losses per service connection per day per meter pressure	gal/conn/day/psi	0.67
	Unavoidable Annual Real Losses (UARL)	MG/year	5.35
	Infrastructure Leakage Index (ILI)	--	1.4

Figure 3.1 Water Loss Performance Indicators

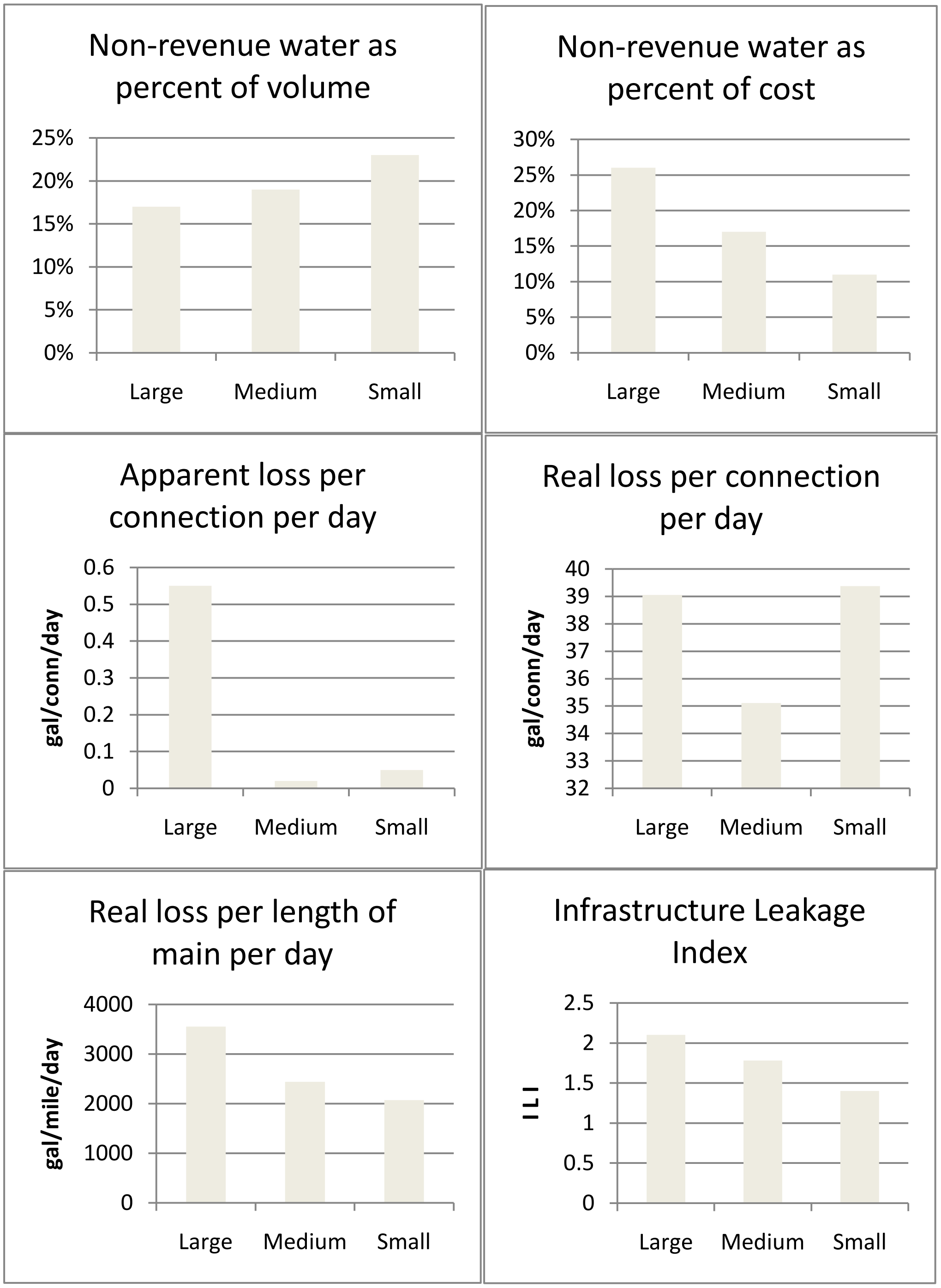


Table 3.4 General Guidelines for Setting a Target Level Infrastructure Leakage Index
(In lieu of having a determination of the system-specific Economic Level of Leakage)

Target ILI Range	Water Resources Considerations	Operational Considerations	Financial Considerations
1.0 – 3.0	Available resources are greatly limited and are very difficult and/or environmentally unsound to develop	Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand	Water resources are costly to develop or purchase Ability to increase revenues via water rates is greatly limited due to regulation or low ratepayer affordability
3.0 – 5.0	Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management, water conservation) are included in the long-term planning	Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place	Water resources can be developed or purchased at reasonable expense Periodic water rate increases can be feasibly effected and are tolerated by the customer population
5.0 – 8.0	Water resources are plentiful, reliable, and easily extracted	Superior reliability, capacity, and integrity of the water supply infrastructure make it relatively immune to supply shortages	Cost to purchase or obtain/treat water is low, as are rates charged to customers
Greater than 8.0	While operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective utilization of water as a resource. Setting a target level greater than 8.0 – other than as an incremental goal to a smaller long-term target – is discouraged.		

Source: AWWA Water Loss Control Committee

Table 3.5 Summary of North American Water Loss Performance for Individual Utilities

Year	Location	State/Province	Performance Indicator			
			Non-Revenue Water (%)	Apparent Loss (gal/conn/day)	Real Loss (gal/conn/day)	ILI
2001	Halifax Central	NS			16	0.9
NA	Seattle	WA			28	
2003	Orlando	FL		17	32	2.2
2002	Anonymous	ON			39	
1999	Anonymous	KY			42	2.7
2004	Los Angeles	CA		36	46	2.2
2003	Salt Lake City	UT	8.5	26	48	2
2003	Anonymous	AZ		20	58	3.3
NA	El Dorado Irrigation District	CA			66	
2002	Anonymous	TX		13	68	4.6
2003	Anonymous	UT		26	68	2.8
NA	Halifax	NS			83	
2004	Cleveland	OH	28.6	54.8	84.5	4.2
NA	Dallas	TX			91	
2002	Nashville	TN		42	93	5.2
2001	Halifax East	NS			95	2.9
NA	Birmingham	AL			98	
2001	Fort Worth	TX		17	108	5.4
2003	Philadelphia	PA		24	129	11.8
2004	Philadelphia	PA	35.4	20.3	132.6	12.2
NA	Philadelphia	PA			151	
2001	Boston	MA		24	160	9
1999	Anonymous	FL			165	11.6
2001	Halifax West	NS			172	11.5
NA	Halifax	NS				4
NA	Fort Worth	TX	14.0			5.4
2004	Fort Worth	TX				5.5
2001	Charlotte County	FL		4		
2003	Halifax	NS		6.4		
2002	Anonymous	ON		37		2.9

Source: Analysis of Water Loss, Texas Water Development Board (2007)

3.3 Estimated Costs and Savings for Defined Levels of Water Loss Control

In an effort to produce the most accurate depiction of the analysis of the leaks and losses analysis, results will be discussed both statewide and by utility size. Results were calculated to illustrate five levels of WLC analysis including:

- **Baseline Analysis**: Calculations completed based on available 2009 PSC Annual Report Data from 520 utilities, as described Section 3.1.
- **PSC Leaks and Losses Compliance Analysis**: Ch. PSC 185 of the Wisconsin Administrative Code establishes compliance standards set forth by PSC of 15 percent allowable losses for large and medium utilities and 25 percent allowable losses for small utilities. Calculations were completed to determine avoided total losses and avoided costs if these standards were met (or exceeded based on current leaks and losses) by all utilities.
- **Technical Water Efficiency Potential Implementation Scenario**: As defined by PSC, the technical water efficiency potential is a measure of the theoretical maximum amount of water savings, assuming immediate implementation of all technologically feasible measures, regardless of cost-effectiveness. Based on this definition, CDM concluded that the technical water efficiency potential could be defined as elimination of all leaks and losses statewide, with the exception of UARL.
- **Economic Water Efficiency Potential Implementation Scenario**: As defined by PSC, the economic water efficiency potential is a measure of a subset of the technical potential which assumes immediate implementation of only the most cost-effective water efficient technology for any given application. Based on this definition, CDM defines economic water efficiency potential criteria as reducing all statewide water leaks and losses by utilities to 10 percent.
- **Achievable Water Efficiency Potential Implementation Scenario**: As defined by PSC, the achievable water efficiency potential is a measure of the amount of water savings that can be realistically expected. Based on this definition, CDM defines achievable water efficiency potential as reducing all statewide water leaks and losses by utilities to 15 percent.

Baseline analysis shows that 57 percent of large utilities (72 analyzed) currently comply with the 15 percent leaks and losses allowance standard enforced by PSC. Additionally, 58 percent of medium utilities (130 analyzed) comply with this standard. Small utilities are given a standard leaks and losses threshold allowance of 25 percent, and analysis shows that 77 percent of these utilities (318 analyzed) comply with this standard. Current leaks and losses analysis based on the 2009 PSC annual reports show that an estimate of nearly $35 million is lost annually as a result of an estimated 31,020 million gallons (MG) of water leaks and losses from Wisconsin public utilities. Based on these results, calculations were completed to determine the total gallons saved and total costs avoided if non-compliant utilities reduced leaks and losses to meet the PSC standards. Results of this analysis show that utilities statewide could potentially save an estimated 5,259 MG of water per year and avoid estimated annual costs of over $6.5 million if PSC compliance standards are met.

The technical water loss control implementation scenario is the most stringent set of evaluation standards. This category of water savings assumes immediate implementation of all water loss control measures regardless of customer and utility costs. While this is not likely a realistic scenario for water loss efficiency in the State of Wisconsin, it does allow exploration of the maximum potential water and cost savings. Technical water efficiency water savings would involve eliminating all leaks and losses statewide with the exception of UARL. Achieving this level of savings would involve repair of all existing leaks as well as replacement of any aging water conveyance structures with significant potential to leak. By eliminating all leaks and losses statewide, with the exception of UARL, utilities could save an estimated 15,654 MG of water per year resulting in estimated avoided annual costs of over $18.5 million.

The economic water loss control implementation scenario involves reducing all leaks and losses statewide to less than 10 percent of total water supplied by utilities. Meeting this standard would involve aggressive implementation of a leaks and losses program to detect and repair all existing leaks and losses in a timely manner. Regulations needed to implement this level of compliance would likely be met with some resistance by utilities and customers, as increased costs of implementation programs may lead to customer water rate increases. By implementing this standard, however, utilities statewide could save an estimated 11,021 MG of water per year, leading to avoided costs of over $14.2 million annually, which could offset the necessary rate increases.

The achievable water loss control implementation scenario is assumed to reduce the overall percentage of leaks and losses for utilities to 15 percent of their total water supplied. While current PSC standards require large and medium utilities to comply with this standard percentage, small utilities must comply with a 25 percent leaks and losses compliance standard. Analysis completed to reduce utilities to the 15 percent leaks and losses standard includes savings from small utilities with leaks and losses percentages currently above this standard, as well as large and medium utilities currently operating with water loss percentages above the 15 percent standard. By implementing and enforcing a 15 percent leaks and losses percentage, the State could save an estimated 5,642 MG of water annually, leading to estimated avoided costs of over $7.2 million.

Based on 2009 PSC report data, some utilities have already met the most stringent set of proposed water loss standards. It was assumed that utilities with water losses below the leaks and losses threshold of each category would have no net additional water savings or avoided costs. A summary of the number of utilities affected by the implementation of water loss control can be viewed in **Table 3.6**.

Table 3.6 Number of Utilities Affected by Implementation and Enforcement of Leaks and Losses Standards
(Data compiled from 2009 PSC Annual Reports)

Implementation Scenario	LARGE UTILITIES		MEDIUM UTILITIES		SMALL UTILITIES		STATEWIDE TOTAL	
	N	% Affected	N	% Affected	N	% Affected	N	% Affected
Number of Utilities	**72**		**130**		**318**		**520**	
PSC Standard Compliance	31	43%	55	42%	72	23%	158	30%
Technical Water Efficiency	60	83%	85	65%	149	47%	294	57%
Economic Water Efficiency	50	69%	88	68%	231	73%	369	71%
Achievable Water Efficiency	31	43%	55	42%	161	51%	247	48%

Average water loss control savings and avoided costs per affected utility were calculated based on each standard category. The average utility statewide is estimated to save between 22,844 MG and 53,246 MG per year based on the specific scenario. These water savings equate to between $29,016 and $62,972 in avoided costs per year. Complete results of this analysis can be seen in **Table 3.7**.

Table 3.7 Average Water Loss Control Savings and Avoided Costs per Affected Utility
(Data compiled from 2009 PSC Annual Reports)

Implementation Scenario	LARGE UTILITIES		MNEDIUM UTILITIES		SMALL UTILITIES		STATEWIDE AVERAGE	
	Water Saved/ Year (MG)	Avoided Costs/ Year	Water Saved/ Year (MG)	Avoided Costs/ Year	Water Saved/ Year (MG)	Avoided Costs/ Year	Water Saved/ Year (MG)	Avoided Costs/ Year
PSC Standard Compliance	132.3	$155,444	16.9	$23,383	3.2	$5,243	33.3	$41,027
Technical Water Efficiency	215.6	$248,283	21.7	$27,925	5.8	$8,342	53.2	$62,972
Economic Water Efficiency	168.2	$206,479	18.5	$24,765	4.3	$7,372	29.9	$38,499
Achievable Water Efficiency	132.3	$155,444	16.9	$23,383	3.8	$6,597	22.8	$29,016

Estimates of average total water losses and costs avoided were also calculated for each utility size. These average totals, as well as statewide average totals, can be viewed in **Table 3.8**.

Table 3.8 Estimated Average Water Savings and Avoided Costs Resulting from Implementation of Leaks and Losses Standards for All Utilities
(Data compiled from 2009 PSC Annual Reports)

Implementation Scenario	LARGE UTILITIES		MEDIUM UTILITIES		SMALL UTILITIES		STATEWIDE AVERAGE	
	Water Saved/ Year (MG)	Avoided Costs/ Year	Water Saved/ Year (MG)	Avoided Costs/ Year	Water Saved/ Year (MG)	Avoided Costs/ Year	Water Saved/ Year (MG)	Avoided Costs/ Year
PSC Standard Compliance	4,100	$4,818,763	928	$1,286,053	231	$377,496	5,259	$6,482,312
Technical Water Efficiency	12,939	$14,896,989	1,848	$2,373,643	868	$1,242,998	15,654	$18,513,630
Economic Water Efficiency	8,411	$10,323,940	1,627	$2,179,333	983	$1,702,943	11,021	$14,206,216
Achievable Water Efficiency	4,100	$4,818,763	928	$1,286,053	614	$1,062,046	5,642	$7,166,862

Costs to utilities for leak repair and detection were based on data from a number of sources including AWWA's 2009 Water Audits and Loss Control Programs Manual, and Thorton's Water Loss Control Manual (AWWA 2009, Thornton 2002). In addition, empirical data from projects managed by Water Accountability, LLC were utilized.

Average leak repair costs were estimated for leaks in hydrants and valves, service lines, and main lines. These average repair costs were estimated to be $250 to $2,000 per leak, as shown in **Table 3.9**. Average repair costs were then combined with the average percent of leaks for each leak type, per system for each leakage category. Results of these calculations show the estimated average cost range to utilities to repair each leak is $500 to $630 per leak systemwide. Complete cost assumptions can be seen in **Table 3.9**.

Additionally, current leak detection costs average $150/mile based on cost of leakage surveys, with a national average of one leak for every three miles of leak detection survey completed. Therefore, leak detection costs are estimated to be $450 per leak. By combining the average costs of leak detection and leak repair, the total estimated average cost of leak repair and detection per leak was found to be $950 to $1,080.

Table 3.9 Estimated Leak Repair and Leak Detection Costs per Leak

Leak Repair Costs			
Leak Types	Average Repair Costs ($)	Leak Percentage/ System	Average Repair Costs/ System ($) (Cost Range * Percentage)
Hydrant/Valves	$250-300	60%	$150-180
Service Lines	$500-600	25%	$125-150
Main Lines	$1500-2000	15%	$225-300
Total	$2250-2900	100%	$500-630
Leak Detection Costs			
	Average Detection Cost ($/Mile)	Average Miles Surveyed per Leak Detected (Miles)	Average Cost/Leak Detected ($)
Leak Surveys	$150	3	$450

The average leak rate (water lost) per unreported leak was also estimated. **Table 3.10** shows average estimated leakage rates. Based on average leak rates for hydrants and valves, service lines, and main lines, an estimated average leak rate of 6,000 gpd for all leak types was calculated. Therefore, assuming that an unreported leak runs for 365 days, the leak would result in a total loss of 2.19 MG per year.

Table 3.10 Estimated Average Daily and Annual Leakage Rates

Leakage Rate for Unreported Leaks		
Leak Types	Leakage Rate (gpd)	Leakage Rate (gallons per year)
Hydrant/Valves	1,000	3,650
Service Lines	5,000	1,825,000
Main Lines	12,000	4,380,000
Average	**6,000**	**2,190,000**

By combining the results of these analyses, the total estimated cost for leak repair and detection per 1,000 gallons was determined. These total costs to utilities were estimated to range from $0.43/1,000 gallons to $0.49/1,000 gallons. Data from this analysis can be viewed in **Table 3.11**.

Table 3.11 Estimated Leak Repair and Detection Costs per 1,000 Gallons of Water

Average Leak Repair (LR) Cost (per leak) (See Table 3.8)	Average Leak Detection (LD) Cost (per leak)	Total Leak Repair and Detection Cost (LR+LD)	Average Annual Leak Rate (gallons per year) (See Table 3.9)	Leak Repair and Detection Costs ($/1000 gallons) (Total LR+LD/ Annual Leak Rate)
$500-630	$450	$950-1080	2,190,000	$0.43-0.49

Estimated leak repair and detection costs per 1,000 gallons were used to calculate WLC costs for utilities by scenario and utility size. These calculations were completed to show total results over a time period of 20 years from 2010 to 2030. The average leak repair and detection cost of $0.46 per 1,000 gallons of water was multiplied by the quantity of water saved by implementation of each of the standards. This calculation resulted in the total program costs for a leaks and losses program adequate to reduce water losses to the thresholds for each evaluation standard. Revenue impacts to utilities were also calculated based on income lost from retail costs. Assuming the 2 percent average apparent losses percentage calculated from PSC data, the average total gallons lost to apparent losses was determined. Calculated apparent losses were multiplied by the average retail cost (by utility size) to determine revenue impacts to utilities.

The approach described in Section 2.3 for evaluating efficiency measures was applied to the water loss control implementation scenarios. The costs of detection and repair, as well as the value of water savings over the planning horizon (from 2010 to 2030) were discounted back to year 2010 dollars. The same discount rate of 6.5 percent used to discount efficiency measures costs and benefits was used to discount the water loss control costs and benefits. This rate is equivalent to the average municipal bond interest rate in Wisconsin.

Net present value is determined by subtracting the discounted cost of detection and repair from the discounted benefits (i.e., the value of water saved). The benefit-cost ratio is determined by dividing the discounted costs by the discounted benefits. The results of these statewide analyses can be viewed in **Table 3.12**. Results further broken down by utility size can be viewed in **Appendix B.**

The estimated benefit-cost ratios ranged from 2.5 to 3.76 across different implementation conditions and utility size. This indicates that the benefits of the water loss control efforts are more than two times the cost. Statewide, investing $29 million to bring utilities into compliance with current PSC standards is estimated to generate over $48 million in benefits, including $4 million in additional revenues to utilities over the 20 year planning period.

Table 3.12 Statewide Benefit-Cost Analysis of Water Loss Control 2010-2030

Implementation Scenarios	STATEWIDE TOTAL				
	Water Saved (GPD)	Leaks and Losses Repair Costs to Utilities (PV)	Revenue Impacts to Utilities (PV)	Net Present Value	Benefit-Cost Ratio
PSC Standard Compliance	14,408,372	$29,074,760	$4,333,258	$48,832,951	2.68
Technical Water Efficiency	42,888,948	$86,545,925	$12,898,671	$135,960,271	2.57
Economic Water Efficiency	30,195,535	$60,931,792	$9,081,181	$109,805,722	2.80
Achievable Water Efficiency	15,458,899	$31,194,626	$4,649,199	$54,940,354	2.76

*PV = Present Value

Section 4
Water Efficiency Measures Assumptions and Analysis

This section follows the methodology described in Section 2 to estimate potential water savings from the water use efficiency measures identified in Section 1. The estimated potential water savings from all measures provides the statewide findings for the technical water efficiency potential scenario.

Typical water use patterns are established for each of the generic utility systems to serve as the basis of evaluating impacts of the water use efficiency measures. Implementation costs are estimated for each measure, and generic avoided costs are estimated by class size. The economic metrics described in Section 2 are evaluated for each measure by utility class size.

Results of the economic analysis allow for a ranking of measures and provide the statewide findings for the economic water efficiency potential scenario. Results of the customer satisfaction impact survey are incorporated with the economic ranking of measures to provide the statewide findings for the achievable water efficiency potential scenario.

4.1 Develop Generic System Profiles

Water conservation and water use efficiency occur at the end use level. That is, water savings involves either technological change (e.g., replacing a fixture) or a behavioral change (using the fixture less) related to a specific end use. Studies documenting water savings from water efficiency measures typically report the water savings as a gallon per day (gpd) savings or as a percent reduction in water use. Most efficiency measures target specific end uses. Some measures such as water rates and building codes may affect multiple end uses. The first step in determining the impact of water use efficiency measures is to establish a baseline water use by end use in the targeted service area.

Average residential and nonresidential water use and number of customers by utility class size were obtained from the 2009 PSC Annual Reports data described in Section 2.4, as shown in **Table 4.1**.

Table 4.1 Average System Accounts, Use and GPD per Account by Utility Size

	Accounts		GPD	% of Use	gpd/acct
Average Wisconsin System Profile (n=520)					
Average Residential	2,229	65%	334,368	39%	150
Average Nonresidential	310	9%	425,277	50%	1,372
Average Other*	909	26%	91,153	11%	100
Total Deliveries	3,448	100%	850,798	100%	247
Average Wisconsin Large (AB) System Profile (n=72)					
Average Residential	11,158	64%	1,792,388	37%	161
Average Nonresidential	1,473	8%	2,377,516	49%	1,614
Average Other*	4,856	28%	636,149	13%	131
Total Deliveries	17,487	100%	4,806,053	100%	275
Average Wisconsin Medium (C) System Profile (n=130)					
Average Residential	1,827	64%	239,583	46%	131
Average Nonresidential	268	9%	268,261	52%	1,001
Average Other*	776	27%	8,782	2%	11
Total Deliveries	2,871	100%	516,626	100%	180
Average Wisconsin Small (D) System Profile (n=318)					
Average Residential	371	74%	42,998	47%	116
Average Nonresidential	64	13%	47,449	52%	741
Average Other*	69	14%	1,431	2%	21
Total Deliveries	504	100%	91,878	100%	182

*Other includes public and private fire, other, resale, and interdepartmental accounts and deliveries.

The average rate of water use by end use was estimated from (a) the average gpd per residential or nonresidential customer usage by utility size in **Table 4.1** and (b) research on residential and nonresidential water use patterns. The resulting estimates of residential and nonresidential water use by end use by utility size are summarized in **Table 4.2**. Data sources for water use by end use included:

- Residential End Uses of Water, American Water Works Research Foundation, 1999.
- California Single-Family Water Use Efficiency Study, Aquacraft, 2011.
- Commercial and Institutional End Uses of Water, American Water Works Research Foundation, 2000.
- Commercial, Institutional, Industrial Water Use & Conservation Baseline Study, Santa Clara Valley Water District, 2008.
- Conservation Potential in Commercial, Industrial and Institutional Sector Indoor Water Use, Los Angeles Department of Water and Power, 2010.

Table 4.2 End Use Assumptions for Wisconsin Utilities

	RESIDENTIAL Per Account			NONRESIDENTIAL Per Account		
	Large	Medium	Small	Large	Medium	Small
	GPD	GPD	GPD	GPD	GPD	GPD
Toilet	29.0	23.6	20.9	322.8	200.2	148.2
Shower	29.0	23.6	20.9	64.6	40.0	29.6
Bath	4.8	3.9	3.5	0.0	0.0	0.0
Faucet	29.0	23.6	20.9	16.1	10.0	7.4
Dishwasher	1.6	1.3	1.2	-	-	-
Prerinse Spray Valve	-	-	-	52.5	32.2	22.8
CII Dishwasher	-	-	-	205.9	128.3	95.9
Washing machine	29.0	23.6	20.9	80.7	50.1	37.1
Water softener	3.2	2.6	2.3	0.0	0.0	0.0
Urinal	0.0	0.0	0.0	64.6	40.0	29.6
Evaporative cooler	0.0	0.0	0.0	0.0	0.0	0.0
Boiler feed	0.0	0.0	0.0	0.0	0.0	0.0
Processing	0.0	0.0	0.0	209.8	130.1	96.3
Cooling/condensing	0.0	0.0	0.0	226.0	140.1	103.7
Other indoor	19.3	15.7	13.9	96.8	60.1	44.5
Landscape irrigation	11.3	9.2	8.1	274.4	170.2	126.0
Swimming pool	1.6	1.3	1.2	0.0	0.0	0.0
Vehicle washing	1.6	1.3	1.2	0.0	0.0	0.0
Other outdoor	1.6	1.3	1.2	0.0	0.0	0.0
Total	161.0	131.0	116.0	1,614.0	1,001.0	741.0
Indoor	144.9	117.9	104.4	1,339.6	830.8	615.0
Outdoor	16.1	13.1	11.6	274.4	170.2	126.0

4.2 Estimated Measure Savings

Once average gpd per end use estimates were established and calibrated to average customer usage rates in Wisconsin, the impacts of water efficiency measures could be estimated. CDM used the end use models within its proprietary software, the IWR-MAIN Conservation Manager to replicate residential and nonresidential average water use per day based upon information obtained from the PSC database and other sources.

The water conservation measures identified in Section 1 were set up within the Conservation Manager with information that identified the measure start and end years, number of participants per year, affected end uses, and the level of efficiency achieved. For the fixture related measures, the start and end years were assumed to be 2010 and 2015, respectively. This assumes that a utility would implement the program over a period of five years. Measures related to ordinances and rates were assumed to start in 2010 and end in 2030, which is the end of the period of analysis (i.e., a 20 year planning period). For all measures, it was assumed that 5 percent of customers within the targeted sector (residential and/or nonresidential) would participate or comply with the measure per year during the active period defined for each measure. Savings and cost estimates will vary depending on implementation assumptions.

In order to estimate the number of customers affected per year, it was necessary to estimate the number of residential and nonresidential customers by utility size for future years. CDM used Wisconsin Department of Administration 2008 data on the number of households by type of municipality. This data provided 2000 Census number of households and 2030 projected number of households for cities, towns and villages. The annualized growth rates for cities, towns and villages were applied to the current number of customers in large, medium and small utilities, respectively to estimate the future number of customers for each generic utility system. These projections are summarized in **Table 4.3**.

Table 4.3 WI DOA 2008 Projections of Households by Community Size Applied to Generic Utility Customers

Cities		Households				
	2000	1,203,968				
	2030	1,492,112				
	0.72% annual growth rate					
Large Utility	Accounts	2010	2015	2020	2025	2030
	Residential	11,158	11,564	11,985	12,422	12,874
	Nonresidential	1,473	1,527	1,582	1,640	1,700
Towns		Households				
	2000	578,127				
	2030	811,008				
	1.13% annual growth rate					
Medium Utility	Accounts	2010	2015	2020	2025	2030
	Residential	1,872	1,981	2,096	2,217	2,346
	Nonresidential	268	284	300	317	336
Villages		Households				
	2000	302,481				
	2030	435,357				
	1.22% annual growth rate					
Small Utility	Accounts	2010	2015	2020	2025	2030
	Residential	371	394	419	445	473
	Nonresidential	64	68	72	77	82

The shift in water use efficiency associated with each measure was also defined. Within the IWR-MAIN Conservation Manager end use model, there are up to three levels of water use efficiency that can be set for a given end use. These three levels of efficiency are defined as nonconserving (NC), conserving (C), and ultra-conserving (UC). For example, the efficiency levels for toilets are set at 3.5 gallons per flush (gpf), 1.6 gpf, and 1.28 gpf, respectively. Associated with the efficiency levels of each end use are the percentages of current customers operating at the respective efficiency levels. For example, it was assumed that among residential customers in Wisconsin, 85 percent have 3.5 gpf toilets, 13 percent have 1.6 gpf toilets, and only 2 percent have 1.28 gpf toilets. These percentages were estimated from 2010 U. S. Census data on year homes were built in Wisconsin. Similar percentages were set for each end use. In many cases, the percentages were set to 33 percent, 33 percent, and 34 percent if the most efficient technology has been on the market for a period of time. In other cases, only two levels of efficiency were set (conserving and ultra-conserving) with the percentages set at 50 percent each, if no other information was available. The assumed 2010 starting levels of efficiency by end uses, sector and utility size are summarized in **Appendix C, Tables C.1 through C.3.** The measure start and end years, targeted sectors and end uses, and types of shifts assumed for each measure are summarized in **Appendix C, Table C.4.**

Water savings occur as customers participate in, or comply with, measures each year. For programs ending in 2015, the estimated water savings increase each year up to 2015 and then remain the same through 2030. Generally there is a degradation of water savings over a long period of time, however, for the purposes of this analysis no degradation was assumed. **Table 4.4** shows the estimated water savings in 2015 and 2030 for each water efficiency measure by utility size. The statewide savings show the estimated technical water efficiency potential savings if all measures were implemented by all utilities. However, it should be noted that it is unrealistic to assume implementation of all measures simultaneously, or that the estimated savings could be achieved without overlapping affects between measures.

Table 4.4 Estimated Water Efficiency Savings per Utility and Statewide Total in Gallons per Day

	Large Utility Savings		Medium Utility Savings		Small Utility Savings		Statewide Total Savings	
	2015	2030	2015	2030	2015	2030	2015	2030
	GPD	GPD	GPD	GPD	GPD	GPD	GPD	GPD
Dual flush & 1.28 gpf toilets	68,476	68,476	9,495	9,495	1,656	1,656	6,691,134	6,691,134
Low-flow or non-water Urinals	13,275	13,275	1,490	1,490	267	267	1,234,553	1,234,553
LF Showerheads & Faucets	69,631	69,631	9,339	9,339	1,646	1,646	6,750,959	6,750,959
Dishwashers - Residential	1,347	1,347	197	197	33	33	133,090	133,090
Dishwashers - Nonresidential	124,830	124,830	14,316	14,316	2,558	2,558	11,662,350	11,662,350
Pre-rinse Spray Valves	23,625	23,625	2,666	2,666	450	450	2,190,844	2,190,844
Clothes Washer	27,449	27,449	3,763	3,763	657	657	2,674,280	2,674,280
Smart Sprinkler Controllers	12,883	12,883	1,779	1,779	310	310	1,257,388	1,257,388
Cooling Tower Controllers	16,065	16,065	1,832	1,832	324	324	1,498,016	1,498,016
Irrigation Ordinances	28,251	37,273	3,382	4,915	596	889	2,663,263	3,605,266
Water Waste Ordinances	42,308	63,881	5,006	8,201	885	1,484	3,978,367	6,137,567
Stricter Building Codes	125,064	304,758	15,878	39,986	2,804	7,117	11,960,560	29,403,936
Submetering	140,860	297,027	19,441	43,379	3,409	7,702	13,753,288	29,474,409
Residential and CII Audits	728,997	728,997	90,081	90,081	15,892	15,892	69,251,971	69,251,971
Property Manager Workshops	287,227	287,227	39,592	39,592	6,942	6,942	28,034,957	28,034,957
Landscape Contractor Workshops	56,502	56,502	6,764	6,764	1,192	1,192	5,326,525	5,326,525
Increasing Block Rates	637,644	662,026	78,725	81,330	13,849	14,296	60,548,643	62,784,903
Seasonal Rates	637,644	662,026	78,725	81,330	13,849	14,296	60,548,643	62,784,903
Total Savings	3,042,077	3,457,300	382,472	440,454	67,321	77,712	290,158,833	330,897,053

All programs are assumed to start in 2010 with 5 percent participation per year.

4.3 Cost Assumptions and Economic Metrics

The estimated water savings shown in **Table 4.4** represent the potential technical water savings from implementation of all of the water efficiency measures. Program implementation costs were estimated for each measure. An average rebate or incentive was estimated for each of the fixture-related measures. Average customer installation costs were assumed for all measures except the irrigation and water waste ordinances, which target behaviors rather than technological change. A program administration cost was estimated for each measure.

Those measures that impact heated water use, such as showers, faucets, dishwashers, and clothes washers, also provide energy savings from reduced water use. The EPA EnergyStar program (www.energystar.gov) and Salt River Project personnel (Collins, 2010) have developed estimates of embedded energy use associated with residential water use. In general, the energy associated with water usage is approximately 23 kilowatt-hours per 1,000 gallons. At a cost of $0.10 per kwh, this is about $2.30 per 1,000 gallons. However, for this analysis a more conservative monthly cost reduction per participant was estimated. The estimated costs associated with each measure are summarized in **Appendix C, Table C.5.**

Additionally, reduced water usage results in reduced water bills for customers and reduced revenues for utilities. The average retail volume charge for water among the large, medium, and small utilities was derived from the 2009 PSC annual reports. The reported rates were converted to 2010 dollars using the consumer price index. The average volume charge of water for the large, medium, and small utilities in 2010 dollars is estimated to be $3.29 to $3.23, and $3.54 per 1,000 gallons, respectively. The average revenue impact of each measure was estimated for each utility size based on the reduced volume of use.

As described in Section 2.3, the annual costs and monetary benefits associated with the implementation of measures in future years must be discounted to their current (present worth) values. Standard economic discounting adjusts future dollar values for the time-value of money (i.e., a dollar today is worth more than a dollar in the future) using a discount rate that is equivalent to the cost of money. For this analysis, a discount rate of 6.5 percent was used. This rate is equivalent to the municipal bond interest rate in Wisconsin in recent years. **Table 4.5** shows the present value of implementation costs, revenue impacts, and estimated energy savings for each measure over the 20 year planning period from the perspective of utilities by size, as well as the statewide total.

The statewide total water savings for the <u>technical water efficiency potential</u> scenario of 330.9 million gallons per day by 2030 are estimated to cost about $391 million dollars over the 20 year period, assuming that all the measures are implemented and can concurrently achieve their estimated savings. The estimated revenue impact suggests that water rates would need to be increased over time if utility revenues are to remain unaffected as savings occur in response to these measures. It is estimated that implementation of all these measures could potentially save customers about $732 million over the next 20 years in energy bills.

Table 4.5 Present Value of Measure Costs by Utility Size and Statewide Total over 20 Years

	Large Present Value Costs + Incentives $	Large Present Value Revenue Impacts $	Large Present Value Customer Energy Savings at $0.10/kwh $	Medium Present Value Costs + Incentives $	Medium Present Value Revenue Impacts $	Medium Present Value Customer Energy Savings at $0.10/kwh $	Small Present Value Costs + Incentives $	Small Present Value Revenue Impacts $	Small Present Value Customer Energy Savings at $0.10/kwh $	Statewide Present Value Costs + Incentives (sum) $	Statewide Present Value Revenue Impacts (sum) $	Statewide Present Value Customer Energy Savings at $0.10/kwh (sum) $
Dual flush & 1.28 gpf toilets	$321,733	$749,303	$ -	$54,515	$101,949	$ -	$10,822	$19,485	$ -	$33,693,263	$73,399,309	$ -
Low-flow or non-water Urinals	$42,478	$145,261	$ -	$7,810	$16,003	$ -	$1,867	$3,145	$ -	$4,667,513	$13,539,397	$ -
LF Showerheads & Faucets	$99,330	$761,938	$147,939	$16,998	$100,278	$25,333	$3,461	$19,371	$5,159	$10,462,030	$74,055,434	$15,585,330
Dishwashers R	$160,867	$16,157	$522,738	$27,258	$2,314	$88,634	$5,411	$427	$17,598	$16,846,631	$1,599,985	$54,755,713
Dishwashers NR	$196,945	$1,365,948	$3,105,783	$36,209	$153,716	$571,416	$8,658	$30,102	$136,641	$21,640,286	$127,903,828	$341,352,360
Pre-rinse Spray Valves	$40,547	$258,516	$258,815	$7,455	$28,627	$47,618	$1,782	$5,300	$11,387	$4,455,353	$24,020,239	$28,446,030
Clothes Washer	$275,311	$329,157	$2,383,820	$46,563	$44,299	$403,361	$9,241	$8,473	$80,057	$28,814,108	$32,152,527	$249,529,979
Smart Sprinkler Controllers	$248,612	$140,977	$ -	$42,125	$19,102	$ -	$8,363	$3,646	$ -	$26,035,703	$13,792,881	$ -
Cooling Tower controllers	$106,196	$175,791	$ -	$19,524	$19,670	$ -	$4,668	$3,818	$ -	$11,668,782	$16,428,207	$ -
Irrigation Ordinances	$80,310	$349,207	$ -	$14,071	$42,641	$ -	$2,880	$8,311	$ -	$8,527,348	$33,329,116	$ -
Water Waste Ordinances	$80,310	$573,787	$ -	$14,071	$68,847	$ -	$2,880	$13,453	$ -	$8,527,348	$54,540,878	$ -
Stricter Building Codes	$80,310	$2,198,993	$ -	$14,071	$ 277,971	$ -	$2,880	$53,986	$ -	$8,527,348	$211,631,275	$ -
Submetering	$70,944	$2,302,154	$ -	$12,309	$319,301	$ -	$2,456	$61,678	$ -	$7,489,089	$226,877,947	$ -
Residential and CII Audits	$331,101	$8,009,760	$147,939	$56,659	$971,635	$25,333	$11,536	$187,846	$5,159	$34,873,432	$762,750,453	$15,585,330
Property Manager Workshops	$584,970	$3,173,325	$261,369	$99,118	$429,245	$44,317	$19,677	$82,478	$8,799	$61,260,478	$310,509,301	$27,377,856
Landscape Contractor Workshops	$662,203	$618,271	$ -	$113,318	$72,631	$ -	$23,072	$14,025	$ -	$69,746,864	$58,417,603	$ -
Increasing Block Rates	$160,620	$ 7,266,439	$ -	$28,142	$878,377	$ -	$5,760	$169,265	$ -	$17,054,695	$691,198,729	$ -
Seasonal Rates	$ 160,620	$7,266,439	$ -	$28,142	$878,377	$ -	$5,760	$169,265	$ -	$17,054,695	$691,198,729	$ -
Total	$3,703,407	$35,701,420	$ 6,828,403	$638,357	$4,424,984	$1,206,012	$131,174	$854,074	$264,799	$391,344,965	$3,417,345,838	$732,632,599

In order to assess the benefits of water efficiency measures to utilities, it is necessary to estimate potential reductions in capital expenditures and variable operating costs that may occur as a result of reduced water production and reduced wastewater treatment. Variable water and wastewater operating costs and potential deferred system expansion costs and delay rates were estimated for each generic utility system. Capital and operating costs associated with new wellfields, water treatment facilities, and wastewater facilities were estimated from PSC benchmark data, as well as the 2007 *Water Supply Cost Estimation Study* conducted by CDM for the South Florida Water Management District. The assumed capital expansion costs and operating costs from various sources were converted to 2010 dollars using the consumer price index for the respective years. Assumed delayed capital costs and avoided operating costs by utility size are shown in **Table 4.6**.

In addition, a delay rate is assumed for each generic utility system. The delay rate represents the number of years a capital expansion can be delayed per volume of water saved. It is a function of the growth rate of water demand (or wastewater treatment) and is typically represented as a value between zero and one. Given the small projected increases in water customers shown in **Table 4.2** above, a maximum value of 1.0 is assumed for small and medium utilities in Wisconsin. For large utilities, a delay rate of 0.17 years per mgd was calculated. For this analysis, all capital expansion projects that could potentially be delayed by reduced water needs were assumed to be on-line in the year 2020 if not delayed.

Table 4.6 Delayed Capital Costs and Avoided Variable Costs by Utility Size

	Large	Medium	Small
Delayed Capital Expansion Costs			
New source of water supply	$660,000	$465,000	$465,000
Capacity of water transmission facility	$2,194,000	$1,460,000	$993,000
Capacity of water treatment plant	$44,362,000	$26,382,000	$15,345,000
Capacity of water distribution	$2,194,000	$1,460,000	$993,000
Capacity of sewage collectors	$10,000,000	$5,000,000	$2,500,000
Capacity of sewage treatment	$75,659,000	$43,603,000	$27,167,000
Capacity of sewage pumping	$2,194,000	$1,460,000	$993,000
Avoided Variable Costs ($ per 1,000 gallons)			
Variable purchased water cost	$2.39	$2.39	$2.39
Variable cost - water	$0.49	$0.64	$0.89
Variable cost - wastewater	$0.79	$0.81	$0.84

The discounted costs and benefits are used to calculate the NPV, benefit-cost ratio, and unit cost of water saved metrics for each measure, as defined in Section 2.3. These metrics are used to rank the potential measures and determine which are economically viable and fall within the economic water efficiency potential scenario. Any measure with a positive NPV is economically viable. Similarly, measures with a benefit-cost ratio (BCR) greater than 1.0 are economically viable. Any measure that generates a unit cost of water saved less than the cost of alternative or new water supply is preferred. For this analysis, the benchmark cost of alternative water supply of $1.86 per 1,000 gallons was assumed, as determined by averaging the wholesale cost of water reported by all utilities in the 2009 Annual Report. Given the generality of the cost assumptions used in this analysis, any measure with a BCR close to 1.0 (i.e., from 0.9 to 1.1), and any measure with a unit cost within about 5 percent of $1.86 per 1,000 gallons were deemed *marginal* and are recommended for closer analysis.

Given these criteria, the color codes shown in **Table 4.7** were developed for characterizing the measures. In addition, the results of the customer satisfaction impact assessment survey were similarly categorized. Results of the customer satisfaction survey are used as indicators of each measure's likely acceptance across all Wisconsin utilities. Thus, incorporation of the survey findings provides the benchmark for identification of the measures within the achievable water efficiency potential scenario.

Results of the economic analysis of measures are presented in detail in **Appendix C** for each utility size and statewide totals. A summary of results of both the economic and achievable scenarios is provided in Section 5.2.

Table 4.7 Coding for Ranking Potential Measures

	Not Good	Marginal	Good
Net Present Value	Less than 0		Greater than 0
Benefit-Cost Ratio	Less than 0.9	0.9 - 1.1	Greater than 1.1
Unit Cost	Greater than $2.00	$1.65 - $2.00	Less than $1.65
Customer Impact	Less than 0	0 - 0.5	Greater than 0.5

Section 5
Findings

The survey of Wisconsin water utility managers and clerks described in Section 2.1 was conducted to gauge the likely effect of conservation measures on customer satisfaction. Respondents were asked to score nineteen water conservation measures as to the likely impact on customer satisfaction ranging from mostly positive to mostly negative. Respondents were also asked to identify conservation measures that have already been implemented in their utility service areas.

5.1 Ranking of Measures by Customer Satisfaction Assessment

The PSC received 286 responses (a 50.3 percent response rate). Results of the survey are described in a PSC memorandum included as **Appendix A** of this report. In general respondents indicated the following:

- Conservation measures in general tend to have a positive effect on customer satisfaction
- Voluntary and incentive-based conservation measures tend to have the most positive effect
- Ordinances, rates and other mandated measures tend to have negative effects on customer satisfaction
- One-third of utilities currently provide some conservation education and information programs for their customers
- Less familiar conservation measures (e.g., cooling tower conductivity controllers, or property manager workshops) tend to have neutral ratings

It was assumed the respondents (i.e., utility managers) have a good understanding of the opinions and attitudes of their community; however, there is the potential for respondents to introduce their own personal biases (pro or con) into the survey responses. There is also a possible 'familiarity' bias among responses. For example, AMR and education programs received high scores for acceptability and are also the most frequently implemented programs. Similarly, programs that have already been implemented may have been given a neutral or negative score. The low score for a pre-rinse spray valve program may be the result of a large-scale energy utility replacement program in the recent past.

Two common concerns were identified by respondents in the open comment section: (1) how to fund conservation programs and (2) the loss of revenue that may occur following the implementation of conservation measures. The first concern suggests that external funding from the state may be required to spur implementation of programs or to inform utilities about conservation programs that may be recovered with rates. The second concern suggests that utilities may need to re-design rate structures to be less sensitive to fluctuations in water consumption.

Results of this survey represent a statewide assessment of potential measures. It is recommended that individual utilities assess the appropriateness and customer acceptability of any program or measure within its service area prior to implementation.

The survey response scores of each measure were averaged as shown in **Appendix A, Table 3**. The statewide average scores were used to categorize the measures as shown in **Figure 5.1**. The average scores are used to rank the measures on the basis of customer impact as shown in **Table 5.1**. For some measures, the residential and non-residential scores are used independently, or are not applicable for both sectors. If the measure is applicable to both sectors the two sector scores are averaged together.

The positive, marginal and negative categories shown in **Figure 5.1** are used in conjunction with the economic metrics to rank and select measures for the achievable water efficiency potential scenario.

Results of this survey represent a statewide assessment of potential measures. It is recommended that individual utilities assess the appropriateness and customer acceptability of any program or measure within its service area prior to implementation. In particular, measures receiving a marginal statewide categorization should be re-evaluated for acceptability within a given service area.

Figure 5.1 Categorization of Survey Scores

<table>
<tr><th>Mostly Positive (2)</th><th colspan="2">Somewhat Positive (1)</th><th colspan="2">No Effect (0)</th><th>Somewhat Negative (-1)</th><th>Mostly Negative (-2)</th></tr>
<tr><td colspan="2">Greater than 0.5
Positive</td><td colspan="3">0 to 0.5
Marginal</td><td colspan="2">Less than zero
Negative</td></tr>
</table>

Table 5.1 Likely Effect of Measures on Customer Satisfaction

Measure	Sector	Sector Score	Average Score
AMR and automatic customer notification	Residential	1.05	1.01
	Non-residential	0.96	
Education and information	Residential	0.86	0.82
	Non-residential	0.77	
Clothes washer rebate	Residential	0.86	0.70
	Non-residential	0.54	
Toilet repair and rebate	Residential	0.65	0.61
	Non-residential	0.56	
Low-flow showerhead and faucet replacement	Residential	0.69	0.57
	Non-residential	0.45	
Dishwasher replacement	Residential	0.52	0.52
	Non-residential	0.36	0.36
Pre-rinse spray valve retrofit and replacement	Non-residential	0.46	0.46
Low-flow or waterless urinal	Non-residential	0.39	0.39
Water audits	Residential	0.36	0.37
	Non-residential	0.38	
Recirculating cooling tower with conductivity controller incentive	Non-residential	0.34	0.34
Property manager workshops	Residential	0.28	0.28
Submetering multifamily accounts	Residential	0.26	0.26
Rain sensor/weather based irrigation controller incentive	Residential	0.21	0.23
	Non-residential	0.24	
Landscape contractor workshops	Residential	0.21	0.22
	Non-residential	0.22	
Inclining block rates for residential customers	Residential	-0.23	-0.23
Water waste ordinance	Residential	-0.30	-0.27
	Non-residential	-0.24	
Lawn watering/outdoor water use ordinance	Residential	-0.38	-0.34
	Non-residential	-0.30	
Seasonal rates	Residential	-0.41	-0.42
	Non-residential	-0.42	
More stringent building codes	Residential	-0.43	-0.45
	Non-residential	-0.47	

Positive	Marginal	Negative

5.2 Ranking of Measures Including Water Loss Control for Large, Medium and Small Systems

The assessment of WLC programs and water use efficiency measures, as well as the customer impact assessment are combined to provide a ranking of all measures and WLC programs. Note that the WLC programs are designated by implementation scenario. The ranking of measures and WLC programs follow the same evaluation criteria and categories as shown in **Section 4, Table 4.7**. Details of the rankings are provided in **Appendix C, Tables C.6, C.7, C.8, and C.9** for the large, medium, small utilities and statewide totals. The rankings of the measures and WLC programs are summarized in **Table 5.2**.

5.3 Identifying Water Loss Control Programs and Measures by Implementation Scenario

Results of the rankings of WLC programs and water efficiency measures shown in **Table 5.2** are used to create groups of programs and measures according to the implementation scenarios defined in Section 2.5.

The technical water efficiency potential scenario reflects the *theoretical maximum* amount of water savings from water efficiency measures *regardless of cost-effectiveness* and the elimination of all leaks and losses statewide, with the exception of UARL.

The economic water efficiency potential scenario is a subset of the technical potential scenario which assumes implementation of *only the most cost-effective* measures, and water loss control programs required for the reduction of water leaks and losses by all utilities to 10-percent.

The achievable water efficiency potential scenario is a subset of the economic potential scenario and reflects water savings that can be *realistically expected*. What is achievable within a given community is dependent upon education, attitudes and understanding of the need to use water efficiently. This will vary from one community to the next. Similarly, more education regarding water efficiency can change attitudes and shift some measures from marginal to acceptable. For the water loss control programs, technical water efficiency potential is defined as the reduction of water leaks and losses by all utilities to 15 percent. For the water efficiency measures, the utilities would implement all measures with a benefit-cost ratio of 1.0 or greater and received positive ratings on the customer satisfaction impact survey.

As indicated in **Appendix C, Tables C.6, C.7, C.8, and C.9**, the measures that qualify for the economic and achievable scenarios vary by utility size and the statewide totals. The qualifying measures are paired with the appropriate WLC program in **Tables 5.3** through **5.5** for the technical, economic and achievable scenarios, respectively.

Measures with marginal economic and satisfaction impact rankings are included in the economic and achievable scenarios, respectively. In addition, state funding of measures, or mandates such as rate increases and ordinances, can potentially provide incentives or requirements that would add potential measures to the list of measures in the achievable scenario.

Table 5.2 Ranking of Measures and WLC Programs by Utility Size and Statewide Total

Large Utility Perspective		Medium Utility Perspective		Small Utility Perspective		Statewide Perspective	
1	Water Loss Control - Economic Efficiency	1	Water Loss Control - Standard Compliance	1	Water Loss Control - Economic Efficiency	1	Water Loss Control - Economic Efficiency
2	Water Loss Control - Standard Compliance	2	Water Loss Control - Achievable Efficiency	2	Water Loss Control - Achievable Efficiency	2	Water Loss Control - Achievable Efficiency
3	Water Loss Control - Achievable Efficiency	3	Water Loss Control - Economic Efficiency	3	Water Loss Control - Standard Compliance	3	Water Loss Control - Standard Compliance
4	Water Loss Control - Technical Efficiency	4	Water Loss Control - Technical Efficiency	4	Water Loss Control - Technical Efficiency	4	Water Loss Control - Technical Efficiency
5	Submetering	5	Submetering	5	Submetering	5	Submetering
6	Stricter Building Codes	6	Stricter Building Codes	6	Increasing Block Rates	6	Stricter Building Codes
7	Increasing Block Rates	7	Increasing Block Rates	7	Seasonal Rates	7	Increasing Block Rates
8	Seasonal Rates	8	Seasonal Rates	8	Stricter Building Codes	8	Seasonal Rates
9	Residential and CII Audits	9	Residential and CII Audits	9	Residential and CII Audits	9	Residential and CII Audits
10	Low-flow Showerheads & Faucets	10	Low-flow Showerheads & Faucets	10	Low-flow Showerheads & Faucets	10	Low-flow Showerheads & Faucets
11	Water Waste Ordinances	11	Water Waste Ordinances	11	Water Waste Ordinances	11	Water Waste Ordinances
12	Dishwashers - Nonresidential	12	Property Manager Workshops	12	Property Manager Workshops	12	Property Manager Workshops
13	Pre-rinse Spray Valves	13	Dishwashers - Nonresidential	13	Dishwashers - Nonresidential	13	Dishwashers - Nonresidential
14	Property Manager Workshops	14	Pre-rinse Spray Valves	14	Pre-rinse Spray Valves	14	Pre-rinse Spray Valves
15	Irrigation Ordinances	15	Irrigation Ordinances	15	Irrigation Ordinances	15	Irrigation Ordinances
16	Low-flow or Non-water Urinals	16	Low-flow or Non-water Urinals	16	Dual flush & 1.28 gpf Toilets	16	Low-flow or Non-water Urinals
17	Dual flush & 1.28 gpf Toilets	17	Dual flush & 1.28 gpf Toilets	17	Low-flow or Non-water Urinals	17	Dual flush & 1.28 gpf Toilets
18	Cooling Tower Controllers	18	Cooling Tower Controllers	18	Clothes Washer	18	Cooling Tower Controllers
19	Clothes Washer	19	Clothes Washer	19	Cooling Tower Controllers	19	Clothes Washer
20	Landscape Contractor Workshops	20	Landscape Contractor Workshops	20	Landscape Contractor Workshops	20	Landscape Contractor Workshops
21	Smart Sprinkler Controllers	21	Smart Sprinkler Controllers	21	Smart Sprinkler Controllers	21	Smart Sprinkler Controllers
22	Dishwashers - Residential	22	Dishwashers - Residential	22	Dishwashers - Residential	22	Dishwashers - Residential

Measure categorization based on utility perspective.

Positive	Marginal	Negative

Table 5.3 2030 Savings and Net Present Value of WLC Program and Efficiency Measures for Technical Implementation Scenario

	Large Utility Savings 2030 GPD	Large Utility Net Present Value $	Medium Utility Savings 2030 GPD	Medium Utility Net Present Value $	Small Utility Savings 2030 GPD	Small Utility Net Present Value $	Statewide Savings 2030 GPD	Statewide Utility Net Present Value (sum) $
Dual flush & 1.28 gpf Toilets	68,476	$(70,996)	9,495	$(1,292)	1,656	$(2,351)	6,691,134	$(6,027,203)
Low-flow or non-water Urinals	13,275	$6,133	1,490	$546	267	$(500)	1,234,553	$353,597
Low-flow Showerheads & Faucets	69,631	$155,635	9,339	$35,353	1,646	$4,961	6,750,959	$17,379,231
Dishwashers - Residential	1,347	$(155,555)	197	$(26,097)	33	$(5,230)	133,090	$(16,255,775)
Dishwashers - Nonresidential	124,830	$260,112	14,316	$44,035	2,558	$4,430	11,662,350	$25,861,454
Pre-rinse Spray Valves	23,625	$45,963	2,666	$7,492	450	$522	2,190,844	$4,449,353
Clothes Washer	27,449	$(167,096)	3,763	$(24,347)	657	$(5,653)	2,674,280	$(16,993,789)
Smart Sprinkler Controllers	12,883	$(201,435)	1,779	$(32,152)	310	$(6,778)	1,257,388	$(20,838,339)
Cooling Tower Controllers	16,065	$(47,368)	1,832	$(9,254)	324	$(3,008)	1,498,016	$(5,570,155)
Irrigation Ordinances	37,273	$37,544	4,915	$8,645	889	$780	3,605,266	$4,075,023
Water Waste Ordinances	63,881	$115,727	8,201	$23,542	1,484	$3,145	6,137,567	$12,392,846
Stricter Building Codes	304,758	$673,167	39,986	$138,539	7,117	$21,392	29,403,936	$73,280,789
Submetering	297,027	$721,077	43,379	$164,187	7,702	$25,399	29,474,409	$81,338,629
Residential and CII Audits	728,997	$2,345,099	90,081	$448,985	15,892	$70,019	69,251,971	$249,481,062
Property Manager Workshops	287,227	$474,627	39,592	$123,911	6,942	$16,080	28,034,957	$55,395,143
Landscape Contractor Workshops	56,502	$(455,310)	6,764	$(75,399)	1,192	$(16,974)	5,326,525	$(47,981,862)
Increasing Block Rates	662,026	$2,267,897	81,330	$428,762	14,296	$67,692	62,784,903	$240,553,719
Seasonal Rates	662,026	$2,267,897	81,330	$428,762	14,296	$67,692	62,784,903	$240,553,719
WLC - Technical Efficiency	590,816	$1,791,781	59,566	$215,420	15,952	$68,072	42,888,948	$135,960,271
Totals	4,048,116	$10,064,898	500,021	$1,899,638	93,664	$309,690	373,786,001	$1,027,407,712

Table 5.4 2030 Savings and Net Present Value of WLC Program and Efficiency Measures for Economic Implementation Scenario

	Large Utility Savings 2030 GPD	Large Utility Net Present Value $	Medium Utility Savings 2030 GPD	Medium Utility Net Present Value $	Small Utility Savings 2030 GPD	Small Utility Net Present Value $	Statewide Savings 2030 GPD	Statewide Utility Net Present Value (sum) $
Low-flow or non-water Urinals	13,275	$6,133	1,490	$546	-	-	1,234,553	$353,597
Low-flow Showerheads & Faucets	69,631	$155,635	9,339	$35,353	1,646	$4,961	6,750,959	$17,379,231
Dishwashers - Nonresidential	124,830	$260,112	14,316	$44,035	2,558	$4,430	11,662,350	$25,861,454
Pre-rinse Spray Valves	23,625	$45,963	2,666	$7,492	450	$522	2,190,844	$4,449,353
Irrigation Ordinances	37,273	$37,544	4,915	$8,645	889	$780	3,605,266	$4,075,023
Water Waste Ordinances	63,881	$115,727	8,201	$23,542	1,484	$3,145	6,137,567	$12,392,846
Stricter Building Codes	304,758	$673,167	39,986	$138,539	7,117	$21,392	29,403,936	$73,280,789
Submetering	297,027	$721,077	43,379	$164,187	7,702	$25,399	29,474,409	$81,338,629
Residential and CII Audits	728,997	$2,345,099	90,081	$448,985	15,892	$70,019	69,251,971	$249,481,062
Property Manager Workshops	287,227	$474,627	39,592	$123,911	6,942	$16,080	28,034,957	$55,395,143
Increasing Block Rates	662,026	$2,267,897	81,330	$428,762	14,296	$67,692	62,784,903	$240,553,719
Seasonal Rates	662,026	$2,267,897	81,330	$428,762	14,296	$67,692	62,784,903	$240,553,719
WLC - Economic Efficiency	460,902	$1,551,509	50,663	$195,407	11,654	$65,084	30,195,535	$109,805,722
Totals	3,735,479	$10,922,386	467,288	$2,048,167	84,927	$347,196	343,512,155	$1,114,920,286

Measures selected based on utility perspective.

Table 5.5 2030 Savings and Net Present Value of WLC Program and Efficiency Measures for Achievable Implementation Scenario

	Large Utility Savings 2030 GPD	Large Utility Net Present Value $	Medium Utility Savings 2030 GPD	Medium Utility Net Present Value $	Small Utility Savings 2030 GPD	Small Utility Net Present Value $	Statewide Savings 2030 GPD	Statewide Utility Net Present Value (sum) $
Low-flow or non-water Urinals	13,275	$6,133	1,490	$546	-	-	1,234,553	$353,597
Low-flow Showerheads & Faucets	69,631	$155,635	9,339	$35,353	1,646	$4,961	6,750,959	$17,379,231
Dishwashers - Nonresidential	124,830	$260,112	14,316	$44,035	2,558	$4,430	11,662,350	$25,861,454
Pre-rinse Spray Valves	23,625	$45,963	2,666	$7,492	450	$522	2,190,844	$4,449,353
Submetering	297,027	$721,077	43,379	$164,187	7,702	$25,399	29,474,409	$81,338,629
Residential and CII Audits	728,997	$2,345,099	90,081	$448,985	15,892	$70,019	69,251,971	$249,481,062
Property Manager Workshops	287,227	$474,627	39,592	$123,911	6,942	$16,080	28,034,957	$55,395,143
WLC - Achievable Efficiency	362,387	$1,136,941	46,208	$187,782	10,456	$58,181	15,458,899	$54,940,354
Totals	1,906,999	$4,008,645	247,072	$1,012,291	45,647	$179,592	164,058,943	$489,198,823

Measures selected based on utility perspective.

5.4 Estimated Statewide Water Efficiency Potential Costs and Savings

Tables 5.3 through **5.5** provide the estimated water savings in the year 2030 and the NPV of each WLC program and water use efficiency measure qualified for each of the three implementation scenarios. The total water savings and implementation costs from each scenario are summarized in **Table 5.6** by utility size and for the statewide total. The present value of program implementation costs are derived from **Section 4, Table 4.5** for the efficiency measures and **Section 3, Table 3.9** for the water loss control program by implementation scenario.

The difference between the technical and economic implementation scenarios shows a small decrease in water savings and a rather significant decrease in implementation costs. This is because the non-cost-effective (i.e., higher cost per gallon saved) measures have been dropped from the economic scenario.

The difference between the economic and achievable implementation scenarios shows a large decrease in water savings and a lesser decrease in implementation costs. This is because some of the more cost-effective measures were deemed to be unfavorable with respect to their impact on customer satisfaction with the utilities. Again, rate changes and ordinances mandating water efficient fixtures or behaviors are perceived as unpopular, yet provide significant water saving potential.

Table 5.6 Summary of Savings and Costs of WLC Program and Efficiency Measures by Implementation Scenario

	Implementation Scenario					
	Technical		Economic		Achievable	
	Savings 2030 GPD	Present Value Costs + Incentives	Savings 2030 GPD	Present Value Costs + Incentives	Savings 2030 GPD	Present Value Costs + Incentives
Large Utility	4,048,116	$4,895,619	3,735,479	$2,858,542	1,906,999	$2,097,579
Medium Utility	500,021	$758,556	467,288	$437,287	247,072	$329,800
Small Utility	93,664	$163,364	84,927	$91,246	45,647	$68,670
Statewide Total	373,786,001	$477,890,889	343,512,155	$265,471,406	164,058,943	$176,042,807

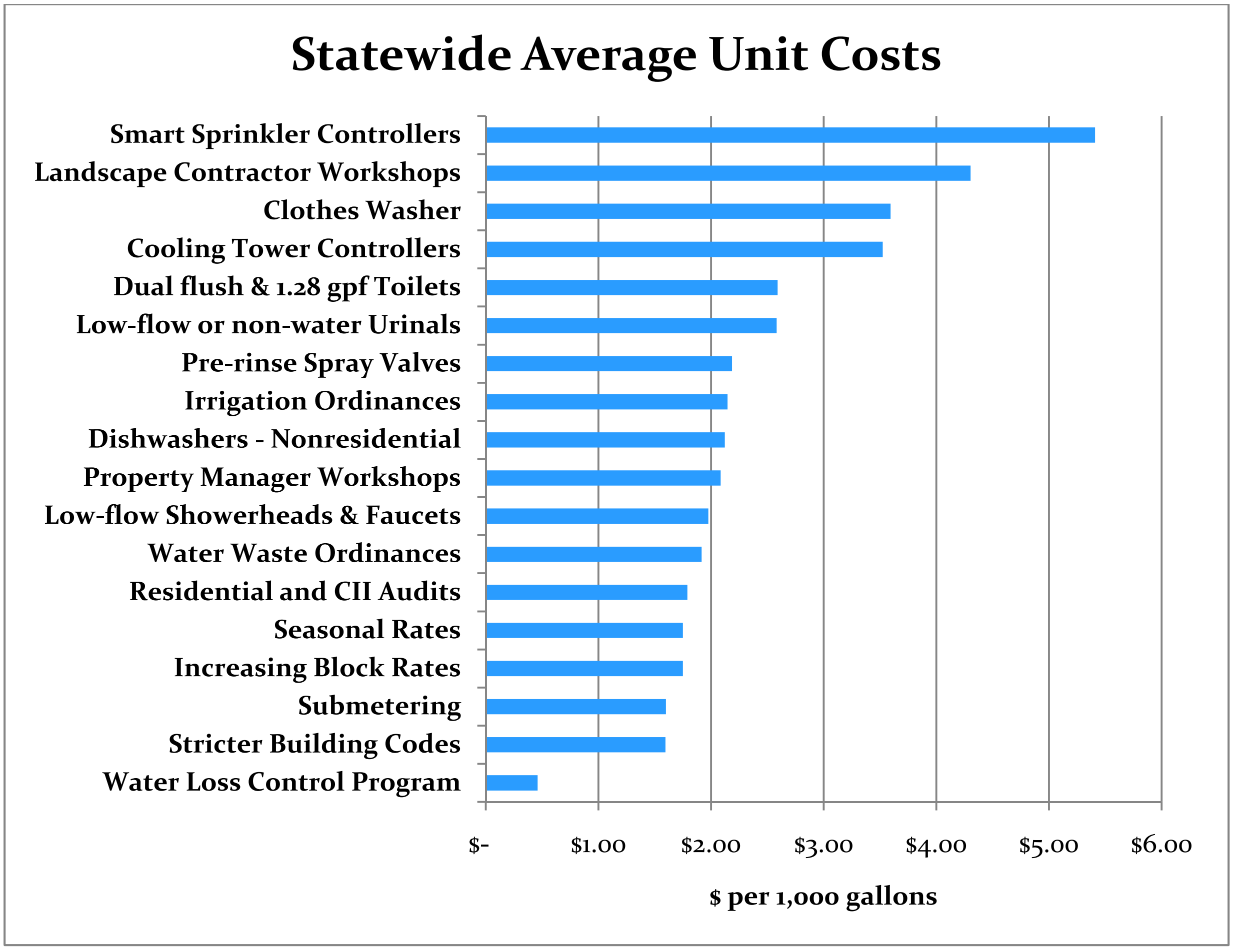
Table 5.7 presents the unit costs in dollars per 1,000 gallons saved for the WLC program and each measure. Note that these costs are based upon assumptions described in Sections 3 and 4, and will vary under actual implementation conditions. For most Wisconsin utilities of any size, a WLC program is the most cost-effective and provides the most water savings for the utility's investment. The estimated cost of water saved from water loss control is less than half the cost of water saved through water efficiency measures, given the assumptions used in this analysis. Although water loss control is more cost-effective, there may be non-economic and social considerations that would lead a utility to implement water efficiency measures in addition to water loss control.

As illustrated in **Figure 5.2**, a number of efficiency measures provide water savings in a range from an estimated $1.59 per 1,000 gallons for stricter building codes to $2.19 per 1,000 gallons for pre-rinse spray valves (note that the residential dishwasher measure is not shown in **Figure 5.2**). The dishwasher measure as evaluated in this analysis provides minimal water savings at a cost of about $20 per 1,000 gallons saved. The true value of the dishwasher replacement program is in the energy savings to the consumer, rather than to the water utility. Many of these measures may be cost-effective for utilities to implement. Individual utilities should assess conditions within their service area, as well as the costs of additional water supply which the utility faces, to determine if a given water efficiency measure is appropriate for implementation.

Table 5.7 Unit Costs in Dollars per 1,000 Gallons

Measure	Large Utility Unit Cost $/kgal	Medium Utility Unit Cost $/kgal	Small Utility Unit Cost $/kgal	Statewide Utility Unit Cost (average) $/kgal
Dual flush & 1.28 gpf Toilets	$2.32	$2.44	$2.71	$2.59
Low-flow or non-water Urinals	$2.10	$2.37	$2.78	$2.58
Low-flow Showerheads & Faucets	$1.83	$1.86	$2.06	$1.98
Dishwashers - Residential	$18.46	$21.14	$24.77	$22.99
Dishwashers - Nonresidential	$1.86	$1.97	$2.25	$2.12
Pre-rinse Spray Valves	$1.88	$2.01	$2.33	$2.19
Clothes Washer	$3.09	$3.39	$3.79	$3.59
Smart Sprinkler Controllers	$4.48	$5.10	$5.74	$5.41
Cooling Tower Controllers	$2.60	$3.17	$3.88	$3.52
Irrigation Ordinances	$1.93	$2.03	$2.24	$2.15
Water Waste Ordinances	$1.76	$1.81	$1.99	$1.92
Stricter Building Codes	$1.52	$1.50	$1.65	$1.59
Submetering	$1.53	$1.51	$1.65	$1.60
Residential and CII Audits	$1.69	$1.69	$1.85	$1.79
Property Manager Workshops	$1.93	$1.97	$2.17	$2.09
Landscape Contractor Workshops	$3.36	$4.07	$4.61	$4.30
Increasing Block Rates	$1.66	$1.65	$1.81	$1.75
Seasonal Rates	$1.66	$1.65	$1.81	$1.75
Water Loss Control Program	$0.46	$0.46	$0.46	$0.46

Figure 5.2 Statewide Average Unit Cost in Dollars per 1,000 Gallons



Note that residential dishwashers ($22.99 per 1000 gallons) are excluded from this chart.

Section 6
Conclusions and Recommendations

This report provides an objective, statewide analysis to estimate and quantify achievable economic water savings under various water conservation and efficiency options. It is important to note that throughout this document, assumptions are made with the intent to be representative of statewide conditions. Such assumptions may not be representative of any single water utility, and are intended to provide a reasonable statewide assessment. It is highly recommended that information contained within this report be modified with individual utility information in order for the results and assessments to be relevant at the utility level

6.1 Conclusions

This section provides a summary of the findings of this analysis with respect to the impact of water efficiency measures on customer satisfaction with utilities, the analysis of efforts by utilities to control water loss, and the analysis of costs and savings of water use efficiency measures that could be implemented in Wisconsin.

As noted, the DNR and PSC convened a stakeholder group to discuss demand-side water conservation options available to public water utilities. Results of this process are documented in: *Water Conservation, A Menu of Demand Side Initiatives for Water Utilities, 2006* and provide the list of water efficiency measures evaluated in the customer satisfaction survey and the analysis of potential savings.

Water efficiency costs and savings, as well as WLC program costs and savings vary with the size of the utility. Therefore, three generic water utility systems were defined as average representative utilities in Wisconsin for this statewide analysis. Statistics were calculated to identify average performance indicators for all utilities statewide, **large** (class AB) utilities, **medium** (class C) utilities, and **small** (class D) utilities.

The performance indicators and metrics were evaluated for three different potential implementation scenarios defined as:

- **Technical** water efficiency potential scenario reflecting the theoretical maximum amount of water savings, assuming immediate implementation of all technologically feasible measures, regardless of cost-effectiveness. WLC program implementation was assumed sufficient to achieve reductions to the level of the UARL benchmark.

- **Economic** water efficiency potential scenario assuming implementation of only the most cost-effective measures and programs from the technical scenario. WLC program implementation was assumed sufficient to achieve reductions to the 10 percent NRW benchmark.

- **Achievable** water efficiency potential scenario reflecting water savings that can be realistically expected, assuming implementation of only those measures from the economic scenario that receive positive ratings on the customer satisfaction impact survey. WLC program implementation was assumed sufficient to achieve reductions to the 15 percent NRW benchmark.

In addition, the WLC program was assessed under a fourth implementation scenario, in which all utilities statewide meet the current PSC water loss standards.

6.1.1 Summary of Customer Impact Survey

A survey was designed to assess the impact to customer service and satisfaction of each measure for residential and non-residential users served by public water utilities. The survey was administered electronically in June 2011 by email to water utility managers and clerks throughout the state. The PSC received a 50.3 percent response rate.

In general respondents indicated the following:

- Conservation measures in general tend to have a positive effect on customer satisfaction
- Voluntary and incentive-based conservation measures tend to have the most positive effect
- Ordinances, rates, and other mandated measures tend to have negative effects on customer satisfaction
- One-third of utilities currently provide conservation education and information programs for their customers
- Measures already implemented tend to receive higher ratings
- Less familiar conservation measures (e.g., cooling tower conductivity controllers, or property manager workshops) tend to have neutral ratings

Two common concerns were identified by respondents in the open comment section: (1) how to fund conservation programs and (2) the loss of revenue that may occur following the implementation of conservation measures. The first concern suggests that external funding from the state may be required to spur implementation of programs. The second concern suggests that utilities may need to re-design rate structures to be less sensitive to fluctuations in water consumption.

6.1.2 Summary of Water Loss Control Assessment

The analysis of WLC efforts in Wisconsin is based upon a water system audit format and water loss metrics established by the IWA and adopted by the AWWA. This format differentiates between apparent loss and real loss components of NRW within a utility system. Based on the results of the statewide analysis of water loss, both real and apparent losses among utilities in Wisconsin provide a great opportunity for improving water efficiency statewide into the future. While the PSC has worked hard to implement water control standards for these utilities, a number of utilities are not currently in compliance. By enforcing compliance standards and bringing all utilities to the current water loss allowance, Wisconsin water utilities could potentially save over 5,000 MG of water statewide in one year. Furthermore, by implementing stricter standards for water loss control, utilities could potentially save over 15,000 MG of water per year.

Methods for improving WLC are readily available and offer an affordable alternative to aiming water conservation strategies solely at the end user. Both proactive and reactive control of water losses not only save large quantities of water, but also reduce lost revenues and wasted energy resources by water utilities. This study shows that statewide utilities could potentially save an estimated $6.8 to $19.6 million in avoided costs and recovered revenue per year. The costs of leak repair and detection to recover these costs range from $2.4 to $7.2 million statewide per year. As a result, utilities statewide could potentially realize a net savings of $4.4 to $12.4 million per year as a result of implementing WLC practices. **Table 6.1** provides a summary of the estimated annual water loss costs and savings.

Table 6.1 Estimated Annual Water and Cost Savings Statewide Resulting from Implementation of Water Loss Control

Implementation Scenarios	STATEWIDE TOTAL				
	Water Saved/ Year (MG)	Avoided Costs/ Year	Revenue Impacts	Water Control Program Costs	Net Benefit
PSC Standard Compliance	5,259	$6,482,312	$360,549	$2,419,166	$4,423,695
Technical Water Efficiency	15,654	$18,513,630	$1,073,234	$7,201,054	$12,385,810
Economic Water Efficiency	11,021	$14,206,216	$755,600	$5,069,830	$9,891,986
Achievable Water Efficiency	5,642	$7,166,862	$386,837	$2,595,549	$4,958,149

Over the period of analysis (2010 to 2030) with a 6.5 percent discount rate, this equates to a net value of $48.8 million to $136.0 million, as shown in **Table 6.2**.

Table 6.2 Statewide Benefit-Cost Analysis of Water Loss Control

Implementation Scenarios	STATEWIDE TOTAL				
	Water Saved (GPD)	Leaks and Losses Repair Costs to Utilities (PV)	Revenue Impacts to Utilities (PV)	Net Present Value	Benefit-Cost Ratio
PSC Standard Compliance	14,408,372	$29,074,760	$4,333,258	$48,832,951	2.68
Technical Water Efficiency	42,888,948	$ 86,545,925	$12,898,671	$135,960,271	2.57
Economic Water Efficiency	30,195,535	$60,931,792	$ 9,081,181	$109,805,722	2.80
Achievable Water Efficiency	15,458,899	$31,194,626	$4,649,199	$54,940,354	2.76

6.1.3 Summary of Water Efficiency Analysis

Water conservation and water use efficiency occur at the end use level. That is, water savings involves either technological change (e.g., replacing a fixture) or a behavioral change (using the fixture less) related to a specific end use. The water use efficiency measures identified for analysis include programs that would: (a) offer incentives, such as rebates, to encourage customers to install new fixtures or water efficient technology, (b) draft ordinances prohibiting wasteful behaviors or requiring the use of advanced water efficiency technologies, or (c) implement water rate structures to promote water use efficiency.

Measures implemented and administered by utilities, such as rebate programs were assumed to be implemented over a five year period from 2010 to 2015. Ordinances and rate structures were assumed to be in effect throughout the period of analysis (2010 to 2030). Program implementation costs include the costs of incentives given to program participants and administrative costs. Benefits to the utilities include avoided costs of expanding water and wastewater treatment facilities, and reduced variable operating costs associated with reductions in water demand. Revenue impacts of reduced water use are considered as a cost to the utility and a benefit to program participants. Assessment from the participant perspective also considers the installation costs and reduced energy costs associated with any fixtures using hot water. The benefit-cost analysis of measures was conducted for both the utility and program participant perspectives.

Over the period of analysis (2010 to 2030) with a 6.5 percent discount rate, the program costs to the utilities range from $391 million to $145 million and generate water savings ranging from 331 million gpd down to 149 million gpd. The net value of the measures from the utility perspective ranges from $1,005 million to $434 million. **Table 6.3** provides a summary of the estimated net present of efficiency measures costs and savings.

The difference between the technical and economic implementation scenarios shows a small decrease in water savings and a significant decrease in implementation costs. This is because the non-cost-effective (i.e., higher cost per gallon saved) measures were dropped from the economic scenario.

The difference between the economic and achievable implementation scenarios shows a large decrease in water savings and a lesser decrease in implementation costs. This is because some of the more cost-effective measures were deemed to be unfavorable with respect to their impact on customer satisfaction with the utilities. Again, rate changes and ordinances mandating water efficient fixtures or behaviors are perceived as unpopular, yet provide significant water saving potential.

The estimated energy savings for customers ranges from about $428 to $733 million over the 20 year period of analysis. There is no difference in customer energy savings between the economic and achievable implementation scenarios as none of the measures were dropped for which energy savings were estimated.

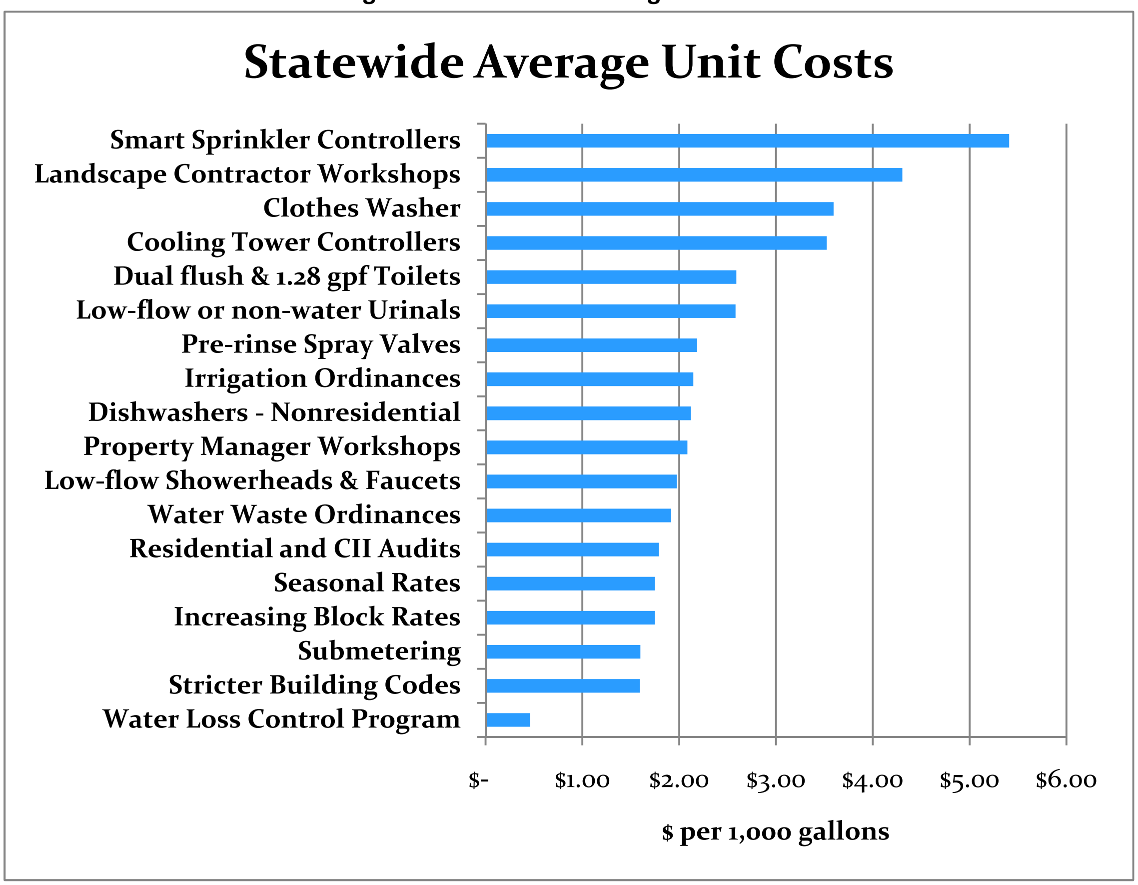
While the water loss control programs offer the best return on investment, the water efficiency measures offer up to ten times the water savings.

Table 6.3 Statewide Benefit-Cost Analysis of Water Use Efficiency Measures

Implementation Scenarios	STATEWIDE TOTAL			
	Water Saved (GPD)	Program Costs to Utilities (PV)	Net Present Value	Customer Energy Savings
Technical Water Efficiency	330,897,053	$391,344,965	$891,447,441	$732,632,599
Economic Water Efficiency	313,316,620	$204,539,614	$1,005,114,565	$428,346,907
Achievable Water Efficiency	148,600,044	$144,848,181	$434,258,468	$428,346,907

The unit cost in dollars per 1,000 gallons saved for the WLC program and each measure provides a standardized metric for comparing all programs, determining which measures are cost-effective, and allows water loss programs and efficiency measures to be compared with new or alternative water supply costs. The WLC program is the most cost effective and provides the most water savings for the investment, as illustrated in **Figure 6.1**. (Note that residential dishwashers are excluded from this chart.) A number of efficiency measures provide water savings in a range from an estimated $1.59 for stricter building codes to $2.19 for pre-rinse spray valves. Many of these measures may be cost-effective for utilities to implement. Individual utilities should assess conditions within their service area, as well as the costs of additional water supply which the utility faces, to determine if a given water efficiency measure is appropriate for implementation.

Figure 6.1 Statewide Average Unit Costs



6.2 Recommendations

As noted previously, assumptions are made throughout this analysis with the intent to be representative of statewide conditions. Such assumptions may not be representative of any single water utility, and are intended to provide a reasonable statewide assessment. It is highly recommended that information contained within this report be modified with individual utility information in order to for the results and assessments to be relevant at the utility level.

Similarly the results of survey of customer satisfaction represent a statewide assessment of potential measures. It is recommended that individual utilities assess the appropriateness and customer acceptability of any program or measure within its service area prior to implementation.

Recommendations can be made for statewide initiatives to promote greater water efficiency, improve data gathering, and allow tracking of water use efficiency statewide. These recommendations include:

- Provide utilities with information on reporting practices for calculation and determination of water losses (i.e., apparent losses and real losses), such as the use of the AWWA water loss control software
- Require reporting of meter testing data, annual operating pressure, and other information in annual reports as required for calculation of water loss control performance indicators such as:
  - Apparent loss and real loss per day per connection
  - Real loss per day per mile of main
  - Real loss per day per connection per psi
  - Unavoidable annual real loss
  - Infrastructure leakage index
- Require utilities to utilize the best management practices appropriate for each utility's size and performance indicators as found in the AWWA Water Audits and Loss Control Programs, M36 Publication, to reduce leaks and losses
- Require counties and municipalities to implement stricter building codes that require WaterSense, Energy Star and CEE labels for toilets, urinals, showerheads, faucets, clothes washers, dishwashers, irrigation controllers and other water-using fixtures
- Require utilities to implement water use efficiency measures that are cost-effective within their service areas, such as:
  - Submetering of multi-unit properties
  - Residential and nonresidential property water audits
  - Pre-rinse spray valves for commercial kitchens
- Provide funding or statewide initiatives, particularly among smaller utilities, to promote water use efficiency for measures which may not be cost-effective for individual utilities yet result in significant water savings, such as:

  - Weather-controlled sprinkler system controllers
  - Cooling tower conductivity controllers
  - High-efficiency residential clothes washers
  - High efficiency toilets and urinals
  - Water efficiency workshops for property managers

- Provide guidance and assistance for utilities in designing and implementing water rates less sensitive to variations in water demand while maintaining a pricing incentive for efficient water use. For example:
  - Shifting a larger portion of revenue to fixed charges to increase revenue stability
  - Establish separate rates by user characteristics (e.g., residential, commercial, industrial)
  - Establish higher rates or surcharges by season or volume for users that drive peak water demand

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Appendix A:

Customer Impact Survey

Water Conservation
Customer Satisfaction Survey

June 2011
Amy Klusmeier, Division of Water, Compliance and Consumer Affairs

The Wisconsin Department of Natural Resources (DNR) and the Public Service Commission of Wisconsin (PSC) are developing a statewide water conservation and efficiency program to promote water efficiency and conservation across all water use sectors. This survey is one element of the joint DNR and PSC Water Conservation Potential Study, scheduled to be completed in September 2011.

In June 2011, the PSC surveyed 569 Wisconsin water utility managers and clerks to gauge the effect of conservation measures on customer satisfaction. The PSC assumed the utility professionals have a good understanding of their communities and would provide responses representative of their customers' interests. However, it is important to recognize the possibility of personal biases in responses. The PSC received 286 responses for a response rate of 50.3%. Respondents were asked to score nineteen water conservation measures as to the likely impact on customer satisfaction ranging from mostly positive to mostly negative (Table 3). Respondents were also asked to identify conservation measures that have already been implemented in their utility service areas.

Notable Findings:

- Most respondents believe that conservation measures will likely have a positive effect on customer satisfaction (Figure 1)
- Voluntary conservation measures (i.e. incentives) will have the most positive effect
- 1/3 of utilities currently provide conservation education and information programs for their customers

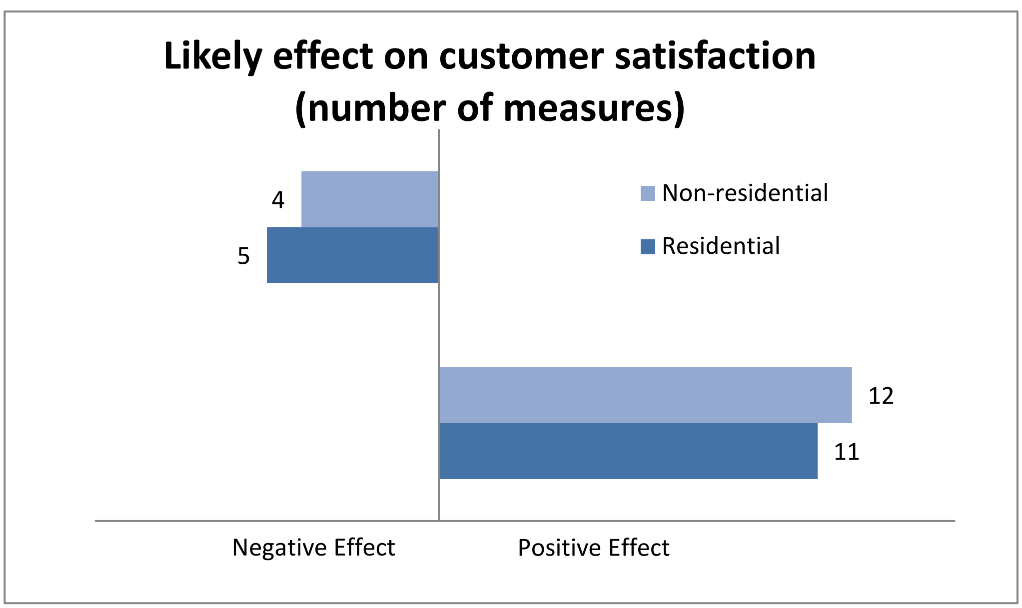

Figure 1: Likely effect of water conservation measures on customer satisfaction

Customer Satisfaction

Programs related to information and education ranked as having the most positive effect on customer satisfaction. The highest ranking measure was the installation of automatic meter reading and the use of automatic customer notifications. Over 70% of respondents indicated a positive impact on both residential and non-residential customers. This measure is also the most commonly implemented throughout the state, as shown in Table 1. The second highest ranked measure was education and information programs. A majority of respondents indicated a positive impact on both residential (73%) and non-residential (66%) customers.

If the high efficiency items are mandated to replace current items the response would be "Mostly Negative."
-Utility Manager

Responses revealed a preference for voluntary and incentive-based conservation programs. Five conservation measures were identified as having a negative effect on customer satisfaction: adoption of an outdoor water use ordinance, a water waste ordinance, more stringent building codes, implementation of inclining block rates for residential customers and seasonal rates for service areas. Of the nineteen conservation measures in the survey, these five were the only measures that would make implementation of water conservation programs mandatory.

Comments and Concerns

Two common concerns were identified by respondents in the open comment section: 1) how to fund conservation programs and 2) the loss of revenue that may occur following the implementation of conservation measures.

Implementation

Respondents indicated that one or more water conservation measures have already been implemented in 174 utility service areas (Table 2). Survey respondents identified a range of implementation mechanisms including water utility rebate programs, municipal ordinances, installation of automated meters and Community Development Authority grant programs. Several respondents also included Focus on Energy and other rebate programs for appliances, illustrating the nexus of water and energy conservation.

We currently offer a dishwasher rebate but it has been based more on the electric savings than water.
-Utility Manager

Table 1: Most Commonly Implemented Conservation Measures

Conservation Measure	Utility Service Areas
Automated meter reading and customer notifications	88
Education and information programs	85
Water audits	43
Submetering multifamily accounts	39
Outdoor water use ordinance	36

Table 2: Implemented Water Conservation Measures

Have you implemented the following measures in your service area?			Response Count
AMR and automatic customer notification	Yes	34.1%	261
	No	65.9%	
Education and information	Yes	33.1%	263
	No	66.9%	
Water audits	Yes	16.9%	261
	No	83.1%	
Submetering multifamily accounts	Yes	14.7%	266
	No	85.3%	
Lawn watering/outdoor water use ordinance	Yes	13.4%	269
	No	86.6%	
Low-flow showerhead and faucet replacement	Yes	6.1%	280
	No	93.9%	
Seasonal rates	Yes	6.1%	261
	No	93.9%	
Water waste ordinance	Yes	4.5%	268
	No	95.5%	
Toilet repair and rebate	Yes	3.5%	285
	No	96.5%	
Inclining block rates for residential customers	Yes	3.4%	263
	No	96.6%	
Clothes washer rebate	Yes	3.3%	273
	No	96.7%	
Dishwasher replacement	Yes	1.8%	275
	No	99.6%	
Recirculating cooling tower with conductivity controller incentive	Yes	1.5%	270
	No	98.5%	
Low-flow or waterless urinal	Yes	1.4%	282
	No	98.6%	
Property manager workshops	Yes	0.8%	264
	No	99.2%	
Landscape contractor workshops	Yes	0.8%	259
	No	99.2%	
Rain sensor/weather based irrigation controller incentive	Yes	0.7%	268
	No	99.3%	
Pre-rinse spray valve retrofit and replacement	Yes	0.4%	273
	No	99.6%	

Table 3 Likely Effect of Water Conservation Measures on Customer Satisfaction

Measures ranked from most positive to most negative. Where applicable, ranking is based on the average of residential and non-residential scores.

			Mostly Positive (2)	Somewhat Positive (1)	No Effect (0)	Somewhat Negative (-1)	Mostly Negative (-2)	Average Points	Response Count
1	**AMR and automatic customer notification**	Residential	35.0%	40.4%	20.4%	3.1%	1.2%	1.05	260
		Non-residential	32.9%	37.4%	24.3%	3.6%	1.8%	0.96	222
2	**Education and information**	Residential	17.7%	55.4%	23.5%	2.3%	1.2%	0.86	260
		Non-residential	15.3%	50.5%	32.0%	0.9%	1.4%	0.77	222
3	**Clothes washer rebate**	Residential	19.9%	54.0%	19.5%	5.4%	1.1%	0.86	261
		Non-residential	13.8%	33.3%	46.7%	5.8%	0.4%	0.54	225
4	**Toilet Repair and Rebate**	Residential	14.3%	47.8%	28.3%	7.7%	1.8%	0.65	272
		Non-residential	11.3%	41.4%	39.7%	6.7%	0.8%	0.56	239
5	**Low-flow showerhead and faucet replacement**	Residential	15.2%	53.5%	18.2%	10.8%	2.2%	0.69	269
		Non-residential	10.9%	33.5%	47.1%	7.2%	1.4%	0.45	221
6	**Pre-rinse spray valve retrofit and replacement**	Residential	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		Non-residential	10.8%	36.8%	42.0%	8.6%	1.9%	0.46	269
7	**Dishwasher replacement**	Residential	9.9%	46.8%	31.9%	8.7%	2.7%	0.52	263
		Non-residential	10.0%	29.6%	48.3%	10.4%	1.7%	0.36	230
8	**Low-flow or waterless urinal**	Residential	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		Non-residential	6.1%	40.1%	42.7%	9.0%	2.2%	0.39	279
9	**Water audits**	Residential	10.8%	42.9%	23.9%	15.8%	6.6%	0.36	259
		Non-residential	12.8%	38.4%	29.2%	13.7%	5.9%	0.38	219

Table 3: Customer Satisfaction Responses, continued

#	Measure	Customer Type	Mostly Positive (2)	Somewhat Positive (1)	No Effect (0)	Somewhat Negative (-1)	Mostly Negative (-2)	Average Points	Response Count
10	**Recirculating cooling tower with conductivity controller incentive**	Residential	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		Non-residential	8.7%	27.0%	56.3%	5.3%	2.7%	0.34	263
11	**Property Manager Workshops**	Multifamily	6.6%	27.2%	56.4%	6.6%	3.1%	0.28	257
12	**Submetering multifamily accounts**	Multifamily	9.8%	34.5%	31.8%	19.3%	4.5%	0.26	264
13	**Rain sensor/weather based irrigation controller incentive**	Residential	5.8%	25.6%	56.6%	8.1%	3.9%	0.21	258
		Non-residential	6.2%	26.5%	56.6%	6.6%	4.0%	0.24	226
14	**Landscape contractor workshops**	Residential	4.6%	25.1%	60.2%	6.9%	3.1%	0.21	259
		Non-residential	5.0%	26.8%	57.7%	6.4%	4.1%	0.22	220
15	**Inclining block rates for residential customers**	Residential	3.1%	23.5%	32.3%	30.0%	11.2%	-0.23	260
		Non-residential	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	**Water waste ordinance**	Residential	2.3%	16.7%	39.5%	31.4%	10.1%	-0.30	258
		Non-residential	2.3%	16.8%	45.5%	25.9%	9.5%	-0.24	220
17	**Lawn watering/outdoor water use ordinance**	Residential	5.7%	17.7%	24.5%	36.6%	15.5%	-0.38	265
		Non-residential	4.5%	13.2%	43.2%	25.5%	13.6%	-0.30	220
18	**Seasonal rates**	Residential	3.5%	18.9%	25.9%	36.3%	15.4%	-0.41	259
		Non-residential	3.2%	15.0%	34.5%	31.4%	15.9%	-0.42	220
19	**More stringent building codes**	Residential	3.8%	16.8%	27.1%	37.4%	14.9%	-0.43	262
		Non-residential	4.0%	12.9%	29.3%	39.6%	14.2%	-0.47	225

Appendix B:

Water Loss Metrics

Appendix B
Benefit-Cost Analysis of Water Loss Control by Utility Size 2010-2030

Implementation Scenario	LARGE UTILITIES				
	Water Saved (GPD)	Leaks and Losses Repair Costs to Utility (PV)	Revenue Impacts to Utility (PV)	Net Present Value	Benefit-Cost Ratio
PSC Standard Compliance	362,387	$731,263	$104,602	$1,136,941	2.55
Technical Water Efficiency	590,816	$1,192,212	$170,538	$1,791,781	2.50
Economic Water Efficiency	460,902	$930,057	$133,039	$1,551,509	2.67
Achievable Water Efficiency	362,387	$731,263	$104,602	$1,136,941	2.55
	MEDIUM UTILITIES				
PSC Standard Compliance	46,208	$93,244	$13,095	$187,782	3.01
Technical Water Efficiency	59,566	$120,199	$16,880	$215,420	2.79
Economic Water Efficiency	50,663	$102,233	$14,357	$195,407	2.91
Achievable Water Efficiency	46,208	$93,244	$13,095	$187,782	3.01
	SMALL UTILITIES				
PSC Standard Compliance	8,791	$ 17,738	$2,730	$45,275	3.55
Technical Water Efficiency	15,952	$ 32,190	$4,954	$ 68,072	3.11
Economic Water Efficiency	11,654	$23,517	$3,620	$65,084	3.77
Achievable Water Efficiency	10,456	$21,100	$3,248	$58,181	3.76

Appendix C:

Water Efficiency Metrics

Table C.1a Residential End Use Assumptions for Large Utilities

END USE	Presence	M1	M2	M3	Comment	S1	S2	S3	Intensity	Comment
Toilet	1.00	3.50	1.60	1.28	gallons per flush	0.85	0.13	0.02	9.050	flushes per day
Shower	1.00	3.50	2.50	1.80	gallons per minute	0.45	0.42	0.13	10.100	minutes per day
Bath	1.00	50.00	50.00	25.00	gallons per event	0.00	0.50	0.50	0.127	events per day
Faucet	1.00	3.50	2.50	1.50	gallons per minute	0.45	0.42	0.13	10.300	minutes per day
Dishwasher	0.75	14.00	10.00	7.00	gallons per load	0.10	0.50	0.40	0.230	loads per day
Washing machine	1.00	55.00	40.00	25.00	gallons per load	0.10	0.50	0.40	0.820	loads per day
Water softener	0.20	25.00	25.00	20.00	gallons per minute	0.00	0.50	0.50	0.700	minutes per day
Urinal	0.00	1.50	1.00	0.00		0.00	0.50	0.50	0.000	
Evaporative cooler	0.00	7.00	7.00	3.00		0.00	0.50	0.50	1.000	
Boiler feed	0.00	100.00	100.00	85.00		0.00	0.50	0.50	0.000	
Processing	0.00	100.00	100.00	85.00		0.00	0.50	0.50	0.000	
Cooling/condensing	0.00	100.00	100.00	85.00		0.00	0.50	0.50	2.600	
Other indoor	1.00	10.00	7.50	5.00	gallons	0.33	0.33	0.34	2.600	
Landscape irrigation	1.00	90.00	76.50	63.00	gallons per 1000 sq.ft	0.50	0.30	0.20	0.140	1000 sq.ft per day
Swimming pool	0.10	500.00	450.00	350.00	gallons per event	0.33	0.33	0.34	0.037	events per day
Vehicle washing	0.50	50.00	50.00	42.50	gallons per event	0.00	0.50	0.50	0.070	events per day
Other outdoor	1.00	10.00	7.50	5.00	gallons	0.33	0.33	0.34	0.210	

Table C.1b Nonresidential End Use Assumptions for Large Utilities

END USE	Presence	M1	M2	M3	Comment	S1	S2	S3	Intensity	Comment
Toilet	1.00	3.50	1.60	1.28	gallons per flush	0.85	0.13	0.02	100.500	flushes per day
Shower	0.50	3.50	2.50	1.80	gallons per minute	0.30	0.50	0.20	48.500	minutes per day
Bath	0.05	50.00	50.00	25.00	gallons per event	0.00	0.50	0.50	0.000	events per day
Faucet	1.00	3.50	2.50	1.50	gallons per minute	0.30	0.50	0.20	6.200	minutes per day
Prerinse Spray Valve	0.10	5.00	2.00	1.50	gallons per minute	0.50	0.50	0.00	150.000	minutes per day
CII Dishwasher	0.10	20.00	10.00	1.00	gallons per load	0.50	0.40	0.10	146.000	loads per day
Washing machine	0.10	55.00	40.00	25.00	gallons per load	0.30	0.50	0.20	19.500	loads per day
Water softener	0.75	25.00	25.00	20.00	gallons per minute	0.50	0.50	0.00	0.000	minutes per day
Urinal	1.00	1.50	1.00	0.00	gallons per flush	0.40	0.50	0.10	59.000	flushes per day
Evaporative cooler	0.00	7.00	7.00	3.00		0.33	0.33	0.34	0.000	
Boiler feed	0.75	100.00	100.00	85.00		0.33	0.33	0.34	0.000	
Processing	0.75	100.00	100.00	85.00		0.33	0.33	0.34	2.950	
Cooling/condensing	0.25	100.00	100.00	85.00		0.33	0.33	0.34	9.520	
Other indoor	1.00	10.00	7.50	5.00	gallons	0.33	0.33	0.34	12.900	
Landscape irrigation	1.00	90.00	76.50	63.00	gallons per 1000 sq.ft	0.33	0.33	0.34	3.590	1000 sq.ft per day
Swimming pool	0.10	500.00	450.00	350.00	gallons per event	0.33	0.33	0.34	0.000	events per day
Vehicle washing	0.10	50.00	50.00	42.50	gallons per event	0.50	0.50	0.00	0.000	events per day
Other outdoor	1.00	10.00	7.50	5.00	gallons	0.33	0.33	0.34	0.030	

Table C.2a Residential End Use Assumptions for Medium Utilities

END USE	Presence	M1	M2	M3	Comment	S1	S2	S3	Intensity	Comment
Toilet	1.00	3.50	1.60	1.28	gallons per flush	0.85	0.13	0.02	7.400	flushes per day
Shower	1.00	3.50	2.50	1.80	gallons per minute	0.45	0.42	0.13	8.300	minutes per day
Bath	1.00	50.00	50.00	25.00	gallons per event	0.00	0.50	0.50	0.100	events per day
Faucet	1.00	3.50	2.50	1.50	gallons per minute	0.45	0.42	0.13	8.300	minutes per day
Dishwasher	0.75	14.00	10.00	7.00	gallons per load	0.10	0.50	0.40	0.200	loads per day
Washing machine	1.00	55.00	40.00	25.00	gallons per load	0.10	0.50	0.40	0.670	loads per day
Water softener	0.20	25.00	25.00	20.00	gallons per minute	0.00	0.50	0.50	0.550	minutes per day
Urinal	0.00	1.50	1.00	0.00		0.00	0.50	0.50	0.000	
Evaporative cooler	0.00	7.00	7.00	3.00		0.00	0.50	0.50	1.000	
Boiler feed	0.00	100.00	100.00	85.00		0.00	0.50	0.50	0.000	
Processing	0.00	100.00	100.00	85.00		0.00	0.50	0.50	0.000	
Cooling/condensing	0.00	100.00	100.00	85.00		0.00	0.50	0.50	0.000	
Other indoor	1.00	10.00	7.50	5.00	gallons	0.33	0.33	0.34	2.100	
Landscape irrigation	1.00	90.00	76.50	63.00	gallons per 1000 sq.ft	0.50	0.30	0.20	0.114	1000 sq.ft per day
Swimming pool	0.10	500.00	450.00	350.00	gallons per event	0.33	0.33	0.34	0.030	events per day
Vehicle washing	0.50	50.00	50.00	42.50	gallons per event	0.00	0.50	0.50	0.056	events per day
Other outdoor	1.00	10.00	7.50	5.00	gallons	0.33	0.33	0.34	0.180	

Table C.2b Nonresidential End Use Assumptions for Medium Utilities

END USE	Presence	M1	M2	M3	Comment	S1	S2	S3	Intensity	Comment
Toilet	1.00	3.50	1.60	1.28	gallons per flush	0.85	0.13	0.02	62.500	flushes per day
Shower	0.50	3.50	2.50	1.80	gallons per minute	0.30	0.50	0.20	30.000	minutes per day
Bath	0.05	50.00	50.00	25.00	gallons per event	0.00	0.50	0.50	0.000	events per day
Faucet	1.00	3.50	2.50	1.50	gallons per minute	0.30	0.50	0.20	3.800	minutes per day
Prerinse Spray Valve	0.10	5.00	2.00	1.50	gallons per minute	0.50	0.50	0.00	92.000	minutes per day
CII Dishwasher	0.10	20.00	10.00	1.00	gallons per load	0.50	0.40	0.10	91.000	loads per day
Washing machine	0.10	55.00	40.00	25.00	gallons per load	0.30	0.50	0.20	12.100	loads per day
Water softener	0.75	25.00	25.00	20.00	gallons per minute	0.50	0.50	0.00	0.000	minutes per day
Urinal	1.00	1.50	1.00	0.00	gallons per flush	0.40	0.50	0.10	36.000	flushes per day
Evaporative cooler	0.00	7.00	7.00	3.00		0.33	0.33	0.34	1.000	
Boiler feed	0.75	100.00	100.00	85.00		0.33	0.33	0.34	0.000	
Processing	0.75	100.00	100.00	85.00		0.33	0.33	0.34	1.830	
Cooling/condensing	0.25	100.00	100.00	85.00		0.33	0.33	0.34	5.900	
Other indoor	1.00	10.00	7.50	5.00	gallons	0.33	0.33	0.34	8.030	
Landscape irrigation	1.00	90.00	76.50	63.00	gallons per 1000 sq.ft	0.33	0.33	0.34	2.230	1000 sq.ft per day
Swimming pool	0.10	500.00	450.00	350.00	gallons per event	0.33	0.33	0.34	0.000	events per day
Vehicle washing	0.10	50.00	50.00	42.50	gallons per event	0.50	0.50	0.00	0.000	events per day
Other outdoor	1.00	10.00	7.50	5.00	gallons	0.33	0.33	0.34	0.001	

Table C.3a Residential End Use Assumptions for Small Utilities

END USE	Presence	M1	M2	M3	Comment	S1	S2	S3	Intensity	Comment
Toilet	1.00	3.50	1.60	1.28	gallons per flush	0.85	0.13	0.02	6.500	flushes per day
Shower	1.00	3.50	2.50	1.80	gallons per minute	0.45	0.42	0.13	7.300	minutes per day
Bath	1.00	50.00	50.00	25.00	gallons per event	0.00	0.50	0.50	0.093	events per day
Faucet	1.00	3.50	2.50	1.50	gallons per minute	0.45	0.42	0.13	7.400	minutes per day
Dishwasher	0.75	14.00	10.00	7.00	gallons per load	0.10	0.50	0.40	0.170	loads per day
Washing machine	1.00	55.00	40.00	25.00	gallons per load	0.10	0.50	0.40	0.590	loads per day
Water softener	0.20	25.00	25.00	20.00	gallons per minute	0.00	0.50	0.50	0.500	minutes per day
Urinal	0.00	1.50	1.00	0.00		0.00	0.50	0.50	0.000	
Evaporative cooler	0.00	7.00	7.00	3.00		0.00	0.50	0.50	0.000	
Boiler feed	0.00	100.00	100.00	85.00		0.00	0.50	0.50	0.000	
Processing	0.00	100.00	100.00	85.00		0.00	0.50	0.50	0.000	
Cooling/condensing	0.00	100.00	100.00	85.00		0.00	0.50	0.50	0.000	
Other indoor	1.00	10.00	7.50	5.00	gallons	0.33	0.33	0.34	1.860	
Landscape irrigation	1.00	90.00	76.50	63.00	gallons per 1000 sq.ft	0.50	0.30	0.20	0.100	1000 sq.ft per day
Swimming pool	0.10	500.00	450.00	350.00	gallons per event	0.33	0.33	0.34	0.027	events per day
Vehicle washing	0.50	50.00	50.00	42.50	gallons per event	0.00	0.50	0.50	0.050	events per day
Other outdoor	1.00	10.00	7.50	5.00	gallons	0.33	0.33	0.34	0.160	

Table C.3b Nonresidential End Use Assumptions for Small Utilities

END USE	Presence	M1	M2	M3	Comment	S1	S2	S3	Intensity	Comment
Toilet	1.00	3.50	1.60	1.28	gallons per flush	0.85	0.13	0.02	46.200	flushes per day
Shower	0.50	3.50	2.50	1.80	gallons per minute	0.30	0.50	0.20	22.250	minutes per day
Bath	0.05	50.00	50.00	25.00	gallons per event	0.00	0.50	0.50	0.000	events per day
Faucet	1.00	3.50	2.50	1.50	gallons per minute	0.30	0.50	0.20	2.850	minutes per day
Prerinse Spray Valve	0.10	5.00	2.00	1.50	gallons per minute	0.50	0.50	0.00	65.000	minutes per day
CII Dishwasher	0.10	20.00	10.00	1.00	gallons per load	0.50	0.40	0.10	68.000	loads per day
Washing machine	0.10	55.00	40.00	25.00	gallons per load	0.30	0.50	0.20	9.000	loads per day
Water softener	0.75	25.00	25.00	20.00	gallons per minute	0.50	0.50	0.00	0.000	minutes per day
Urinal	1.00	1.50	1.00	0.00	gallons per flush	0.40	0.50	0.10	27.000	flushes per day
Evaporative cooler	0.00	7.00	7.00	3.00		0.33	0.33	0.34	0.000	
Boiler feed	0.75	100.00	100.00	85.00		0.33	0.33	0.34	0.000	
Processing	0.75	100.00	100.00	85.00		0.33	0.33	0.34	1.350	
Cooling/condensing	0.25	100.00	100.00	85.00		0.33	0.33	0.34	4.370	
Other indoor	1.00	10.00	7.50	5.00	gallons	0.33	0.33	0.34	5.950	
Landscape irrigation	1.00	90.00	76.50	63.00	gallons per 1000 sq.ft	0.33	0.33	0.34	1.650	1000 sq.ft per day
Swimming pool	0.10	500.00	450.00	350.00	gallons per event	0.33	0.33	0.34	0.000	events per day
Vehicle washing	0.10	50.00	50.00	42.50	gallons per event	0.50	0.50	0.00	0.000	events per day
Other outdoor	1.00	10.00	7.50	5.00	gallons	0.33	0.33	0.34	0.001	

Table C.4 Measure Implementation Assumptions

Measure	Dual flush & 1.28 gpf toilets	Low-flow or non-water Urinals	LF Showerheads & Faucets	Dishwashers R	Dishwashers NR	Pre-rinse Spray Valves	Clothes Washer	Smart Sprinkler Controllers	Cooling Tower controllers	Irrigation Ordinances	Water Waste Ordinances	Stricter Building Codes	Submetering	Residential and CII Audits	Property Manager Workshops	Landscape Contractor Workshops	Increasing Block Rates	Seasonal Rates
Start year	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010
End year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2030	2030	2030	2030	2015	2015	2015	2030	2030
Shift*	NC-UC	NC-C	C-UC	NC-UC	NC-UC	NC-UC	NC-UC	NC-UC	NC-UC	C-UC	C-UC	C-UC	C-UC	NC-UC	NC-UC	NC-UC	NC-C	NC-C
Sector (R, NR)	R	NR	R, NR	R	NR	NR	R	R	NR	R, NR	R, NR	R, NR	R	R, NR	R	R, NR	R, NR	R, NR
Units affected	5%	5%	5%, 5%	5%	5%	5%	5%	5%	5%	5%, 5%	5%, 5%	5%, 5%	5%	5%, 5%	5%	5%, 5%	5%, 5%	5%, 5%
End Uses Affected																		
toilet	√											√	√	√	√		√	√
shower			√									√	√	√	√		√	√
bath																	√	√
faucet			√									√	√	√	√		√	√
dishwasher				√									√	√	√		√	√
pre-rinse spray valve						√						√		√			√	√
CII dishwasher					√							√		√			√	√
washing machine							√				√(NR)		√	√	√		√	√
other indoor													√	√	√		√	√
landscape irrigation								√		√	√		√	√	√	√	√	√
swimming pool														√	√		√	√
other outdoor														√			√	√
urinal		√										√		√			√	√
evaporative cooler														√			√	√
boiler feed														√			√	√
process														√			√	√
cooling/condensing									√			√		√			√	√
vehicle washing											√						√	√
water softener												√		√	√		√	√

* Shifts in efficiency represent nonconserving to conserving (NC-C), conserving to ultra-conserving (C-UC), or nonconserving to ultra-conserving (NC-UC).

Sectors are either residential (R) , nonresidential (NR), or both.

Units affected is the percent of units within the targeted sector that participate in the program per year between the start and end years.

Table C.5 Measure Implementation Costs per Participant

Measure	Incentives	Customer Costs	Administrative Costs	Heating Bill Savings
Dual flush & 1.28 gpf toilets	$100	$200	$10	
Low-flow or non-water Urinals	$100	$200	$10	
Low Flow Showerheads & Faucets	$25	$25	$5	$5
Dishwashers Residential	$50	$500	$5	$20
Dishwashers Nonresidential	$500	$5,000	$10	$900
Pre-rinse Spray Valves	$100	$100	$5	$75
Clothes Washer	$100	$900	$10	$100
Smart Sprinkler Controllers	$75	$150	$10	
Cooling Tower controllers	$250	$500	$25	
Irrigation Ordinances			$10	
Water Waste Ordinances			$10	
Stricter Building Codes		$500	$10	
Submetering		$180	$10	
Residential and CII Audits		$200	$100	$5
Property Manager Workshops		$200	$200	$10
Landscape Contractor Workshops		$200	$200	
Increasing Block Rates		$100	$10	
Seasonal Rates		$100	$10	

All costs are dollars per participant.

Table C.6 Ranking of Measures and WLC Programs for Large Utilities

		Large Utility savings 2015 GPD	Large Utility savings 2030 GPD	Large Utility Present Value Costs + Incentives $	Large Present Value Revenue Impacts $	Large Utility Present Value Customer Energy Savings at $0.10/kwh$	Large Utility Net Present Value $	Large Utility Benefit-Cost Ratio	Large Utility Unit Cost $/kgal	Large Utility Participant Net Present Value $	Large Utility Participant Benefit-Cost Ratio	Customer Impact Score
1	Water Loss Control - Economic Efficiency	460,902	460,902	$930,057	$133,039	n/a	$1,551,509	2.67	$0.46	n/a	n/a	n/a
2	Water Loss Control - Standard Compliance	362,387	362,387	$731,263	$104,602	n/a	$1,136,941	2.55	$0.46	n/a	n/a	n/a
3	Water Loss Control - Achievable Efficiency	362,387	362,387	$731,263	$104,602	n/a	$1,136,941	2.55	$0.46	n/a	n/a	n/a
4	Water Loss Control - Technical Efficiency	590,816	590,816	$1,192,212	$170,538	n/a	$1,791,781	2.50	$0.46	n/a	n/a	n/a
5	Submetering	140,860	297,027	$70,944	$2,302,154	$ -	$721,077	1.30	$1.53	$1,025,169	1.80	0.26
6	Stricter Building Codes	125,064	304,758	$80,310	$2,198,993	$ -	$673,167	1.30	$1.52	$(1,816,503)	0.55	-0.45
7	Increasing Block Rates	637,644	662,026	$160,620	$7,266,439	$ -	$2,267,897	1.31	$1.66	$5,660,241	4.52	-0.23
8	Seasonal Rates	637,644	662,026	$160,620	$7,266,439	$ -	$2,267,897	1.31	$1.66	$5,660,241	4.52	-0.42
9	Residential and CII Audits	728,997	728,997	$331,101	$8,009,760	$147,939	$2,345,099	1.28	$1.69	$7,495,496	12.32	0.37
10	Low-flow Showerheads & Faucets	69,631	69,631	$99,330	$761,938	$147,939	$155,635	1.18	$1.83	$909,877	11.99	0.57
11	Water Waste Ordinances	42,308	63,881	$80,310	$573,787	$ -	$115,727	1.18	$1.76	$573,787	-	-0.27
12	Dishwashers - Nonresidential	124,830	124,830	$196,945	$1,365,948	$3,105,783	$260,112	1.17	$1.86	$2,733,984	2.42	0.36
13	Pre-rinse Spray Valves	23,625	23,625	$40,547	$258,516	$258,815	$45,963	1.15	$1.88	$517,331	14.40	0.46
14	Property Manager Workshops	287,227	287,227	$584,970	$3,173,325	$261,369	$474,627	1.13	$1.93	$2,849,724	5.87	0.28
15	Irrigation Ordinances	28,251	37,273	$80,310	$349,207	$ -	$37,544	1.09	$1.93	$349,207	-	-0.34
16	Low-flow or Non-water Urinals	13,275	13,275	$42,478	$145,261	$ -	$6,133	1.03	$2.10	$106,645	2.38	0.39
17	Dual flush & 1.28 gpf Toilets	68,476	68,476	$321,733	$749,303	$ -	$(70,996)	0.93	$2.32	$456,818	1.78	0.61
18	Cooling Tower Controllers	16,065	16,065	$106,196	$175,791	$ -	$(47,368)	0.83	$2.60	$79,249	1.41	0.34
19	Clothes Washer	27,449	27,449	$275,311	$329,157	$2,383,820	$(167,096)	0.72	$3.09	$710,712	1.32	0.70
20	Landscape Contractor Workshops	56,502	56,502	$662,203	$618,271	$ -	$(455,310)	0.64	$3.36	$(43,932)	0.93	0.22
21	Smart Sprinkler Controllers	12,883	12,883	$248,612	$140,977	$ -	$(201,435)	0.48	$4.48	$(78,387)	0.82	0.23
22	Dishwashers - Residential	1,347	1,347	$160,867	$16,157	$522,738	$(155,555)	0.12	$18.46	$(777,287)	0.47	0.52

Measure categorization based on utility perspective.

Good
Marginal
Not good

Table C.7 Ranking of Measures and WLC Programs for Medium Utilities

		Medium Utility savings 2015 GPD	Medium Utility savings 2030 GPD	Medium Utility Present Value Costs + Incentives $	Medium Utility Present Value Revenue Impacts $	Medium Utility Present Value Customer Energy Savings at $0.10/kwh	Medium Utility Net Present Value $	Medium Utility Benefit-Cost Ratio	Medium Utility Unit Cost $/kgal	Medium Utility Participant Net Present Value $	Medium Utility Participant Benefit-Cost Ratio	Customer Impact Score
1	Water Loss Control - Standard Compliance	46,208	46,208	$93,244	$13,095	n/a	$187,782	3.01	$0.46	n/a	n/a	n/a
2	Water Loss Control - Achievable Efficiency	46,208	46,208	$93,244	$13,095	n/a	$187,782	3.01	$0.46	n/a	n/a	n/a
3	Water Loss Control - Economic Efficiency	50,663	50,663	$102,233	$14,357	n/a	$195,407	2.91	$0.46	n/a	n/a	n/a
4	Water Loss Control - Technical Efficiency	59,566	59,566	$120,199	$16,880	n/a	$215,420	2.79	$0.46	n/a	n/a	n/a
5	Submetering	19,441	43,379	$12,309	$319,301	$0	$164,187	1.50	$1.51	$97,745	1.44	0.26
6	Stricter Building Codes	15,878	39,986	$14,071	$277,971	$0	$138,539	1.47	$1.50	($425,585)	0.40	-0.45
7	Increasing Block Rates	78,725	81,330	$28,142	$878,377	$0	$428,762	1.47	$1.65	$596,954	3.12	-0.23
8	Seasonal Rates	78,725	81,330	$28,142	$878,377	$0	$428,762	1.47	$1.65	$596,954	3.12	-0.42
9	Residential and CII Audits	90,081	90,081	$56,659	$971,635	$25,333	$448,985	1.44	$1.69	$883,651	8.80	0.37
10	Low-flow Showerheads & Faucets	9,339	9,339	$16,998	$100,278	$25,333	$35,353	1.30	$1.86	$125,611	9.87	0.57
11	Water Waste Ordinances	5,006	8,201	$14,071	$68,847	$0	$23,542	1.28	$1.81	$68,847	-	-0.27
12	Property Manager Workshops	39,592	39,592	$99,118	$429,245	$44,317	$123,911	1.23	$1.97	$374,444	4.78	0.28
13	Dishwashers - Nonresidential	14,316	14,316	$36,209	$153,716	$571,416	$44,035	1.23	$1.97	$405,644	2.14	0.36
14	Pre-rinse Spray Valves	2,666	2,666	$7,455	$28,627	$47,618	$7,492	1.21	$2.01	$76,245	11.74	0.46
15	Irrigation Ordinances	3,382	4,915	$14,071	$42,641	$0	$8,645	1.15	$2.03	$42,641	-	-0.34
16	Low-flow or Non-water Urinals	1,490	1,490	$7,810	$16,003	$0	$546	1.02	$2.37	$8,903	1.63	0.39
17	Dual flush & 1.28 gpf Toilets	9,495	9,495	$54,515	$101,949	$0	($1,292)	0.99	$2.44	$52,390	1.53	0.61
18	Cooling Tower Controllers	1,832	1,832	$19,524	$19,670	$0	($9,254)	0.76	$3.17	$1,921	1.05	0.34
19	Clothes Washer	3,763	3,763	$46,563	$44,299	$403,361	($24,347)	0.73	$3.39	$109,022	1.29	0.70
20	Landscape Contractor Workshops	6,764	6,764	$113,318	$72,631	$0	($75,399)	0.59	$4.07	($40,687)	0.64	0.22
21	Smart Sprinkler Controllers	1,779	1,779	$42,125	$19,102	$0	($32,152)	0.47	$5.10	($18,068)	0.76	0.23
22	Dishwashers - Residential	197	197	$27,258	$2,314	$88,634	($26,097)	0.12	$21.14	($132,068)	0.47	0.52

Measure categorization based on utility perspective.

Good
Marginal
Not good

Table C.8 Ranking of Measures and WLC Programs for Small Utilities

		Small Utility savings 2015 GPD	Small Utility savings 2030 GPD	Small Utility Present Value Costs + Incentives $	Small Utility Present Value Revenue Impacts $	Small Utility Present Value Customer Energy Savings at $0.10/kwh	Small Utility Net Present Value $	Small Utility Benefit-Cost Ratio	Small Utility Unit Cost $/kgal	Small Utility Participant Net Present Value $	Small Utility Participant Benefit-Cost Ratio	Customer Impact Score
1	Water Loss Control - Economic Efficiency	11,654	11,654	$23,517	$3,620	n/a	$65,084	3.77	$0.46	n/a	n/a	n/a
2	Water Loss Control - Achievable Efficiency	10,456	10,456	$21,100	$3,248	n/a	$58,181	3.76	$0.46	n/a	n/a	n/a
3	Water Loss Control - Standard Compliance	8,791	8,791	$17,738	$2,730	n/a	$45,275	3.55	$0.46	n/a	n/a	n/a
4	Water Loss Control - Technical Efficiency	15,952	15,952	$32,190	$4,954	n/a	$68,072	3.11	$0.46	n/a	n/a	n/a
5	Submetering	3,409	7,702	$2,456	$61,678	$0	$25,399	1.40	$1.65	$17,469	1.40	0.26
6	Increasing Block Rates	13,849	14,296	$5,760	$169,265	$0	$67,692	1.39	$1.81	$111,668	2.94	-0.23
7	Seasonal Rates	13,849	14,296	$5,760	$169,265	$0	$67,692	1.39	$1.81	$111,668	2.94	-0.42
8	Stricter Building Codes	2,804	7,117	$2,880	$53,986	$0	$21,392	1.38	$1.65	($90,006)	0.37	-0.45
9	Residential and CII Audits	15,892	15,892	$11,536	$187,846	$5,159	$70,019	1.35	$1.85	$169,933	8.37	0.37
10	Low-flow Showerheads & Faucets	1,646	1,646	$3,461	$19,371	$5,159	$4,961	1.22	$2.06	$24,529	9.51	0.57
11	Water Waste Ordinances	885	1,484	$2,880	$13,453	$0	$3,145	1.19	$1.99	$13,453	-	-0.27
12	Property Manager Workshops	6,942	6,942	$19,677	$82,478	$8,799	$16,080	1.16	$2.17	$71,600	4.64	0.28
13	Dishwashers - Nonresidential	2,558	2,558	$8,658	$30,102	$136,641	$4,430	1.11	$2.25	$90,352	2.06	0.36
14	Pre-rinse Spray Valves	450	450	$1,782	$5,300	$11,387	$522	1.07	$2.33	$16,687	10.83	0.46
15	Irrigation Ordinances	596	889	$2,880	$8,311	$0	$780	1.07	$2.24	$8,311	-	-0.34
16	Dual flush & 1.28 gpf Toilets	1,656	1,656	$10,822	$19,485	$0	($2,351)	0.92	$2.71	$9,646	1.49	0.61
17	Low-flow or Non-water Urinals	267	267	$1,867	$3,145	$0	($500)	0.90	$2.78	$1,448	1.43	0.39
18	Clothes Washer	657	657	$9,241	$8,473	$80,057	($5,653)	0.68	$3.79	$21,324	1.28	0.7
19	Cooling Tower Controllers	324	324	$4,668	$3,818	$0	($3,008)	0.65	$3.88	($426)	0.95	0.34
20	Landscape Contractor Workshops	1,192	1,192	$23,072	$14,025	$0	($16,974)	0.54	$4.61	($9,047)	0.61	0.22
21	Smart Sprinkler Controllers	310	310	$8,363	$3,646	$0	($6,778)	0.44	$5.74	($3,733)	0.75	0.23
22	Dishwashers - Residential	33	33	$5,411	$427	$17,598	($5,230)	0.10	$24.77	($26,248)	0.47	0.52

Measure categorization based on utility perspective.

Good
Marginal
Not good

Table C.9 Ranking of Measures and WLC Programs on Statewide Totals

		Statewide Savings 2015 GPD	Statewide Savings 2030 GPD	Statewide Present Value Costs + Incentives (sum) $	Statewide Present Value Revenue Impacts (sum) $	Statewide Present Value Customer Energy Savings at $0.10/kwh (sum)	Statewide Utility Net Present Value (sum) $	Statewide Utility Benefit-Cost Ratio (average)	Statewide Utility Unit Cost (average) $/kgal	Statewide Participant Net Present Value (sum) $	Statewide Participant Benefit-Cost Ratio (average)	Customer Impact Score
1	Water Loss Control - Economic Efficiency	81,831	81,831	$60,931,792	$9,081,181	n/a	109,805,722	2.80	$0.46	n/a	n/a	n/a
2	Water Loss Control - Achievable Efficiency	62,587	62,587	$31,194,626	$4,649,199	n/a	54,940,354	2.76	$0.46	n/a	n/a	n/a
3	Water Loss Control - Standard Compliance	91,192	91,192	$29,074,760	$4,333,258	n/a	48,832,951	2.68	$0.46	n/a	n/a	n/a
4	Water Loss Control - Technical Efficiency	145,881	145,881	$86,545,925	$12,898,671	n/a	135,960,271	2.57	$0.46	n/a	n/a	n/a
5	Submetering	13,753,288	29,474,409	$7,489,089	$226,877,947	$0	81,338,629	1.41	$1.60	$92,074,345	1.46	0.26
6	Stricter Building Codes	11,960,560	29,403,936	$8,527,348	$211,631,275	$0	73,280,789	1.39	$1.59	($214,736,103)	0.40	-0.45
7	Increasing Block Rates	60,548,643	62,784,903	$17,054,695	$691,198,729	$0	240,553,719	1.40	$1.75	$520,651,778	3.20	-0.23
8	Seasonal Rates	60,548,643	62,784,903	$17,054,695	$691,198,729	$0	240,553,719	1.40	$1.75	$520,651,778	3.20	-0.42
9	Residential and CII Audits	69,251,971	69,251,971	$34,873,432	$762,750,453	$15,585,330	249,481,062	1.36	$1.79	$708,588,919	9.02	0.37
10	Low-flow Showerheads & Faucets	6,750,959	6,750,959	$10,462,030	$74,055,434	$15,585,330	17,379,231	1.23	$1.98	$89,640,764	9.94	0.57
11	Water Waste Ordinances	3,978,367	6,137,567	$8,527,348	$54,540,878	$0	12,392,846	1.21	$1.92	$54,540,878	-	-0.27
12	Property Manager Workshops	28,034,957	28,034,957	$61,260,478	$310,509,301	$27,377,856	55,395,143	1.17	$2.09	$276,626,680	4.84	0.28
13	Dishwashers - Nonresidential	11,662,350	11,662,350	$21,640,286	$127,903,828	$341,352,360	25,861,454	1.15	$2.12	$278,312,485	2.13	0.36
14	Pre-rinse Spray Valves	2,190,844	2,190,844	$4,455,353	$24,020,239	$28,446,030	4,449,353	1.12	$2.19	$52,466,269	11.55	0.46
15	Irrigation Ordinances	2,663,263	3,605,266	$8,527,348	$33,329,116	$0	4,075,023	1.09	$2.15	$33,329,116	-	-0.34
16	Low-flow or Non-water Urinals	1,234,553	1,234,553	$4,667,513	$13,539,397	$0	353,597	0.95	$2.58	$9,296,204	1.61	0.39
17	Dual flush & 1.28 gpf Toilets	6,691,134	6,691,134	$33,693,263	$73,399,309	$0	(6,027,203)	0.94	$2.59	$42,769,070	1.54	0.61
18	Cooling Tower Controllers	1,498,016	1,498,016	$11,668,782	$16,428,207	$0	(5,570,155)	0.70	$3.52	$5,820,223	1.04	0.34
19	Clothes Washer	2,674,280	2,674,280	$28,814,108	$32,152,527	$249,529,979	(16,993,789)	0.70	$3.59	$72,125,358	1.29	0.7
20	Landscape Contractor Workshops	5,326,525	5,326,525	$69,746,864	$58,417,603	$0	(47,981,862)	0.57	$4.30	($11,329,261)	0.66	0.22
21	Smart Sprinkler Controllers	1,257,388	1,257,388	$26,035,703	$13,792,881	$0	(20,838,339)	0.45	$5.41	($9,179,799)	0.76	0.23
22	Dishwashers - Residential	133,090	133,090	$16,846,631	$1,599,985	$54,755,713	(16,255,775)	0.11	$22.99	($81,480,377)	0.47	0.52

Measure categorization based on utility perspective.

Good
Marginal
Not good