Chapter VII

WATER CONSERVATION

INTRODUCTION

On a global scale, potable water is a limited and increasingly precious natural resource that needs to be carefully husbanded and conserved. Under the pressure of increased population levels, water is becoming a scarce and costly commodity in some areas of the world. Within some parts of the United States, water has for some time been a limited resource of great concern to competing agricultural and urban users. Southeastern Wisconsin, however, is a water-rich area and water supply has long been regarded as a virtually limitless resource. That historic viewpoint is, however, changing under the effects of areawide urbanization, and the attendant increases in water use and changes in hydrology due to increases in impervious surfaces. The need for, and importance of, water conservation and water supply system efficiency are becoming increasingly evident to elected and appointed officials, business community, and citizens. In addition, to water supply system efficiency and demand side water conservation measures, stormwater management measures designed to maintain or improve the infiltration of stormwater into the groundwater aquifers are important to a comprehensive water supply management strategy in many parts of the Region. Such measures are described in Chapter VI of this report. This chapter is intended to focus upon water conservation measures, including water system efficiency and demand side measures.

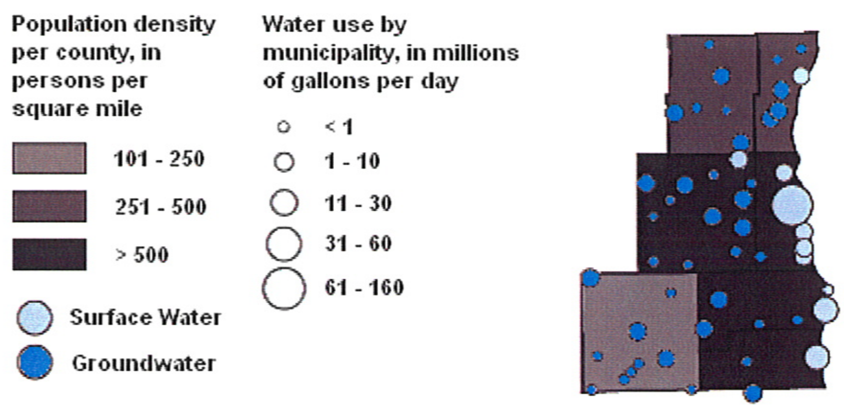
Historically, water conservation was sometimes viewed as the retention of water during periods of high stream flow in reservoirs for future use during periods of low flow. This definition involved the construction of dams and the diversion of surface waters that could result in damage to natural ecosystems. In the early 1970s, the perception of water conservation changed to the present concept of efficient and effective use. Public interest in, and concern over, water conservation varies in different areas of the United States. In the arid southwest, conservation efforts are routinely accepted. In more humid areas where water is more plentiful, such as southeastern Wisconsin, public interest in water conservation has developed only relatively recently.

Southeastern Wisconsin has an abundant supply of water, contained in over 1,150 miles of perennial streams, 176,000 acres of wetlands, 77 miles of Great Lakes shoreline, 101 major inland lakes, and two major groundwater aquifers. Groundwater levels in the deep sandstone aquifer underlying the area, however, have been steadily falling over the past century. This decline may be primarily attributed to pumping from that aquifer for use by rapidly developing urban communities in southeastern Wisconsin and northeastern Illinois. Estimates of water use by municipality and population density in the Southeastern Wisconsin Region are shown in Figure VII-1.

Regardless of the abundance of the supply, there are a number of potential benefits attendant to the conservation of water, including: reduction in the costs of treatment, transmission, and distribution; reductions in associated energy consumption; and environmental protection. In addition, implementation of effective water conservation measures has the potential to reduce future capital costs of water supply facilities, and may contribute to maintaining a sustainable water supply. These savings and related benefits of water conservation measures may be accompanied by a loss of revenue. This chapter presents information on water conservation practices that are considered potentially applicable within southeastern Wisconsin. Included are sections on the descriptions of water conservation measures, the cost of such measures, and the potential impact of the measures on water supply system demands.

Figure VII-1

POPULATION DENSITY BY COUNTY AND WATER USE BY MUNICIPALITY IN THE SOUTHEASTERN WISCONSIN REGION: 2000



Source: U.S. Geological Survey, 2002.

WATER CONSERVATION AND WATER SUPPLY SYSTEM EFFICIENCY IMPLICATIONS

Water conservation and water supply efficiency are interrelated terms. Water conservation may be defined as any beneficial reduction in water loss, waste, or use, including reduction in water use accomplished by implementation of water conservation or water efficiency measures and improved water management practices. Water supply efficiency may be defined as the planned management of water to accomplish a function, task, process, or result with the minimal amount of water practicable. Water supply efficiency is a resource management practice indicative of the relationship between the amount of water required for a particular purpose and the quantity of water actually used or delivered. In these definition of terms, water supply efficiency is a water conservation measure. Given the amounts of water and other resources involved, and the ability to control implementation, water supply efficiency is likely to be the most direct and effective water conservation measure available to water utility managers. This chapter is intended to focus on water conservation measures and practices, including those associated with water utility system efficiency.

All of the utilities within the Southeastern Wisconsin Region have some form of water supply efficiency program. Such programs may include meter testing for accuracy, leak detection and repair, and repair or replacement of water mains with identified problems. These efficiency measures are well established and are system-specific. Such programs are under the control of the utilities and can, therefore, be implemented directly without customer action. However, these programs do require financial resources which need to be provided through water sale revenues. Reductions in revenues supporting these efficiency programs resulting from water conservation programs will have to be made up through increases in rates.

The need for, and implications of, water conservation within the seven-county Southeastern Wisconsin Region differs markedly between those areas utilizing Lake Michigan as a source of supply, lying generally, but not entirely, east of the subcontinental divide, and those areas utilizing groundwater as a source of supply, lying both east and west of that divide. In addition, there is a distinction to be made relative to water conservation programs between water users served by private, self-supplied water systems, and those water users supplied by municipal water supply systems. Those areas of the Region served by Lake Michigan water-supplied systems have access to a bountiful source of high-quality water. Those areas of the Region served by groundwater-supplied systems must be concerned with the ability of the groundwater reservoirs to meet the increasing demands placed upon them by urbanization, and, in the absence of wise use, this ability may become a constraint on the continued social and economic development of the Region. The general need for, and implications of, conservation will, therefore, be different within the areas of the Region served by Lake Michigan-supplied systems, generally lying east of the subcontinental divide and those areas served by groundwater supplies lying both east and west of the subcontinental divide. The need for, and implications of, conservation will also differ in the particulars concerned, such as the characteristics of the individual public and private water supply systems concerned. The implications of conservation will be quite different for a water supply system utilizing Lake Michigan as a source of supply and operating at well below design capacity, than for a public water supply system utilizing groundwater as a source of supply and operating at design capacity. The manner in which the spent water supply is disposed of will also affect the need for conservation. In areas utilizing Lake Michigan as a source of supply, the spent water supply is largely returned to the source, along with additional sewer system clearwater infiltration and inflow, the return flows will typically exceed in total the amount of water supplied. In the areas using groundwater as a source of supply, the spent water is most often not returned to the source of supply. Accordingly, the development of water conservation measures must recognize the differing needs for conservation within the Region.

APPROACH TO WATER CONSERVATION

For the purposes of the regional water supply planning effort, a water conservation program is defined as a combination of practices, procedures, policies, and technologies used to reduce the amount of water usage or to improve or maintain water system efficiency. Public interest in, and demand for, water conservation programs are motivated by several factors, including: perceived limitation of water supplies, high costs and difficulties in developing new supplies, and public interest in, and support for, natural resource conservation and environmental protection.[1]

Water supply planning is a task in which water supply utilities must consider meeting the needs of the communities served in a cost-effective fashion. Water supply planning also requires the consideration of the need to protect and sustain the water resources of the Region. Ideally, utilities should consider a full range of supply and conservation strategies in order to assure that both valid system performance and environmental objectives are met.[2] Conservation programs must be developed on a utility-specific basis to find the best means available for meeting the water supply needs, while maintaining the sustainability of the source, or sources, of supply.

There are several approaches available to the development of a water conservation program. The U.S. Environmental Protection Agency (USEPA) publication *Water Conservation Plan Guidelines* describes a number of such approaches dependent on the size of the population served by individual water suppliers. The guidelines encourage the suppliers to consider and evaluate all practical conservation measures.[3] Once developed, water conservation programs may be carried out by a number of measures, including incentives and regulations. Conservation measures are intended to result in more efficient water use and to meet water conservation objectives. Water conservation measures may involve the use of new technologies, or the promotion of behavioral change. Conservation regulations are measures imposed upon users through legal measures. Conservation

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[1]*American Water Works Association (AWWA),* Water Conservation Programs-A Planning Manual, *2006 (11).*

[2]*Great Lakes Commission,* Selected Guidelines of Water Conservation Measures Applicable to the Great Lakes-St. Lawrence Region, *2002, Available at http://www.glc.org, viewed 08/16/06.*

[3]*U.S. Environmental Protection Agency,* USEPA Water Conservation Plan Guidelines, *August 1998.*

incentives are the measures intended to motivate behavioral change on the part of the users. Public education campaigns and water rate structure revisions are examples of conservation incentives.

COSTS AND BENEFITS

The costs and benefits associated with water conservation have traditionally been difficult to quantify. Each conservation program is unique to the water system concerned. Conservation programs impose costs on both the water suppliers and the water users, with differential attendant benefits.

Water conservation programs can be designed to either reduce the amount of water customers use and/or to reduce the amount of water pumped to meet customer demands through increased water system efficiency. Utilities will incur costs for implementation of conservation programs. The direct costs of conservation programs include staff salaries, contract costs, and program support needs, such as educational materials and publicity. Utilities may incur decreased revenues as a result of implementation of water conservation programs designed to reduce customer demands. Such water conservation programs are intended to result in a reduction in the amount of water supplied to customers; therefore, a loss of revenue will typically be incurred. This reduction in revenue will be proportional to the level of water conservation achieved and will occur over an extended period of time. Such programs may require utilities to modify future budgets to reduce costs or increase rates to maintain needed revenue over time. Capital costs are typically fixed for some period of time and, if water use and attendant revenues are reduced, water rates may need to be increased to recover these fixed costs. Benefits that may accompany reductions attendant to conservation programs that are related to increased efficiencies in operation include reductions in the cost of variable inputs to production, such as chemicals and energy costs. Water saved through increased system efficiency is typically not accounted for in sales and, thus, does not affect revenue.

In most systems, the reduction in revenues attendant to conservation programs will exceed the reductions in direct production costs by a significant amount. In the Southeastern Wisconsin Region, typically 15 to 25 percent of the operation and maintenance budget, and all of the capital-related budget, represent fixed costs that are largely unaffected by conservation measures. Only 7 to 15 percent of the typical utility budget is related to costs which are variable with water demands. Thus, for each $1.00 of water revenue reduction, it is likely that $0.15 or less could be offset by an immediate savings in cost, while $0.85 or more will need to be recovered by other means, including rate increases or reduction in service. A higher proportion of the utility costs may be offset by savings resulting from reductions in water use if the utility concerned has a need for new capital facilities. The avoided cost of such facilities can be a significant factor favoring water conservation programs for utilities which anticipate such capital needs. However, within the Southeastern Wisconsin Region, such capital costs capacity expansion may not be required until well into the future, particularly for those utilities using Lake Michigan as a source of supply. For other utilities, these costs may be more imminent, and avoided capital cost savings will be realized in a relatively short time frame of five to 10 years.

Water customers also incur certain costs and savings when attempting to become more water efficient. The savings that customers will obtain often will result from reduced water bill costs; operation and maintenance of more efficient equipment, fixtures, and appliances; and in energy costs. The costs involve the purchase and installation of the equipment, fixtures, and appliances. If these costs become too high, customers are less likely to participate. Some utilities offer incentives to customers willing to install more-efficient equipment, fixtures, and appliances. In Wisconsin, as of 2006, such a practice is not allowed under the Public Service Commission of Wisconsin utility rate structure policies. Additional capital and operation and maintenance expenses may also be incurred for industrial or commercial facilities that install more-efficient equipment, fixtures, and appliances. Careful consideration of all other costs and benefits of a water conservation program must be considered to ensure the success of a water conservation program.

Costs attendant to the water conservation measures herein considered were obtained from multiple sources. These are cited throughout the remainder of this chapter. These data were updated to 2005 costs using the *Engineering News Record* (ENR) cost indices, as described in Chapter I of this report.

CURRENT LAWS RELATED TO WATER CONSERVATION

A companion SEWRPC technical report contains detailed information on water supply law.[4] This section summarizes those laws relating to water conservation.

The Federal government has enacted several regulations and instituted some policies to address the issue of water conservation. Although some of these regulations apply directly, many of the policies are intended to promote development of conservation programs on the state or local level. Since water conservation needs vary by and within each state, the creation of a single program for the entire country, or even for entire states, is virtually impractical. The Federal laws that most directly affect water conservation in the United States include:

- *The Federal Safe Drinking Water Act*—The Federal Safe Drinking Water Act regulates the level of contaminants in drinking water and the disposal of wastes in groundwater supplies. This act also encourages states to develop and implement strategies for the protection of water supplies. The Amendments of 1986 requires the enforcement of wellhead protection programs in all of the states. This program requires the protection of the area surrounding a well from which groundwater is drawn. The Amendments provided for increased contaminant protection measures, improved consumer information measures, and funding for State and local water systems. While not directly related to water conservation programming, these amendments are considered indirectly related by virtue of their overall impact on water supply system design and operation.

- *The Federal Energy Policy Act (EPAct)*—The Federal Energy Policy Act was enacted in 1992. This act established national water efficiency requirements, including maximum water-flow rates for toilets, urinals, showers, and faucets. This requirement is placed on fixtures for new and renovated residential and nonresidential facilities. The projected goal of the Act is to save between six and nine billion gallons of water per day by the year 2020.[5]

- *The Great Lakes Charter Annex 2001*[6]—The Great Lakes Charter Annex 2001 was adopted by the Great Lakes states and provinces on June 18, 2001 as a supplementary agreement to the Great Lakes Charter. The stated purpose of the Annex was to develop "an enhanced water management system that is simple, durable, efficient, retains and respects authority within the Basin, and most importantly, protects, conserves, restores, and improves the Waters and Water-Dependent Natural Resources of the Great Lakes Basin." Under the Annex, the Governors and Premiers agreed to develop, within three years from the point of adoption of the Annex, binding agreements and implementing legislation to protect, conserve, restore, improve and manage use of the waters and water-dependent natural resources of the Great Lakes basin. The work done pursuant to the Great Lakes Charter Annex has resulted in the Great Lakes Annex Implementing Agreements. On December 13, 2005, the Great Lakes-St. Lawrence River Basin Water Resources Compact (Compact) was signed by the eight Great Lakes State Governors. This Compact will be binding on all the eight Great Lakes states only after it is ratified through concurring legislation by the eight states and consented to by Congress. The objective of this Compact is to establish an enforceable environmental standard for protecting the use of the "Waters and Water-Dependent Natural Resources of the Great Lakes." The agreement has two major components. First, the Compact would prohibit all "diversions" outside the Great Lakes basin, with certain limited exceptions. A "diversion" occurs whenever water

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[4]*SEWRPC Technical Report No. 44,* Water Supply Law for Southeastern Wisconsin*, in preparation.*

[5]*Amy Vickers,* Handbook of Water Use and Conservation*, 2001.*

[6]*The Great Lakes Charter Annex is included under the Federal laws and regulations, since it is a multi-state compact requiring Congressional approval.*

is transferred from the Great Lakes basin into another watershed by any means other than incorporation into a product. Second, the Compact requires each signatory to manage and regulate new or increased withdrawals and consumptive uses in accordance with the provisions of the Compact.

The Compact includes provisions that the regulatory program established by the State for new or increased withdrawals and consumptive uses, and allowed diversions of surface water or groundwater from within the basin must, at a minimum, require compliance with certain criteria. One of these criteria is the implementation of environmentally sound and economically feasible water conservation measures. Environmentally sound and economically feasible water conservation measures are those measures for efficient water use, for reducing water loss, and for reducing withdrawals, that are environmentally sound, reflect best practices, are technically feasible and available, are economically feasible and cost-effective, and take the particular facilities and processes involved into consideration.

Each state has also enacted its own regulations related to water conservation. Wisconsin is a relatively water-rich state with extensive ground and surface water resources, as well as a relatively high amount of annual precipitation. However, many areas in the State have experienced significant reductions in the quality and quantity of water supplies available for use. The following State regulations and policies relate to water conservation:

- *Section NR-140 of the Wisconsin Administrative Code* regulates the quality of groundwater. This code establishes groundwater quality standards to regulate contaminants that may enter or are currently present in groundwater. *Chapter NR 141 of the Wisconsin Administrative Code* establishes standards for the design, construction, abandonment, and documentation of groundwater monitoring wells. NR 140 and 141 together are intended to ensure that existing sources of water are not compromised, which would further reduce the supply.

- *Chapter NR 142 of the Wisconsin Administrative Code* regulates water management and conservation of the waters of the State, including the management of Wisconsin water supply systems. This chapter provides for the management of the waters of the State through the development of a statewide water quantity resources plan; requires the registration of major withdrawals from the waters of the State; and requires Wisconsin Department of Natural Resources (WDNR) approval for major interbasin diversions and consumptive uses of water in order to protect public and private water rights in the State when the level, flow, use or quality of the waters of the state is threatened.

- *Chapter NR 809 of the Wisconsin Administrative Code* establishes standards and procedures for the protection of public health, safety, and welfare in the obtaining of safe drinking water.

- *Chapter NR 811 of the Wisconsin Administrative Code* regulates the management of community water systems and the regulation of wells and water as proposed in NR 140. This code also regulates aquifer storage recovery within the State, which involves the recharge of aquifers.

- *Chapter NR 812 of the Wisconsin Administrative Code* regulates the construction, or reconstruction, abandonment, and maintenance of water systems, including wells. Currently, approval of new high-capacity wells requires the Wisconsin Department of Natural Resources approval. Such approvals involve technical well construction procedures and materials designed to protect the public health.

- *Section 281.34(5) of the Wisconsin Statutes* limits the Wisconsin Department of Natural Resources review of a proposed high-capacity well to determining whether a proposed well adversely affects a public water utility supply well, is located in a groundwater protection area, has a significant environmental impact on a spring, or will result in a water loss of more than 95 percent of the amount of water withdrawn.

- *Section 281.35 of the Wisconsin Statutes* requires conservation measures relating to major water withdrawals. The Statute requires that persons seeking new or increased withdrawals resulting in a "water loss" averaging more than two million gallons per day in any 30-day period apply for and obtain a water loss permit. However, this provision has not been widely enforced in Wisconsin due to the small number of entities that reach two million gallons per day.

- Section Comm 82.34 of the Wisconsin Administrative Code set forth the requirements for design and installation of plumbing wastewater devices, as well as appurtenances and systems. The provisions of this section also regulate the treatment of wastewater for reuse.

- Section Comm *82.70 of the Wisconsin Administrative Code* establishes plumbing treatment standards for plumbing systems that supply water to outlets based on the intended use. The Wisconsin Department of Commerce requires that a plumbing system supply a quality of water at the outlet or at the termination of the plumbing system that meets or exceeds the minimum requirements as specified within the code. Comm 82.70 applies to wastewater treatment devices for reuse systems such as graywater systems.

- *The Groundwater Quantity Act (2003 Wisconsin Act 310)* is a groundwater protection law that expands the State's authority to consider environmental impacts of high capacity wells and takes the first step toward addressing regional water quantity issues in southeastern Wisconsin and the lower Fox River Valley. In addition, the law creates additional oversight of well construction activities and establishes a Groundwater Advisory Committee to recommend strategies for groundwater management and future legislation.

  In this regard, two reports are due to the standing committees of the Legislature with jurisdiction over environmental and natural resources matters on December 31, 2006, and December 31, 2007. These reports are to: 1) provide recommendations on how to best manage groundwater resources in areas of the State with existing groundwater problems; and 2) report on how the scope of the current groundwater legislation is working to protect the groundwater resources. The first charge to be completed by the end of 2006 specifically relates to the regional water supply planning effort in that it is to include recommendations for strategies for addressing groundwater management issues in areas designated as "groundwater management areas" which includes all, or portions, of each of the counties in the Southeastern Wisconsin Region. Ideally, the regional water supply plan for southeastern Wisconsin will serve as the basis for developing management recommendations in the groundwater management areas.

The WDNR also has several programs that relate to the conservation and protection of water supplies. Reports are created and made available to the public to monitor the progress of conservation efforts within the State. In August 2005, the Governor created *Conserve Wisconsin*, a combination of legislation and executive orders designed to protect the State waters, conserve the land, and ensure a sustainable energy future.[7] As part of that initiative, in September 2006, a report entitled *Water Conservation: A Menu of Demand Side Initiatives for Water Utilities* was completed by the Public Service Commission and the Wisconsin Department of Natural Resources which identifies a number of demand side measures for water management and presents information on the economic, environmental, and social aspects of these measures. The list of measures includes water conservation education, water conservation accountability, the use of water saving plumbing and other fixtures, water conservation rate structures, and water reuse and recycling. The list of water conservation initiatives has been designed to provide flexibility for Wisconsin water utilities as they work on their own individual strategies to

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[7] *Public Service Commission of Wisconsin,* Water Conservation Initiative*, 2005, Available at http://psc.wi.gov/conservationWater/index-waterConservation.htm.*

promote water conservation. The report recognizes the uniqueness of the utilities in the State with regard to water use issues.

MUNICIPAL WATER CONSERVATION MEASURES

According to the U.S. Environmental Protection Agency, there are over 55,000 community water supply systems in the United States that process nearly 34 billion gallons of water per day.[8] In the Southeastern Wisconsin Region, as of 2005, there are 79 municipal water utilities and 187 other than municipal, community water supply systems. These supply systems were responsible for the efficient retrieval, treatment, and distribution of potable water. All of the municipal water utilities, and a number of the other than municipal, community water supply systems, may be expected to have some water conservation programs in place. The conservation measures considered viable for municipal systems in southeastern Wisconsin include public education; fixture and plumbing management; water reuse and recycling in industrial, commercial, and residential settings; rate structures; outdoor water use reductions and restrictions; and water system maintenance and loss management.

Public Education

Measures

Water conservation can best be achieved through a cooperative effort between water utilities and water customers. There are several different types of measures that may be used to educate the public, including: water bill inserts, feature articles and announcements in the news media, workshops, booklets, posters and bumper stickers, and the distribution of water-saving devices. To raise public awareness of the need for conservation, educational programs are often a successful measure. School-age children are typically the center of educational programs, since they are the potential future ratepayers and can also influence other family members. Many states, including Wisconsin, have developed contests for elementary children to design educational posters to promote water conservation. Wisconsin has a program called *BeSMART* that encourages high school and college students to find new and innovative ways to reduce waste and recycle water and other materials.[9]

Although school programs to educate children are important, it is also vital that adults become educated about water issues. Adult participation in water conservation programs may be expected to lower water use in the present, and provide positive examples for children. Studies have indicated that although many families may be water conservation oriented with respect to indoor use, outdoor use of water for landscaping and other activities is much higher than necessary.[10] Public educational programs to promote water conservation should address the need to reduce water use for both indoor and outdoor purposes.

The U.S. Environmental Protection Agency has created a program called WaterSense. WaterSense is a voluntary, public-private, partnership to promote and enhance the market for water-efficient services and products. The American Water Works Association (AWWA) has also created an online informational resource for water conservation called WaterWiser. This resource provides updated news on the water conservation issue, as well as links to several educational portals.[11] In addition, there are a number of hard copy and electronic water conservation data sources available. Examples include the Great Lakes Information Network website[12] and the

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[8]*American Water Works Association (AWWA),* Stats on Tap, *2006, Available at http://www.awwa.org/Advocacy/pressroom/statswp5.cfm.*

[9]*Wisconsin BeSMART Coalition,* BeSMART Annual Report, *2005, Available at http://www.besmart.org/index.html.*

[10]*Amy Vickers,* op. cit.

[11]*American Water Works Association (AWWA),* WaterWiser, *2006, Available at http://www.awwa.org/waterwiser/.*

[12]*Great Lakes International Network, http://www.glin.net*

series of fact sheets entitled "The State and Future of Our Water," produced during 2006 by the University of Wisconsin-Milwaukee Great Lakes WATER Institute. In addition, Waukesha County and the City of Waukesha have formed a Water Conservation Coalition with the goal of developing and delivering water supply demand side conservation educational information.

Certain aspects of public informational and educational programming on water conservation can often be carried out most effectively at the county, regional, or State level where programming and related supporting materials have specific applicability. An example of such materials is the special Wisconsin Department of Natural Resources magazine insert entitled, "Groundwater, Wisconsin's Buried Treasure." This is a free-standing educational document containing several articles on groundwater and references to other related sources.

Cost Data
The direct reduction in water use among those who are targeted by public education and the costs to implement this type of conservation program are difficult to estimate. The costs of such educational efforts as brochures, water bill redesign, bill enclosures, media advertisements, billboards, and attendant postage, differ depending on the extent of the program. Many water supply related professional and trade organizations have produced a variety of public educational materials ranging from brochures to educational videos; and these can be utilized by utilities. Funding for public education may come from water rates or government grants. If little or no funding is directly available for water supply related public education, it may be possible to combine such educational programs with existing programs of other municipal departments, neighboring water systems, local environmental groups, or community organizations. Cost data associated with educational programs are presented, along with the cost of other conservation measures, later in this chapter.

Fixture and Plumbing Management
Measures
The efficiency of water fixtures and plumbing systems is an important factor in the management of a successful conservation program. Bathroom fixtures represent over 50 percent of indoor water use, and residential water use comprises approximately 26 percent of the total water use in the United States, or an average of 26,100 million gallons per day (mgd).[13] There have been steady improvements in the efficiency of plumbing fixtures and appliances over the past 25 years. These improvements have been primarily the result of state and national legislative initiatives, and improved industry standards. In 1989, Massachusetts was the first state to require 1.6 gallon per flush toilets, and many other states followed suit.[14] Recent estimates of indoor water use with and without conservation are summarized in Table VII-1.

As already noted, the Federal Energy Policy Act of 1992 is intended to promote national water use efficiency. The State of Wisconsin has also created standards for fixture and plumbing management. Comm 84 of the *Wisconsin Administrative Code*, administered by the Wisconsin Department of Commerce, governs the quality and installation of plumbing materials, fixtures, appliances, appurtenances, and related equipment. In southeastern Wisconsin, residential, commercial, and industrial buildings built prior to 1994 were not required to have new water-saving fixtures. Retrofitting of older buildings with water-saving plumbing fixtures can result in reduced water billing, but at a significant capital cost. The highest savings in water may be expected to be for homes which have toilets installed prior to 1950 when 7.0-gallons-per-flush toilets were used. The lowest savings would be for homes with toilets with 3.5 gallons per flush, which were typically used between 1980 and 1993. It should be noted, however, that it is likely that many of the fixtures in homes built prior to 1980 have already been replaced by homeowners as part of remodeling or repair programs.

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[13]*Amy Vickers,* op. cit.

[14]Ibid.

Table VII-1

ESTIMATES OF INDOOR WATER USE WITH AND WITHOUT CONSERVATION MEASURES

Type of Use	Without Conservation		With Conservation		Reduction (percent)
	Amount (gpcd)[a]	Percent of Total	Amount (gpcd)[a]	Percent of Total	
Toilets	18.3	28.4	10.4	23.2	44
Clothes Washers	14.9	23.1	10.5	23.4	30
Showers	12.2	18.8	10.0	22.4	18
Faucets	10.3	16.0	10.0	22.5	2
Leaks	6.6	10.2	1.5	3.4	77
Baths	1.2	1.9	1.2	2.7	0
Dishwashers	1.1	1.6	1.1	2.4	0
Total	64.6	100.0	44.7	100.0	31

[a]Gallons per capital per day

Source: American Water Works Association, WaterWiser, "Household End Use of Water Without and With Conservation," 1997 Residential Water Use Summary – Typical Single Family Home.

Cost Data

A significant amount of data are available on the costs and savings associated with fixture and plumbing management. For typical water efficiency measures that involve fixture and appliance replacement, estimated costs incurred by the water supplier and water savings are presented in Table VII-2.

Water Reuse

Measures

Water reuse is a practice that is gaining in acceptance, particularly for irrigation purposes. Water reuse reduces the demand on surface or groundwater supplies and may offer a new source of income for wastewater utilities. Such reuse requires the installation of a dual water supply system at substantial capital and operational costs. Capital costs entailed include the construction of a dual treatment, storage, and distribution facilities. Operational costs include energy, chemicals, and staff. The economic benefits to this type of conservation vary from area to area. The economics of reuse are typically least favorable in situations where the existing primary water supply infrastructure for a service area is in place and the reuse water supply is to be retrofitted to serve all, or portions of, that service area. The economics are typically most favorable when considering an internal facility single-use system, or a dedicated supply, for irrigation of nonfood product lands, such as a golf course. However, treatment needs and public health and acceptance issues must also be considered. In addition, climate is an important factor to consider in the design and cost of dual distribution systems. In climates such as that in southeastern Wisconsin, it is necessary to install water mains and appurtenances to depths and with techniques that avoid freezing.

Spent water can also be reused for groundwater recharge. In the case of most communities in the Southeastern Wisconsin Region which use groundwater as a source of supply, municipally treated wastewater treatment plant effluent is discharged to the rivers and streams where it is conveyed downstream into other areas. If the wastewater treatment plant effluent were allowed to recharge shallow aquifers, the water could potentially be

Table VII-2

FIXTURE AND PLUMBING MANAGEMENT: WATER EFFICIENCY MEASURE COSTS AND SAVINGS

Water Efficiency Measure	Costs per Measure	Estimated Water Savings
Residential		
Single-Family Toilet Retrofit	$120	7.9 gpcd(1)
Single-Family Showerheads and Aerators	10	5.5 gpcd(2)
Single-Family Clothes Washer Rebate	170	4.4 gpcd(1)
Multi-Family Toilet Retrofit	105	7.9 gpcd(1)
Multi-Family Showerheads and Aerators	10	5.5 gpcd(2)
Multi-Family Clothes Washer Rebate	150	4.4 gpcd(3)
Commercial		
Commercial Toilet Retrofit	$185	26.0 gpd(3)
Coin-Operated Clothes Washer Rebate	210	24.0 gpd(4)

NOTES: All costs are updated to 2005 costs. The following abbreviations were used: gpcd means gallons per capita per day, and gpd means gallons per day.

Source: Adopted from the following:

(1) AWWA WaterWiser, "Household End Use of Water Without and With Conservation," 1997 Residential Water Use Summary – Typical Single Family Home.

(2) BMP Costs & Savings Study*, California Urban Water Conservation Council, July 2000.*

(3) Amy Vickers, Handbook of Water Use and Conservation*, May 2001.*

(4) GDS Associates, Inc., Texas Water Development Board Study*, May 2001.*

reclaimed by the water utility for some uses. However, as noted in Chapter VI of this report, considerable additional treatment of the wastewater and related public health issues would have to be addressed for this concept to be implemented.

Industrial and Commercial
Industrial and commercial water customers are often the largest volume users of public water supply systems. The industrial—excluding mining and thermoelectric use—and commercial use in the Southeastern Wisconsin Region, are estimated to average 51 mgd and 90 mgd, respectively in 2000. Because of this high use, implementation of water conservation measures by industrial and commercial water customers can have a significant impact on a water system.

A large number of industrial and commercial water users do not require potable water for all water uses. A major portion of water use by industrial and commercial establishments maybe for cleaning, cooling, heating, and irrigation applications. When nonpotable water is acceptable for use, the reuse of municipal wastewater, onsite treated process water, and domestic graywater—untreated, used water from domestic use—may be used as an alternative. Care must be taken, however, to exclude any water from toilets or from other uses that may come in contact with human waste. In Wisconsin, this practice is constrained by regulations set forth in Chapter Comm 82.34, which does not permit the treatment of wastewater discharged from water closets or urinals for drinking water, but does allow treatment for nonpotable reuse if permitted by the Wisconsin Department of Natural Resources or a POWTS that includes an onsite soil dispersal system. Additional information on water reuse is presented later in this chapter.

Residential
The reuse of municipal wastewater treatment plant effluent for irrigation is currently the most viable option for water reuse. However, it is possible to reuse water for other nonpotable water needs, such as toilet flushing, or for aesthetic uses, such as fountains, providing such aesthetic uses are protected from human contact. However, for such aesthetic uses, the provision of recirculation systems using potable water is often a preferred option. Several states have standards and laws that allow the use of onsite graywater systems in some residences. In Wisconsin, this practice is regulated by Chapter Comm 82.70 of the *Wisconsin Administrative Code*, in which plumbing systems are required to supply water of a quality that meets or exceeds the plumbing treatment standards set forth in the Chapter.

The expanded use of, and increased recharge of, rainwater and snowmelt are related measures which can be used to conserve water and maintain groundwater supplies. Many of the municipalities in the Southeastern Wisconsin Region are implementing stormwater management plans to ensure that rainwater and snowmelt can penetrate the ground to replenish groundwater and to reduce the amount of stormwater that runs off. Chapter VI of this report includes information on various type of measures which can be considered for groundwater recharge. Water may also be reused with the use of rain barrels and other rainwater harvesting systems. Some water utilities in arid climate area have developed programs that provide an incentive or rebate for the implementation of rainwater harvesting practices for residential and commercial customers.

Cost Data
The costs of water reuse programs varies with the specific industrial, commercial, and residential applications concerned. The variables involved include cost of conservation devices, the attendant installation costs, the costs of any necessary renovation of existing plumbing, appliances, or related connections, and water use. For large-scale municipal reclaimed water facilities, the capital costs can be substantial, depending upon the level of treatment and storage needed, and the demand upon and extent of the system. For less sophisticated methods of water reuse, cost data are more readily available. The cost to install a graywater system, including pipes, valves, and tanks, at a single-family residential property can be several hundred to several thousand dollars, depending on the size of the system and the method of installation. Typical costs and savings of residential and commercial rainwater harvesting and rain barrel use are summarized in Table VII-3. The cost per measure includes the rebate and the cost of implementation, which includes labor and advertising.

Rate Structures

Measures

Water utility rates can be a particularly effective means of influencing customers' behavior. However, rate structures which promote reductions in water use may be expected to result in reduced revenue. This reduction in revenue may reduce the incentive for utilities to support this type of conservation measure. The rate structure that is available to a water customer may be expected to have a direct impact on the amount of water that is used. The water rate structure selected should be designed to promote utility and community objectives. There must also be an effective means of communication to the customers in order to influence the choices to be made relative to water use patterns. The different types of rate structures available include:

- *Nonpromotional water rates—Nonpromotional, or conservation-related, rates,* provide a financial incentive for customers to reduce water use. This is usually done by applying a surcharge on peak-month usage, or by charging a higher rate as water usage increases. Examples include: inclining block (tier) rates; seasonal rates; marginal cost pricing; and Individually tailored rates.[15]

- *Other rate structures*—Other rate structures do not offer incentives to customers to adopt water-saving measures. Examples include: declining block structures; flat rate structures, or fixed fee regardless of use; and uniform rate structures, or same unit charge regardless of quantity used.

Table VII-3

WATER REUSE: WATER EFFICIENCY MEASURE COSTS AND SAVINGS

Water Efficiency Measure	Cost per Measure	Water Savings (gpd)[a]
Residential		
Single-Family Rainwater Harvesting Rebate	$ 310	21.6
Single-Family Rain Barrel Rebate	65	2.3
Multi-Family Rainwater Harvesting Rebate	2,475	205.7
Commercial		
Rainwater Harvesting Rebate	$2,475	205.7

NOTE: All costs are updated to 2005 costs.

[a]Gallons per day.

Source: Adapted from GDS Associates, Inc., Texas Water Development Board Study, May 2001.

- *Time of day pricing*—Time of day rate structures level relatively higher prices during peak use periods. This tends to restrict water use during peak periods of demand, and promotes water use during nonpeak periods.[16]

Currently, utilities in the Southeastern Wisconsin Region typically utilize a decreasing block rate structure in which the rates decrease as water use increases. This type of rate does little to encourage water conservation. In Wisconsin, increasing rates as water use increases, or inclining block (tiered) structures, have not been used to date, although they offer an incentive for reducing water use. Table VII-4 summarizes typical United States water

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[15]*American Water Works Association (AWWA),* Water Conservation-Oriented Rates: Strategies to Extend Supply, Promote Equity, & Meet Minimum Flow Levels, *2005.*

[16]*American Water Works Association (AWWA),* op. cit.

utility rate structures, together with attendant potential conservation impacts. It should be noted that rate structure revisions have different impacts on different customer classes. Such variations relate to water use amounts and purposes, as well as to a variety of customer-specific considerations.

Cost Data

The costs attendant to modifying a community rate structure are variable. However, typically, the costs may be expected to approximate a one-time cost of $5,000 to $10,000 for staff data development and analyses, and an additional one-time cost of $5,000 to $10,000 for outside consultant services.

Outdoor Water Use Restrictions

Water Use Restrictions

Outdoor water use restrictions are typically applied as a means to manage public water supply during times of drought or other emergency. However, such restrictions may also reduce water use during some nonemergency times. It is important for a water utility to educate the public about the reasons for the water use restrictions. The highest water use peak days typically occur during the summer months when customers irrigate lawns, trees, and

Table VII-4

TYPICAL WATER UTILITY RATE STRUCTURES IN THE UNITED STATES

Rate Structures	Rate Feature	Likely Impact on Water Conservation
Flat Rate	Charges the user a fixed price regardless of the amount of water used	Least effective in encouraging water usage reduction
Uniform Rate	Charges the same unit rate for all water usage	Can be minimally effective in encouraging water usage reduction
Declining Block Rate	Charges the user less as usage increases	Does not encourage water usage reduction for large water users
Increasing Block Rate	Charges the user more as usage increases	Rewards efficient water usage
Seasonal Block Rates Differentiated Seasonal Summer Seasonal	Charges users a higher rate for water used during the summer Surcharge directed only to users whose peak season use exceeds average use during off-peak season	Encourages water users to be efficient by reducing uses during peak season

Source: Midwest Environmental Advocates, 2005.

other landscaping plant materials. Lawn watering during the heat of the day can—due to evaporation—use up to six times the amount of water required in the morning or early evening.

Currently in Wisconsin, there are few restrictions on water usage. Table VII-5 illustrates the quantity of water that is used in the Region. Additional information on outdoor water use reductions are included under the heading "Private Water Supply Conservation" later in this chapter.

Water Conservation on Municipally Managed Lands
Miscellaneous municipal water use in the Southeastern Wisconsin Region totals about 11.9 million gallons per day. Such uses include, among others, fire protection, public facility building and outdoor uses, and park and open space uses. The municipal outdoor water uses can be managed for water conservation using measures similar to those described later in this chapter for individual homeowners outdoor water use, and for agricultural and irrigation uses. The applicable measures include the use of more-efficient irrigation equipment and practices and the use of water-efficient landscape planning and design.

Cost Data
The costs associated with outdoor use restrictions involve public informational and educational activities and, in some cases, the cost of monitoring and enforcement. The public informational and educational activities may be covered under the budgets for a broader programs. The cost for monitoring and enforcement can involve seasonal employees or contracted services which are dependent upon the size of the community involved.

Water Supply System Efficiency Measures, Including Maintenance and Water Loss Management
Measures
Water utilities typically have some form of water system efficiency program in place, involving maintenance and water loss minimization measures. An effective water loss management strategy may be expected to have several beneficial outcomes, including: more efficient use of supplies; reduced loss due to leakage; reduced disruption to customers; increased knowledge of supply-distribution system, and increased system efficiency.

There are two main types of losses that occur in water utilities: real and apparent. Real losses are the actual physical losses of water from the distribution system through, among other factors, leakage and storage facility overflow. Real losses can increase water utility production costs and cause stress on water supply resources. Apparent losses are losses that occur due to meter inaccuracies, billing errors, and unauthorized consumption. These losses can cost the utility revenue and noticeably alter consumption data required to evaluate conservation measures.[17]

Table VII-5

ESTIMATED USE OF WATER IN THE SOUTHEASTERN WISCONSIN REGION: 2000

Type of Use	Amount (million gallons per day)
Domestic	103.1
Industrial	89.9
Commercial	51.0
Agriculture and Irrigation	12.7
Public and Municipal Uses and Losses	67.1
Total	323.8

Source: U.S. Geological Survey.

[17] *American Water Works Association (AWWA),* op. cit.

Water utilities that implement apparent loss control have the advantage of recovering economic losses that are due to the correction of errors. These errors occur due to inaccurate supply, faulty meters, and errors in estimating, accounting, and billing structure. Management of these errors also provides the utility with the opportunity to correct tampering with meters and bypasses, as well as eliminating illegal connections. The review of billing and the comparison to inventory population data and historic water use data can help identify unauthorized water users.

Real loss control is a particularly important component of good utility management. The detection and correction of leaks within a distribution system will decrease the amount of treated water that does not reach the customer. Although a totally leak-free system may be virtually impossible to create, a water utility that maintains a capability to identify and repair leakage will have the advantage of designing or optimizing the distribution system to prevent current and future problems. Currently, unaccounted-for water utilities in the Southeastern Wisconsin Region average about 12 percent of total pumpage, with a range of from 8 to 13 percent for the average unaccounted-for water within each of the seven counties in the Region. The amount of unaccounted-for water pumped by utilities operating within the Region during 2005 was about 10.7 billion gallons, or an average of 29.0 million gallons per day.

The promotion of water supply system efficiency is often termed "supply-side" conservation. The reliability of routine utility auditing and control of water losses are the two principal factors that supply-side conservation relies upon. A water audit is a compilation of the consumptive uses and losses of the water within a system. Water audits are commonplace in most water supply utilities, but generally do not follow a standardized procedure. The lack of standardization makes it difficult to determine the comparative extent of water loss that is occurring within a water distribution system and in the selection of a water control management plan. The International Water Association (IWA) and the American Water Works Association combined efforts to develop a methodology to control water losses. In the combined Water Audit Method, performance indicators are used to evaluate utilities on specific features, such as average pressure within a distribution system and number of service connections.[18] The water balance components for this method are summarized in Table VII-6.

The IWA/AWWA Water Audit Method provides consistent definitions for water consumption and loss in drinking water utilities. These definitions, along with the performance indicators provided in Table VII-7, facilitate the assessment of water losses and performance comparisons with other utilities. The audit provides a way to determine how much loss is occurring, as well as the associated costs. All water is accounted for in this method by measurement or estimation, allowing for a more accurate assessment of the financial impact losses incur on the water utility.

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[18]*American Water Works Association (AWWA),* Water Audit Methodology: Definitions and Performance Indicators for IWA/AWWA Method, *2006, Available at http://www.awwa.org/WaterWiser/waterloss/Docs/03IWA_AWWA_Method.cfm*

Table VII-6

COMPONENTS OF WATER BALANCE FOR A DISTRIBUTION SYSTEM

System Input Volume (corrected for known errors)	Authorized Consumption	Billed Authorized Consumption	Billed Metered Consumption (including water exported)	Revenue Water
			Billed Unmetered Consumption	
		Unbilled Authorized Consumption	Unbilled Metered Consumption	Nonrevenue Water (NRW)
			Unbilled Unmetered Consumption	
	Water Losses	Apparent Losses	Unauthorized Consumption	
			Customer Metering Inaccuracies	
			Data Handling Errors	
		Real Losses	Leakage on Transmission & Distribution Mains	
			Leakage & Overflows at Utility's Storage Tanks	
			Leakage on Service Connections up to point of Customer Metering	

Source: American Water Works Association, 2000.

Cost Data

As previously noted, water supply efficiency measures, including system maintenance and water loss management, are likely to be the most effective and practical water conservation measures. All of the utilities in the Southeastern Wisconsin Region carry out such measures to some extent. The associated costs vary dependent upon the extent of the current and past efficiency measures, the condition of the water supply system and the level of unaccounted-for water being experienced. For all systems, a level of water efficiency is needed just to maintain the current level of unaccounted-for water. The need for, and costs associated with, additional measures should be determined site-specifically using the IWWA-AWWA procedures previously cited.

PRIVATE WATER SUPPLY CONSERVATION

Private Well Use

As of 2005, there were about 127,000 private wells that are operational in the Southeastern Wisconsin Region. Chapter NR 812 of the *Wisconsin Administrative Code* includes regulations for the design, construction, abandonment, and water quality of private wells within the State. However, there are few regulations for the use of private well water by the owner. Although private water suppliers and systems do not provide potable water in the quantities that municipal or government-owned systems supply, the shallow aquifers that these private wells tap into may be needlessly diminished if not managed properly. In more arid areas of the country, including areas that experience moderate to severe drought, it is not uncommon for private wells to "dry out" for extended periods of time. When properly carried out, private water conservation can play an important role in the sustainability of water supply resources. In this regard, most, but not all, of the residences and other land uses served by private wells are also served by onsite sewage disposal systems. This typically results in most of the spent water being returned to the groundwater system. Thus, in areas served by onsite sewage disposal systems, conservation for water quantity maintenance purposes is less an issue than in areas where the spent water is discharged and transported out of the local hydrologic system. This is not the case where a holding tank is the means of onsite sewage disposal and where the spent water discharged to such systems is trucked away from site for treatment and disposal—usually by a public sewage treatment plant. Figure VII-2 depicts the estimated amount of water used by residents served by private wells in the SEWRPC seven-county area.

Table VII-7

PERFORMANCE INDICATORS FOR NONREVENUE WATER AND WATER LOSSES

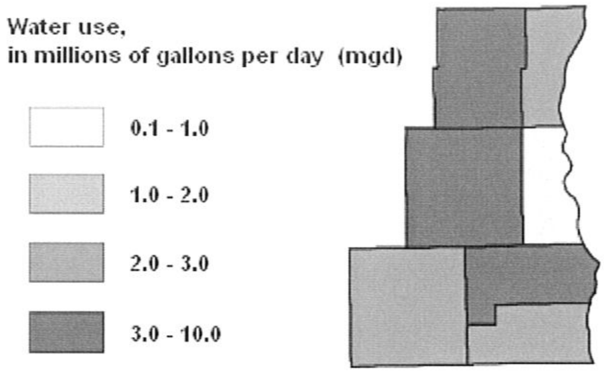
Performance Indicator	Function	Comments
Volume of Nonrevenue Water As a Percentage of System Input Volume	Financial–Nonrevenue water by volume	Can be calculated from a simple water balance; good only as a general financial indicator
Volume of Nonrevenue Water As a Percentage of the Annual Cost of Running the Water System	Financial–Nonrevenue water by cost	Allows different unit costs for nonrevenue water components
Volume of Apparent Losses per Service Connection per Day	Operational–Apparent losses	Basic, but meaningful indicator once the volume of apparent losses has been calculated or estimated
Real Losses As a Percentage of System Input Volume	Inefficiency of use of water resources	Unsuitable for assessing efficiency of management of distribution systems
Normalized Real Losses–Gallons per Service Connection per Day When the System is Pressurized	Operational–Real losses	Good operational performance indicator for target-setting for real loss reduction
Unavoidable Annual Real Losses (UARL)	UARL (gallons/day) = (5.41Lm + 0.15Nc + 7.5Lp) x P where Lm = length of water mains, miles Nc = number of service connections Lp = total length of private pipe, miles = Nc x average distance from curbstop to customer meter P = average pressure in the system, psi	A theoretical reference value representing the technical low limit of leakage that could be achieved if all of today's best technology could be successfully applied. A key variable in the calculation of the Infrastructure Leakage Index (ILI) It is not necessary that systems set this level as a target unless water is unusually expensive, scarce or both
Infrastructure Leakage Index (ILI)	Operational–Real losses	Ratio of Current Annual Real Losses (CARL) to Unavoidable Annual Real Losses (UARL); good for operational benchmarking for real loss control

Source: American Water Works Association, 2000.

Conservation programs for private water systems are similar to those of municipal water systems. Public education is stressed in the promotion of private water conservation. Water users who do not understand the necessity or importance of reducing water demands, or who do not know what measures to take, are less likely to practice conservation measures. The previous section of this chapter presents information on measures and programs, including public education, and fixture and plumbing management which are also applicable to private well owners. The following section outlines additional water conservation measures and practices that may be applicable to private well owners and public water supply system customers alike, including additional information on outdoor water use conservation and on individual behavioral changes.

Figure VII-2

DOMESTIC SELF-SUPPLIED WATER USE IN
THE SOUTHEASTERN WISCONSIN REGION: 2005



Source: SEWRPC.

Conservation Measures for Private and Public Water Consumers

Nationally, the combined indoor and outdoor water use in a single-family household is estimated to average 101 gallons per capita per day (gpcd). Per capita water use in multi-family households ranges between 45 and 70 gpcd.[19] In general, multi-family dwellings use minimal water outdoors and have fewer appliances and fixtures. In southeastern Wisconsin, the combined indoor and outdoor water use in single- or two-family households is estimated to average about 68 gpcd. A breakdown of this water use is shown in Table VII-8.

The installation of more efficient water fixtures and appliances can provide up to a 30 percent reduction in per capita water use.[20] Indoor water conservation can be implemented by fixing leaks, reducing pressure at water outlets, as well as with the installation of low-flush toilets, toilet displacement devices, low-flow showerheads, faucet aerators, high-efficiency clothes- and dishwashers.

The use of higher-efficiency water softeners can be another water conservation measure. Water softeners use about 6 percent of the total flow through the tank for regeneration. Depending upon the percent of the water softened in a residence, this amounts to two to four gallons per capita per day. The savings which could be expected by conversion to more-efficient softeners based upon water volume and/or quality rather than based upon time could be one to two gallons per capita per day. In addition to improved efficiency, water softeners could reduce the amount of sodium chloride discharged to the sanitary sewer system or onsite sewage disposal system. The use of Lake Michigan as a source of supply would eliminate the need for water softening.

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[19] *Amy Vickers,* op. cit.

[20] *American Water Works Association (AWWA),* Stats on Tap, op. cit.

Outdoor Water Use Management

Outdoor water use, primarily lawn, tree, and landscaping plant material irrigation, in the United States is estimated to equal 7.8 billion gallons per day (bgd), or 30 percent of the overall water use.[21] Lawn and landscape maintenance often requires large volumes of water, especially in areas with low rainfall. Outdoor residential water use varies greatly and is highly dependent on geographic location and season. In the United States, outdoor water use in the arid west and southwest is much greater than that in the Midwest. Outdoor water uses also include washing automobiles, maintaining swimming pools and fountains, and cleaning sidewalks and driveways. Outdoor water use by nonresidential customers, such as commercial and publicly owned landscaped areas, is mainly allocated for turf irrigation, and demands approximately 2.7 bgd, on average.[22] However, in Wisconsin, it is expected that outdoor water use, on an annual average, is much lower than that typically estimated in the literature, because of the limited seasonal time period during which outdoor water use occurs. This factor has been accounted for in the development of the data provided in Table VII-8.

A lush, green lawn is commonly considered to be the ideal groundcover for a home and many businesses in the United States and contributes to real property values. Many homeowners are reluctant to reduce the amount of water used to maintain landscaping. To facilitate the use of water for irrigational purposes, many new approaches to landscape design, improved choices in turf and plant selection, and improvements in irrigation systems have been developed. Water-efficient landscaping techniques are popular in the arid southwest. Such techniques incorporate seven principles that promote water conservation and environment protection. While these principles were developed for more arid regions, they are all considered applicable, to some extent, in southeastern Wisconsin: proper planning and design; creation of practical turf areas; selection of low-water plants; use of soil amendments; use of mulches; efficient irrigation; and proper landscape maintenance.

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[21] *Amy Vickers,* op. cit.

[22] Ibid.

Table VII-8

ESTIMATES OF RESIDENTIAL WATER USE WITH AND WITHOUT CONSERVATION ADJUSTED FOR CURRENT CONDITIONS IN SOUTHEASTERN WISCONSIN

Type of Use	Without Conservation (gpcd)[a]	With Conservation (gpcd)[a]	Estimated 2005 Water Uses for Southeastern Wisconsin Areas[b]
Indoor Use[c]			
Toilets	18	10	16
Clothes Washers	15	10	14
Showers	12	10	11
Faucets	10	10	10
Leaks	7	2	3
Baths	1	1	1
Dishwashers	1	1	1
Subtotal	64	44	56
Outdoor Use[d]			
Lawn and Garden Watering	25	N/A	9
Swimming Pools	0	N/A	1
Car Washing	0	N/A	1
Driveway Cleaning and Miscellaneous	0	N/A	1
Subtotal	25	N/A	12
Total	89	- -	68

NOTE: Water use associated with water softening is not specifically included, since it is variable throughout the Region. Where water softeners are used, the regeneration cycle can use about 6 percent of the tank throughput. This would equate to two to four gallons per capita per day.

[a]Gallons per capita per day.

[b]*Ruekert & Mielke, Inc., and SEWRPC.*

[c]*For columns without and with conservation, AWWA,* WaterWiser, *1997 Residential Water Use Summary.*

[d]*For column without conservation, AWWA,* Evaluating Urban Water Conservation Programs, A Procedures Manual, *1993.*

Source: Adopted from footnoted sources.

An effective measure for reducing outdoor water use is to encourage the use of water conserving landscape designs. A natural landscape is typically inherently low maintenance because plants that are chosen are native to the area and have adapted to the climate and the amount of rainfall. Low amounts of supplemental water are required after the plants have become established. Natural landscaping techniques can also decrease the amount of fertilizers and chemicals applied to landscapes and promote the infiltration of water into the ground to recharge aquifers.

Outdoor water conservation may be achieved through the utilization of more efficient landscape irrigation practices and equipment. Typical measures that can be implemented include automatic hose-shutoff nozzles, sensors that shut off sprinkling systems after rain, soil moisture sensors, soaker hoses, improved irrigation system design, weather-driven irrigation system programming, drip irrigation, improved sprinkler heads, rainwater harvesting, and leak repair of hoses and sprinkler systems.

Water conservation may also be achieved through the harvesting of rainwater and use of cisterns. Rainwater harvesting may be defined as the capture, diversion, and storage of rainwater for landscape irrigation (and potable water, in some cases). Rainwater is typically captured in cisterns, barrels, or other types of storage tanks, and can be used for maintenance of landscaped areas, such as parks, schools, commercial and industrial sites, parking lots, and apartment complexes, as well as in landscape plantings for residences. The capture of water from roofs and other impervious surfaces can reduce the amount of runoff that can potentially contribute to stormwater management problems.

More extensive rainwater harvesting systems are used on a limited basis in other areas. Such systems are sometimes designed to serve a dual function of reducing stormwater runoff and harvesting rainwater for selected nonpotable uses. Most rainwater harvesting collection systems are designed to capture rainwater from the roofs of buildings. The water is then transported through gutters and other pipes into cisterns or tanks, where it is stored until needed. The water collected can be used for various nonpotable uses. A typical rainwater collection system may consist of a collection area, usually a roof; a means for conveying the water, usually gutters, downspouts, and piping; a storage tank or cistern; and a system to distribute the water as needed. All collected rainwater will contain some suspended solids and other contaminants which can be present, due to bird droppings, air pollution fallout, and other sources. Thus, care must be taken to prevent unintended human consumption of the water. Some systems have been designed to incorporate first flow diverters, or presettling facilities, to reduce the sediment and related contaminant content of the runoff.

Water Conservation: Behavioral Change

In addition to the physical changes that may be made to reduce indoor and outdoor water usage, a change in the behavior of water consumers is important to water conservation. Behavioral practices include the changing of water use habits to reduce the volume of water consumed in a household or building. The U.S. Environmental Protection Agency recommends a series of water-conserving practices that can be applied to indoor and outdoor water usages. For indoor water conservation, these measures range, for indoor water conservation from not running taps during such chores as shaving, brushing teeth, and washing dishes, to shorter showers and more efficient use of appliances, such as dishwashers and washing machines.

Cost Data

Literature research indicates that the costs attendant to private and public water conservation measures by consumers vary greatly depending on a multiplicity of factors. Conservative estimates of these costs are provided in Table VII-9. Due to the differences in costs found in literature review, a range of values is provided, as summarized in Table VII-9.

AGRICULTURAL AND OTHER IRRIGATION WATER CONSERVATION

In the United States, agricultural irrigation is the predominant use of freshwater supplies. According to the most recent U.S. Geological Survey of national water use conducted in 2000, total freshwater withdrawals for agricultural and horticultural irrigation and other uses, including golf course irrigation, are estimated at 134 bgd, which equals approximately 39 percent of the total withdrawal of freshwater. Of the 134 bgd in withdrawals for these purposes, approximately 61 percent is consumed by crops and livestock, 20 percent becomes return flow to surface water and groundwater supplies, and 19 percent is lost.[23] In the Southeastern Wisconsin Region, during 2000, agricultural and other irrigation water uses were estimated to be 12.7 million gallons per day, or about 4 percent of the total water used within the Region, excluding thermoelectric uses. A depiction of the total water use and locations of irrigation wells throughout the SEWRPC seven-county area is provided in Figure VII-3.

Several factors affect agricultural water use, including: the price of water, water availability, climate and weather, crop requirements, soil, type of irrigation system used, control of water application, and farm characteristics. The depletion of water supplies for agricultural use is an important agricultural concern due to the dependence of some types of farming on irrigation, and the high water usages that some types of farming incur. The protection of surface and groundwater sources from runoff pollution and erosion are also issues that need to be addressed in agricultural water conservation.

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[23]*Amy Vickers,* op. cit.

Measures

Agricultural irrigation efficiency may be defined as crop yield per unit of water use. Irrigation efficiency is also called water use efficiency (WUE). The efficiency of water use on a farm, and indeed in any water supply system, is inevitably less than 100 percent, regardless of conservation measures. This loss is due to a portion of the

Table VII-9

TYPICAL CONSERVATION MEASURES, COSTS, POTENTIAL SAVINGS, AND ADVANTAGES

Conservation Measure	Cost to Implement[a]	Potential Savings in End Use[b]	Advantages
Utility System Leak Detection and Repair	Leak detection: $160-$530 per mile, repair: variable costs[3]	10-20 percent[1]	Benefits include reduced O&M costs, such as chemicals, energy & labor, and reduced capital costs for production, treatment, storage, transportation, and distribution facilities
Utility System Water Audits	Audit cost: $530-$2,650 per leak[3]	12-33 percent [1]	Utility audits are a reliable and standardized way to improve the reporting accuracy for water delivery components of valid usage and losses
Plumbing Retrofits	$15-$40 per kit per household (with installation)[4] $2-$25 per kit per household (without installation)[4]	13.4 gpcd[2] or 20 percent of plumbing and fixture water use	Residential retrofit is one of the most practical and effective approaches in providing water consumers with "how-to" information on altering water use habits. At the same time, it provides them with the technology to save water with the least impact on their lifestyle. The greatest water savings can be achieved by combining the use of conservation devices with behavioral changes since these two actions tend to reinforce each other
Toilet Retrofit	$60-$245 per unit[3]	7.9 gpcd[5]	Toilet retrofit programs can promote consumers in older communities to replace water-inefficient toilets. Toilet rebates and replacements offer attractive incentives to consumers who install ultra-low flush toilets that use 1.6 gpf or less
High-Efficiency Clothes Washer Rebate	$60-$620[4]	4.4 gpcd[4]	High-efficiency clothes washers have the capability to save large quantities of water. Washer rebates promote the water customer to install newer models that save water and reduce energy and utility bills
High-Efficiency Water Softener Installation	400-700	1.0 to 2.0 gpcd	Effectiveness is variable throughout the Southeastern Wisconsin Region. The use of high-efficiency water softeners would reduce the sodium chloride levels in the wastewater. Areas served by Lake Michigan as a source of supply do not need water softening
Residential Surveys and Public Education	$40-$215 per survey, Variable costs for other materials[3]	5-10 percent[1] of use by targeted customers	Public information/education programs are critical tools that create community awareness about water conservation and market water efficiency strategies to customers. The direct costs to implement this type of program, as well as the direct water savings associated, differ with each area and are difficult to estimate
Residential Graywater Reuse	$1,050-$3,160 in parts and installation[3]	20-30 gpcd[1]	Graywater systems have the capability of reducing potable water use for applications such as nonfood irrigation and toilet flushing
Outdoor Residential Audit	Variable costs[3]	5-10 percent of outdoor use[2]	Over 50 percent of residential water use is due to outdoor water use. Residential audits can help the customer become aware of the high usage and to promote more efficient use of water

Table VII-9 (continued)

Conservation Measure	Cost to Implement[a]	Potential Savings in End Use[b]	Advantages
Rate Structure–Increasing Block Rate	Variable costs[(1)]	5 percent[(2)]	Inclining block rates promote water conservation by increasing the price of water as consumption increases
Residential Metering	$265-790 per meter[(3)]	20 percent[(2)]	Metering of residential water allows suppliers to target the areas/households that do not have efficient water use for future conservation programs
Landscape Require-ments for New Developments	Variable costs[(3)]	10-20 percent of outdoor water use in sector[(2)]	Landscape requirements for developers promotes the builders to install efficient irrigation systems. Homeowners in new developments are also required to utilize natural plants that are more water efficient
Landscape Irrigation Ordinance	Variable costs[(3)]	10-20 percent of outdoor water use[(2)]	Landscape irrigation ordinances can reduce the total water demand, as well as peak water demand
Rainwater Harvesting Rain Barrel	$1,000-$10,000[(4)] $70-$140	Variable savings due to regional rainfall differences and operational variability[(4)]	Collected rainwater may be used to save potable water, energy, and chemical costs since the rainwater is used directly instead of first being treated and distributed by a supplier

NOTES: gpcd means gallons per capita per day. Water use associated with water softening is not specifically included, since it is variable throughout the Region. Where water softeners are used, the regeneration cycle can use about 6 percent of the tank throughput. This would equate to two to four gallons per capita per day.

[a]*Costs to implement are based on direct and indirect costs and are updated to 2005 costs.*

[b]*Actual water savings can vary substantially according to a number of factors.*

Sources: *(1) PBS&J, Burton & Associates,* Water Supply Needs & Sources Assessment: Alternative Water Supply Strategies Investigation: Assessment of the Cost Effectiveness of Specific Water Conservation Practices*, 1999.*

(2) U.S. Environmental Protection Agency, USEPA Water Conservation Plan Guidelines*, August 1998.*

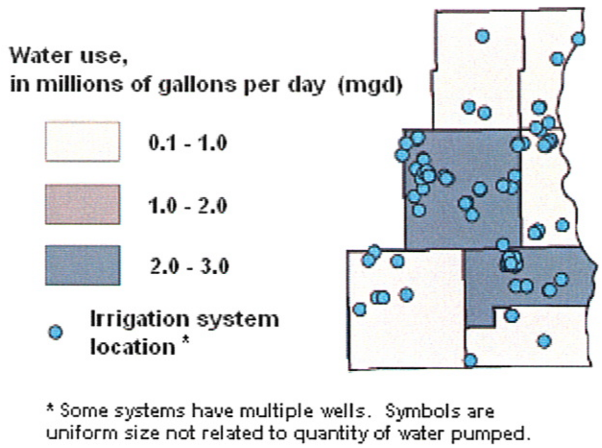
(3) A & N Technical Services, Inc., BMP Costs & Savings Study: A Guide to Data and Methods for Cost-Effectiveness Analysis of Urban Water Conservation Best Management Practices*, March 2005.*

(4) Amy Vickers, Handbook of Water Use & Conservation*, 2001.*

(5) AWWA WaterWiser, *"Household End Use of Water Without and With Conservation," 1997 Residential Water Use Summary – Typical Single Family Home.*

Figure VII-3

IRRIGATION WATER USE SYSTEM LOCATIONS : IN THE SOUTHEASTERN WISCONSIN REGION: 2000



Source: U.S. Geological Survey, 2002.

applied water that is unavailable to crops because of application and weather conditions. Evapotranspiration, leaching requirements, and stored moisture in the soil are the basic needs of a plant that must be satisfied to benefit the crops concerned. The reduction of farm water use by improved irrigation technologies and efficient water management practices are the two types of agricultural water conservation. Irrigation efficiency (IE) is defined by the following equation:[24]

$$IE = \frac{\text{Volume of Irrigation Water Beneficially Used} \times 100}{\text{Volume of Irrigation Water Applied}}$$

Three basic types of agricultural irrigation are currently in use: surface—or gravity—irrigation, sprinkler irrigation, and micro-irrigation. Table VII-10, provides information on the typical efficiencies for each type of irrigation system.

Surface irrigation systems are the most widely used irrigation method in the United States. Fifty percent of the total irrigated farmland uses this type of irrigation.[25] However, this system typically has the lowest water-use efficiency of any irrigation system. Surface irrigation methods include flood and furrow, border, and basin irrigation. In these systems, water is generally pumped to the upper end of a ditch or pipe to create a high enough head to allow water to flow by gravity across the field surface. Capital costs are low with the use of this irrigation system. However, design and management depend largely on soil properties that are difficult to measure, which can create problems.[26] This type of irrigation is not typically used in the Southeastern Wisconsin Region.

Sprinkler irrigation involves the application of water in a manner similar to natural rainfall. The water is pumped through a system of pipes, where it is sprayed into the air and onto the crops concerned through sprinkler heads. The pump supply system, sprinklers, and operating conditions are designed to provide a uniform application of water. In the United States, approximately 46 percent of irrigated farmland is watered by sprinkler systems. In general, sprinkler systems are more water efficient and require less labor than gravity systems, since farmers can more readily control the irrigation schedule and the amount of water applied. Runoff and percolation below the crop root zone is significantly reduced. Sprinkler systems require higher capital costs and more energy than gravity systems.[27] This type of irrigation is the most common type used in the Southeastern Wisconsin Region.

Micro-irrigation, commonly known as drip irrigation, is an irrigation method that slowly applies water to the roots of plants. This is done by depositing the water on the soil surface or directly into the root zone using a network of pipes, valves, tubing, and emitters. Micro-spray heads are sometimes used in place of emitters, in which water will spray in a small area. This type of irrigation is typically used on tree and vine crops, as well as nonrotated crops. Subsurface drip irrigation (SDI) uses buried dripperline or drip tape, and this type of irrigation is becoming more widely used for row crop watering in areas where freshwater supplies are limited. Bubbler irrigation releases small streams of water to form pools on the soil surface. The goal of this type of irrigation system is to minimize water waste. Micro-irrigation is the most costly system of the three basic types, and approximately 4 percent of farmland in the United States is irrigated by this system.[28] This type of system is not typically used in the Southeastern Wisconsin Region.

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[24]Ibid.

[25]Ibid.

[26]*Blaine Hanson, and Larry Schwankl,* On-Farm Irrigation, *Water Management Handbook Series (Publication No. 94-01), 1994, Available at http://www.energy.ca.gov/process/agriculture/ag_pubs/surface_irrigation.pdf.*

[27]*Amy Vickers,* op. cit.

[28]Ibid.

Table VII-10

EFFICIENCIES OF TYPICAL IRRIGATION SYSTEMS

System Type	Efficiency[a] (percent)	System Type	Efficiency[a] (percent)	System Type	Efficiency[a] (percent)
Surface Systems		Sprinkler Systems		Micro-Irrigation Systems	
Level Border	60-80	Linear move	75-90	Surface/subsurface drip	85-95
Furrow	60-80	Center pivot (low pressure)	75-90	Micro spray or mist	85-90
Surge	65-80	Fixed solid set	70-85		
Graded Border	55-75	Center pivot (high pressure)	65-80		
Corrugate	40-55	Hand move or side roll laterals	60-75		
Wild Flood	25-40	Traveling gun	60-70		
		Stationary gun	50-60		

[a]*Efficiencies shown assume appropriate irrigation system selection, correct irrigation design, and proper management.*

Source: Modified from ATTRA, 2006 (http://www.attra.ncat.org).

Agricultural programs that are sponsored by regional, state, and federal agencies and water utilities can encourage farmers and other irrigators to use water more efficiently. In California, for example, the Colorado River Basin and a few other freshwater-limited regions have experienced the use of new approaches to pricing and allocating irrigation water. Tiered pricing strategies have been implemented in which farmers are able to purchase, sell, and trade water based on their needs. These regions also use water banking, which enables a farmer to "deposit" unused water in a bank for another farmer to rent at a price for the depositor.[29] Several options for improving agricultural on-farm irrigation efficiency and crop productivity are summarized in Table VII-11.

The potential water savings from improved agricultural water practices can be as high as 50 percent.[30] Improvements in agricultural water use can be achieved through the use of more efficient technology and water management practices, including water metering (measurement), and improved irrigation scheduling.

It should be noted that in the Southeastern Wisconsin Region, the majority of the farming operations do not use irrigation. Thus, the relatively low percentage—approximately 4 percent—of the total water supply used for this purpose. However, as land becomes more valuable and farming practices change to more-intensive uses, the need for water supply to sustain this industry may increase over time. This will likely be the case on a per acre of agricultural land basis.

Cost Data

Several costs must be considered in the development of agricultural water conservation plans. Table VII-12 summarizes common agricultural water conservation measures and the cost of implementation for each.

INDUSTRIAL, COMMERCIAL, AND INSTITUTIONAL WATER CONSERVATION

In the Southeastern Wisconsin Region, commercial and industrial water use was estimated to average 51 mgd and 90 mgd, respectively, in 2000. This accounts for about 43 percent of the total use, not including thermoelectric water use. The water that is used by industrial and commercial water consumers is provided by a combination of

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[29]Ibid.

[30]Ibid.

Table VII-11

OPTIONS FOR IMPROVING AGRICULTURAL ON-FARM IRRIGATION EFFICIENCY AND CROP PRODUCTIVITY

Category	Options
Institutional	Conservation coordinator to provide technical assistance Conservation plan and program development assistance Policies or inventories for efficient on-farm water use and penalties for inefficient use
Educational	On-farm water audits Field and workshop training programs Training materials, workbooks, and software Newsletters and periodicals Internet information networks and listservs
Financial	Conservation-oriented pricing Water marketing Low-interest loans Grants and rebates for purchase of more efficient irrigation equipment and tools
Managerial	On-farm water measurement (metering) Soil moisture monitoring Irrigation scheduling Evapotranspiration rates and other data from weather station networks Tailwater reuse Conservation tillage Canal and conveyance system lining and management Limited irrigation/dryland farming Deficit irrigation
Technical	Laser-graded land leveling to allow more uniform application of water Furrow diking to promote soil infiltration and minimize runoff Low energy precision application (LEPA) to reduce water losses from evaporation and wind drift Surge irrigation to spread irrigation applications uniformly Drip irrigation to reduce water losses from evaporation, increase crop yields, and reduce chemical and energy use
Agronomic	Enhanced precipitation capture (rainwater harvesting) Reduced evaporation through improved use of crop residues, conservation tillage, and plant spacing Sequencing of crops to optimize yields, given soil and water salinity conditions Selection of native and drought-tolerant crops to match climate conditions and water quality Breeding of water-efficient crop varieties

Source: Amy Vickers, Handbook of Water Use and Conservation, *May 2001.*

public supply systems and self-supplied sources. Figure VII-4 depicts the total self-supplied withdrawals for industrial use in the SEWRPC seven-county area.

Commercial water users generally provide a retail service or product. Retail stores, including food and drug stores, hotels, and amusement complexes are typical examples of commercial users. Institutional water users generally perform a service or function and are similar in the type of water use needs to commercial and businesses. However, water uses are generally high for facilities, such as schools and hospitals. These customers usually require water for domestic applications, cooling and heating, and landscape irrigation. Industrial customers generally engage in product manufacturing and processing operations, such as food and beverage, paper, steel, electronics, and chemicals. This type of customer uses water for four primary functions: heat transfer—heating and cooling, materials transfer—industrial processing, washing, and as an ingredient.[31]

[31]Ibid.

Table VII-12

COSTS OF AGRICULTURAL IRRIGATION WATER CONSERVATION MEASURES

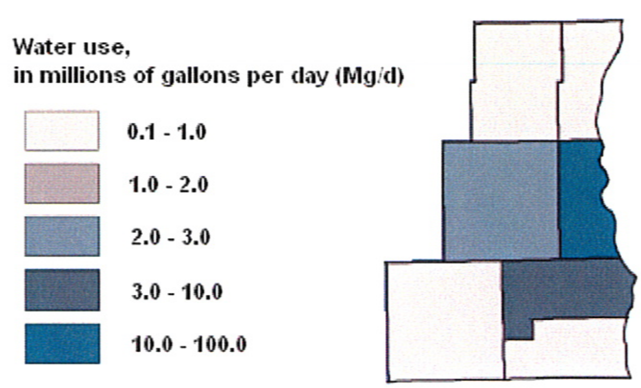
Conservation Measure	Cost to Implement[a]
Irrigation Measurement (metering)	$250-$2,200 per meter
Soil Moisture Monitoring	
Gypsum Blocks and Meter	$6-$20 per block, $250 for meter
Heat Dissipation Blocks and Meter	$40-$65 per block, $185-$745 per meter
Tensiometer	$60-$95
Neutron Probes	$4,300-$5,600 (automated permanent installation: $15,000)
Gravimetric Measurement	$30-$125 per sample
Infrared Thermometer	$3,100-$6,200
Pressure Bomb	$1,400-$3,100
Resistance Probe	$12-$220
Hand-Held Resistance Meter	$185-$310
Capacitance Probe	$620
Irrigation Scheduling	Dependent on needs and existing tools and practices
Laser Leveling	$50 per acre (every two to three years)
Furrow Diking	$185-$310 per row
Low Energy Precision Application (LEPA)	$49,500-$55,600 per system, ($8,000-$10,500 for conversion of existing partial-drop, center-pivot system)
Surge Valves	$15 per acre ($1,250-$1,850 per valve)
Drip Irrigation	$1,050-$1,250 per acre
Tailwater Reuse	Varies (purchase and installation of pumps, pipeline, surge valves, and operation and maintenance costs)
Conservation Tillage	$0-20 per acre
Canal and Conveyance System Lining and Management	Varies significantly

[a]*All costs are updated to 2005 costs.*

Source: Adapted from Amy Vickers, Handbook of Water Use and Conservation, *May 2001.*

Figure VII-4

INDUSTRIAL SELF-SUPPLIED WATER USE IN THE SOUTHEASTERN WISCONSIN REGION: 2000



Source: U.S. Geological Survey, 2002.

Conservation programs for industrial and commercial water users are site-specific and often are typically more difficult to create and execute than for residential users. Industrial, commercial, and institutional processes vary greatly and there may be significant differences in processes used by several companies within the same industry.

There are several State and local government agencies that promote water conservation within industrial commercial, and institutional facilities. Funding, water audits, and consultation are available to many establishments that wish to reduce the total use of water within their processes. For example, the State of Washington has a Toxic Reduction Engineering Efficiency (TREE) team that provides free technical assistance to industry. The goal of this program is to reduce the generation of toxic wastes, as well as to reduce the use of water. Incentives are often the most effective way to motivate industrial, commercial, and institutional water users to engage in water conservation measures. Some water suppliers motivate commercial entities to reduce water use by providing a cash rebate based upon the amount of water use reduction.[32] Inclining water rates and restrictions or prohibitions on inefficient usage are incentives that are often used to drive conservation. Increasing customer awareness of economic, environmental, and regulatory benefits of conservation practices is also a means of promoting efficient water use. Water conservation can create benefits to industrial, commercial, and institutional facilities by a reduction in water use and often with an attendant reduction in wastewater flows. However, the amount of water use reduction which is practically achievable will vary with a number of factors, including the current state of the facilities and processes with regard to water efficiency, the type of facility, and its current water use. In addition, there is typically a cost involved in equipment and process operational changes. Thus, the cost-effectiveness of water conservation can best be determined on a case-by-case basis by the facility owner and operator.

Measures

Water use practices differ greatly for industrial, commercial, and institutional entities, and several technologies and water-efficiency measures are applicable to the water-using activities, processes, and equipment commonly found in these facilities. Many of the measures applied involve operational adjustments and engineering design changes that are unique to particular processes and facilities. The water use of commercial facilities and institutions is often related to the populations they server, such as the number of customers, students, visitors and patients, and employees. There are several methods to estimate the efficiency of water use among industrial, commercial, and institutional facilities; however, the use of an onsite water audit for each facility can produce the most accurate assessment. Conducting a water audit and the preparation of a site water conservation plan are the first steps toward increasing water-use efficiency. The basic steps in conducting a water audit and creating an effective water conservation program can be seen in Table VII-13.

For industrial, commercial, and institutional (ICI) facilities, the greatest water savings have traditionally been achieved through the use of domestic plumbing fixtures such as low-volume toilets, urinals, showerheads, and faucets. The adjustment of blow-down cycles in cooling equipment and recycling process water also contributed to water savings, particularly in industrial facilities. The alteration, or cutting back, of irrigation schedules offers a significant savings in water use, and may be considered one of the most cost-effective measures that can be applied. The evaluation of water use at ICI facilities may also be more cost-effective if water audits are focused on water-efficiency measures for domestic uses, especially at commercial, governmental, and institutional locations. In general, meters and meter readings are beneficial to ICI facilities by providing information on how much and where water is being used. However, facilities with complex production processes that use water will typically require a more complex analysis to identify opportunities for water conservation. The average potential water savings from conservation measures at various types of commercial and institutional facilities has been estimated from onsite water audits and has been summarized in Figure VII-5.

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[32]*GDS Associates, Inc.,* op. cit.

Table VII-13

BASIC STEPS OF A COMMERCIAL/INDUSTRIAL WATER AUDIT

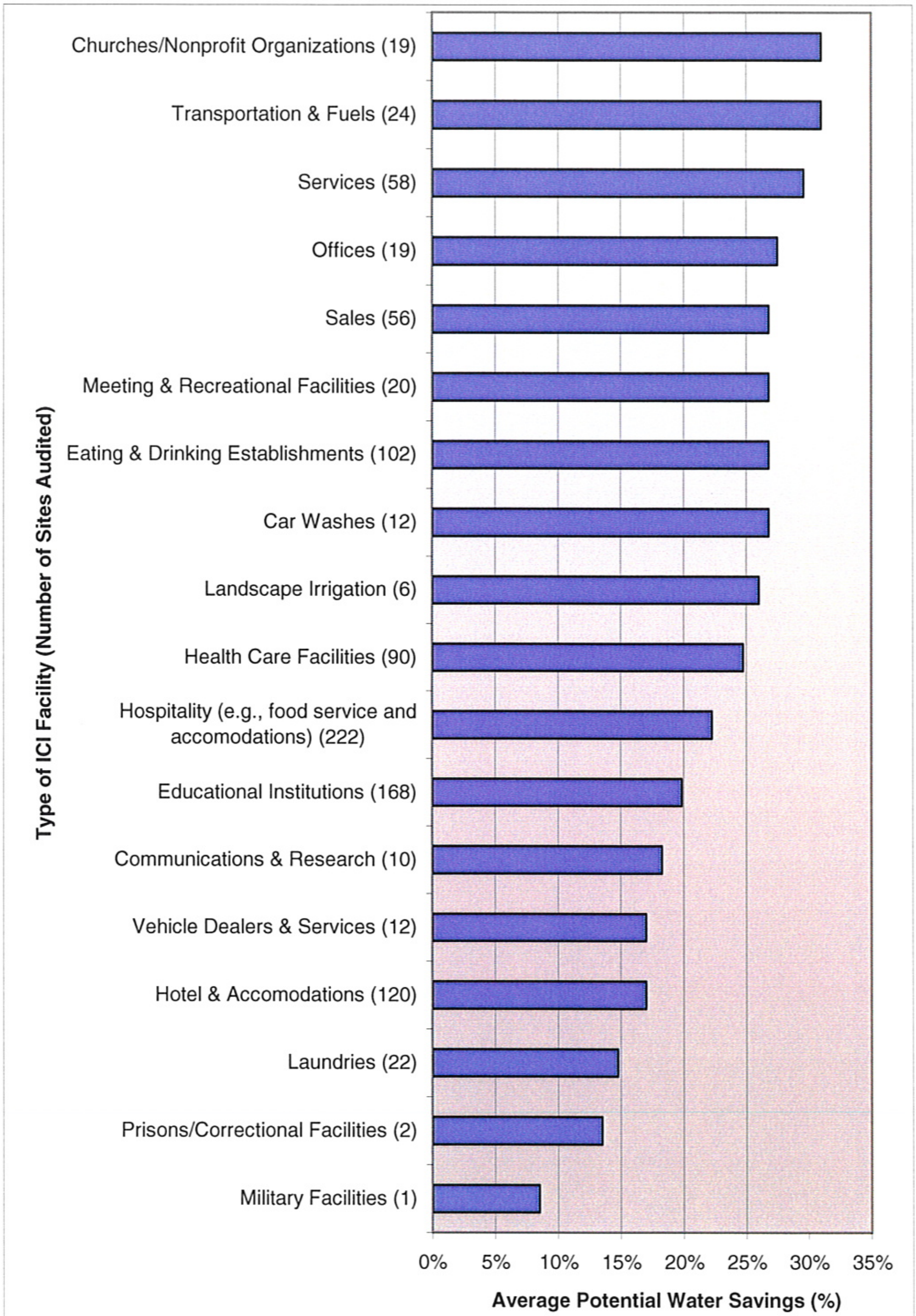
Step 1:	**Obtain Support from the Facility's Owner, Managers, and Employees** Management support is essential to ensure that the resources required to implement a conservation program—personnel, time, and money—are available. Emphasizing the advantages of saving water and related benefits can boost support
Step 2:	**Conduct An Onsite Inventory of Water Use** A fundamental part of a water management plan is knowing where and how much water us used at the facility. Collect meter-reading records for all onsite meters. Complete a walk-through survey of the facility with the plant manager or engineer to collect information on each water-using process, piece of equipment, fixture, and activity. Record the measured or estimated water use and flow rates. The end product of this survey should be a water "balance sheet" that identifies and quantifies water use throughout the facility
Step 3:	**Calculate All Water-Related Costs** Results from the audit and data collected on the water balance sheet can be used to prepare a summary of the volume and cost of water used at the site. Costs associated with water use include those for water and sewer service, energy costs, chemical treatment costs, and waste pretreatment. In cases in which excessive use or leaks have caused property damage, the cost of mitigating the damage should be included. Other costs to consider are future increases in the price of water and sewer service, chemicals, and energy
Step 4:	**Identify and Evaluate Water-Efficiency Measures** Identify all potentially feasible water-efficiency measures for each water-using activity. A detailed description of water-efficiency measures that are applicable to customers, along with information about potential water savings that could be achieved with each measure, determine the capital cost and related expenses associated with the measure. Based on these data, estimate a simple payback period, or the amount of time required for projected cost savings from the measure to equal the investment cost
Step 5:	**Evaluate Payback Periods Using Life-Cycling Costing** Life-cycling costing is a more accurate method for evaluating the cost-effectiveness of efficiency measures because it amortizes costs and benefits over the measure of the life of the measure, including changes in interest rates, instead of taking into account only the initial investment. A measure that appears to be too expensive may be a cost-effective investment when its costs and benefits are amortized
Step 6:	**Prepare and Implement An Action Plan** Prepare a written version of the facility's water management plan. The plan should clearly state the program's goals, the way water is used, the water-efficiency measures to be implemented, projected water savings, benefits and costs associated with the efficiency measures, estimated payback periods, the schedule for implementing the measures, and the person responsible for the program. Once the plan is approved, it should be implemented promptly
Step 7:	**Track and Report Progress** Monitor results of the water-efficiency measures that were implemented to determine reductions in water use and related operational expenses. Keep employees informed about changes in the facility's water demand. Announce water savings in employee bulletins, corporate reports, publications of the facility's trade and professional organizations, and press releases to the media

NOTE: Water-efficiency measures for certain water uses and industries, such as medical and food-processing facilities, should be reviewed with appropriate local, state, and federal regulatory agencies and officials before being implemented.

Source: Adapted from Amy Vickers, Handbook of Water Use and Conservation, *May 2001.*

Figure VII-5

AVERAGE POTENTIAL WATER SAVINGS FROM CONSERVATION FOR MAJOR ICI MARKETS



Source: Amy Vickers, Handbook of Water Use and Conservation, *May 2001.*

Cost Data
The costs associated with industrial, commercial, and institutional water conservation programs are difficult to determine, varying significantly on a site-specific and process-specific basis. Case studies and water-efficiency audits of a large number of industrial, commercial, and institutional facilities have reported variable water savings from conservation measures. ranging from 10 percent to 90 percent of previous water use. The costs for the various measures and practices are variable with the type and size of the facility and the type of process and equipment in place. Furthermore, the analysis of the benefits of potential water savings must be coupled with the costs of equipment and process and operational changes to determine the potential cost-effectiveness of water conservation measures. Thus, no specific cost data is provided herein.

THERMOELECTRIC WATER CONSERVATION

Thermoelectric power generation is the production of energy from fossil fuels, nuclear energy, or geothermal energy. The United States uses more water to produce electricity than for any other application. Thermoelectric plants convert water into steam by heating it with fossil or nuclear fuels, and in turn the steam drives turbine generators. Water is circulated throughout the power plants in large quantities to cool the turbines, clean scrubbers and boilers, and perform a number of other tasks. This type of electricity generation provides 97 percent of electric power in the State of Wisconsin.[33] Figure VII-6 depicts the quantity of thermoelectric water use in Wisconsin versus all other uses. The location of thermoelectric power plants in the SEWRPC seven-county area is shown in Figure VII-7.

Thermoelectric power plants utilize a majority of the water that is withdrawn for cooling the power-producing equipment. Most of the large power plants utilize once-through cooling systems in which water is withdrawn from a source, circulated through the heat exchangers, and then returned to a surface waterbody.

Closed-loop cooling refers to cooling systems in which water is withdrawn from a source, circulated through heat exchangers, cooled, and recycled for further use. Subsequent water withdrawals for a closed-loop system are used to replace water lost to evaporation, blowdown, drift, and leakage. Closed-loop cooling systems typically withdraw less water than once-through cooling systems. However, closed-loop systems result in larger quantities of water that is consumed rather than returned to the source. Power plants that are equipped with once-through cooling systems account for approximately 91 percent of water withdrawals for thermoelectric power, while plants equipped with closed-loop cooling systems withdraw the remaining 9 percent in the United States.[34] Cooling technologies that require less water also allow for the production of thermoelectric power in areas where water is scarce or strictly managed. Water-scarce States such as Arizona, Nevada, and New Mexico use closed-loop cooling systems rather than the more water-intensive once-through cooling systems.

In Oak Creek, Wisconsin, the existing power plant draws up to 1.8 billion gallons of Lake Michigan water per day for use in the once-through cooling system. An expansion is under construction that will have a 20 percent increase in water withdrawal in the same type of system. This expanded plant is expected to returning 99.9 percent of the water back to the Lake. Similar cooling systems are in place at the Valley Power Plant in the City of Milwaukee, and the Port Washington Power Plant in the City of Port Washington. The Pleasant Prairie power plant in the Village of Pleasant Prairie, Wisconsin is located five miles away from Lake Michigan, where a closed-loop system with large cooling towers is used. The majority of the water used is make-

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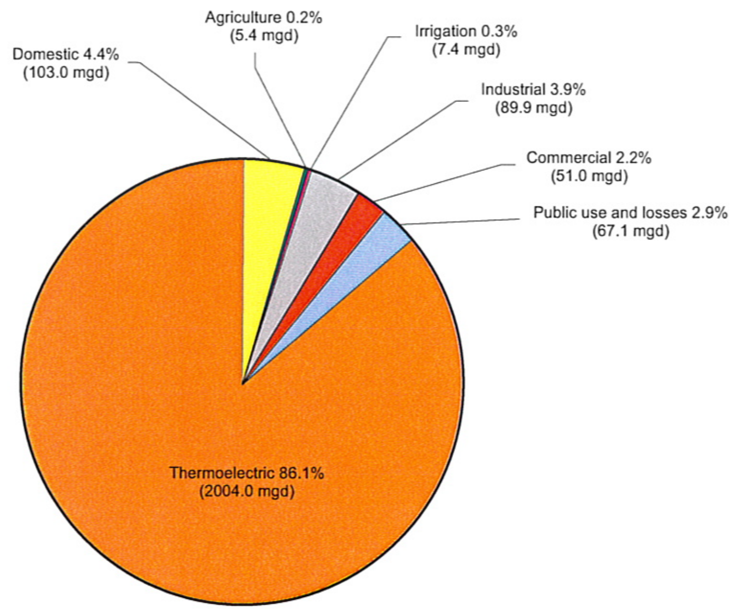
[33]*B.R. Ellefson, et. al.* Water Use In Wisconsin, 2000, *U.S. Geological Survey Open-File Report 02-356. 2002. Available at http://wi.water.usgs.gov/.*

[34]*U.S. Geological Survey,* Estimated Use of Water in the U.S. in 2000, *Mar 2004, Available at http://pubs.usgs.gov/circ/2004/circ1268/htdocs/text-pt.html.*

Figure VII-6

THERMOELECTRIC WATER USE AND OTHER USES IN SOUTHEASTERN WISCONSIN: 2000

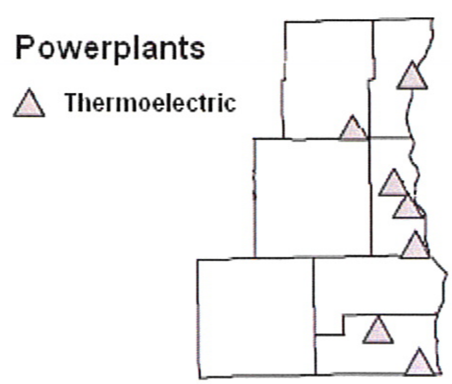


NOTE: mgd means million gallons per day.

Source: U.S. Geological Survey.

Figure VII-7

THERMOELECTRIC POWER PLANT LOCATIONS IN SOUTHEASTERN WISCONSIN REGION



Source: U.S. Geological Survey, 2002.

up water for cooling the towers. We Energies reports that nearly 75 percent of the water used is evaporated to the atmosphere.[35] There are also two small peaking combustion turbine power plants in the Southeastern Wisconsin Region: one in the Village of Germantown in Washington County, and one in the Town of Paris in Kenosha County. These plants use limited amounts of well water for cooling on an intermittent use basis. The Milwaukee County power plant purchase treated surface water from the municipal water system for cooling and other process uses.

In order to conserve water in thermoelectric power production, new technologies are under development to reduce the amount of water withdrawn and consumed in cooling processes. Reductions in water withdrawals and water consumption for thermoelectric power production are also achievable through the use of dry cooling systems. In these systems, water does not come in contact with air. Dry cooling reduces the amount of water needed to replace water lost to evaporation significantly. However, dry cooling systems are less efficient than once-through water cooling systems and have higher capital costs.[36]

In addition to the use of improved technologies, reductions in water withdrawals and water consumption for the purposes of power production may be achieved through energy conservation. When less energy is in demand a lesser amount is produced by power plants, which can conserve the natural resources required in the production process. Although more costly to implement, wind, solar and other renewable energy systems are a growing trend in the United States that can reduce the need for resource consuming power plants. The major power company which serves the Southeastern Wisconsin Region, We Energies, is actively pursuing alternative forms of energy.

Cost Data

Optimization of cooling process water use can result in considerable water savings. The costs to implement more water efficient technology in thermoelectric power plants varies significantly with the water requirements required by the size of the plant. Most of the power used in the Southeastern Wisconsin Region is generated in power facilities using once-through water cooling systems which are the most efficient in terms of water use. Given the private ownership and design and operation expertise of the facility owners, it may be concluded that the cost and benefits of water use conservation measures can only be considered by the utilities involved as facilities are expanded and upgraded.

WATER REUSE AND RECLAMATION

Some communities throughout the United States are considering the reclamation and reuse of water to reduce demands on freshwater supply systems. Water reuse is the use of water or reclaimed water from one application for another. A large number of industries have begun to consider other uses for treated wastewater effluents to regain investments made in the treatment of wastewater to meet restrictive discharge limits. Reclaimed wastewater is currently used as an alternative source of water for a variety of applications, such as landscape and agricultural irrigation, toilet and urinal flushing, industrial processing, power plant cooling, wetland habitat creation, restoration and maintenance, and groundwater recharge.[37] A few communities have fully incorporated the reuse of wastewater into water supply systems, and some states require that municipalities consider water reuse before upgrading or building a new water or wastewater treatment plant.

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[35] *We Energies,* Oak Creek Power Plant Expansion: Protecting Lake Michigan*, 2003, Available at http://www.powerthefuture.net/publications/factsheet_oakcreek_waterusage.pdf.*

[36] *Midwest Environmental Advocates,* Protecting Wisconsin's Water: A Conservation Report & Toolkit*, 2005, Available at http://www.midwestadvocates.org/.*

[37] *U.S. Environmental Protection Agency,* Guidelines for Water Reuse*, September 2004, Available at http://www.epa.gov/ORD/NRMRL/pubs/625r04108/625r04108.pdf.*

For public health and aesthetic reasons, reuse of treated sewage effluent is presently limited to nonpotable applications such as irrigation of nonfood crops and provision of industrial cooling water. There are no known direct reuse schemes using treated wastewater from sewerage systems for potable water uses. Indeed, the only known systems of this type are experimental in nature, although, in some cases, treated wastewater is reused indirectly, as a source of aquifer recharge. Table VII-14 presents guidelines for the utilization of wastewater, indicating the type of treatment required, resultant water quality specifications, and appropriate setback distances. In general, wastewater reuse is a technology that has had limited use, primarily in small-scale projects in the Region, owing to concerns about potential public health hazards. Water reuse and reclamation has been used in Wisconsin only for limited applications, such as the use of treated wastewater treatment plant effluent for various wastewater treatment plant process waters.

Irrigation

Measures

In the United States, less than 1 percent of irrigation withdrawals are from reclaimed water, as of 2001.[38] Agricultural irrigation represents 40 percent of the total water demand in the country, and over 50 percent of the average residential water use is for outdoor irrigation. In the Southeastern Wisconsin Region, irrigation represents less than 3 percent of the total water demand, and it is estimated that 17 percent of residential demand is for outdoor water use. The irrigation of golf courses, parks, cemeteries, and large landscaped areas in urban areas draws large quantities of freshwater. With this high demand, water conservation can create significant benefits with the use of reused or recycled water.

The application of reused water to the groundwater system is regulated under Chapters NR 206 and 140 of the *Wisconsin Administrative Code*. Land treatment systems designed to infiltrate wastewater must treat the water to meet Chapter NR 206 effluent standards and may require additional treatment to meet Chapter NR 140 water quality standards as approved by the Wisconsin Department of Natural Resources. Irrigation systems are regulated to prevent or minimize infiltration to the groundwater by restricting application rates based on soil types and requiring minimum thicknesses of unsaturated soil above the water table. These regulations essentially eliminate the possibility of using these systems for groundwater recharge purposes because the regulations are designed to prevent application of wastewater at a rate that allows such recharge.

In Florida, irrigation with reclaimed water has become common, and an additional municipal utilities based upon recycling and water reuse have been developed. A regional water reuse partnership has been created between Hillsborough and Pasco counties, Tampa Bay Water, and the Southwest Florida Water Management District in which infrastructure costs are shared for the creation of a large-scale water reclamation program. The utilities are also able to expand their reclaimed water customer base to maximize water reuse year-round.[39]

The use of reclaimed water may be an economical means of supplying water for irrigation for some customers. For some water utilities, reclaimed water is estimated to cost 20 to 25 percent less than potable water. Customers that use large quantities of water, such as landscapers and construction companies, may be offered reclaimed water free of charge. However, the use of reclaimed water for irrigation may be costly when the water must be stored.

In agricultural applications, tailwater reuse is common. Tailwater reuse involves the capture of field runoff in pits dug at the end of gravity-irrigated rows in low-lying areas of a field or farm and reapplying the water. Tailwater runoff occurs when soil becomes saturated, causing water to travel down the drainage ditches. Water losses from evaporation and deep percolation may result. A typical tailwater reuse system consists of a drainage ditch, a

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[38]*Amy Vickers,* op. cit.

[39]*Ralph Metcalf, et. al.,* Reuse It All, *Water Environment & Technology Magazine, May 200.*

tailwater reservoir, and a pump and pipeline to collect the tailwater and return it for redistribution. Tailwater reuse pits have the potential to create water savings of 10 to 30 percent.[40]

Table VII-14

GUIDELINES FOR WATER REUSE

Type of Reuse	Minimum Treatment Required	Reclaimed Water Quality	Recommended Monitoring	Setback Distances
Agricultural Food Crops Commercially Processed (not allowed in Wisconsin) Orchards and Vineyards (not allowed in Wisconsin)	Secondary, plus Disinfection	pH = 6 - 9 BOD ≤ 30 mg/l SS = 30 mg/l FC ≤ 200/100 ml Cl_2 residual = 1 mg/l min	pH weekly BOD weekly SS daily FC daily Cl_2 residual continuously	300 feet from potable water supply wells 100 feet from Areas Accessible To Public
Food Crops Not Commercially Processed (not allowed in Wisconsin)	Secondary, plus filtration disinfection	pH = 6 - 9 BOD ≤ 30 mg/l Turbidity ≤ 1 NTU FC ≤ 0/100 ml Cl_2 residual = 1 mg/l min	pH weekly BOD weekly Turbidity daily FC daily Cl_2 residual continuously	50 feet from potable water supply wells
Pasturage	Secondary, plus disinfection	pH = 6 - 9 BOD ≤ 30 mg/l SS = 30 mg/l FC ≤ 200/100 ml Cl_2 residual = 1 mg/l min	pH weekly BOD weekly SS daily FC daily Cl_2 residual continuously	300 feet from potable water supply wells 100 feet from areas accessible to public
Forestation	Secondary, plus disinfection	pH = 6 - 9 BOD ≤ 30 mg/l SS = 30 mg/l FC ≤ 200/100 ml Cl_2 residual = 1 mg/l min	pH weekly BOD weekly SS daily FC daily Cl_2 residual continuously	300 feet from potable water supply wells 100 feet from areas accessible to public
Groundwater Recharge	Site-specific and use-dependent (see Chapter VI)	Site-specific and use-dependent	Depends on treatment and use	Site-specific

Source: U.S. Environmental Protection Agency, Process Design Manual: Guidelines for Water Reuse, *1992. (Report No. EPA-625/R-92-004).*

Cost Data

A reclaimed water system requires considerable resources to construct, operate, and maintain its treatment, storage, and distribution facilities. In some site-specific instances, facilities may be more cost-effective than tapping new potable water sources. However, in other site-specific situations, the significant economic and resource investments needed for reuse may not be justified, particularly for nonessential uses, such as lawn irrigation. Large-scale reuse of wastewater is still relatively new in the United States, and the true costs of such reuse systems are not yet fully understood.[41]

Graywater Systems

Measures

The installation and use of onsite graywater systems has been approved and is regulated in several states, including Wisconsin. Graywater is typically defined as untreated, used household water that does not contain

[40]Ibid.

[41]Ibid.

human wastes. The U.S. Environmental Protection Agency has determined that this water may be reused for toilet flushing and other nonpotable applications, including gardening, lawn maintenance, landscaping, and other uses. Graywater is a potential water resource, provided it is managed in an environmentally responsible manner, and public health is protected. Capturing graywater and using it in an appropriate manner as an alternative to the municipal water supply can reduce water consumption. The use of graywater in Wisconsin is regulated under Chapter NR 82 of the *Wisconsin Administrative Code*. That code sets forth standards for graywater which are relatively stringent and may require treatment of the graywater depending upon the source.

Unless carefully designed and managed, graywater systems can be a potentially unsafe source of water. Graywater can contain disease-causing microorganisms, such as bacteria, protozoa, viruses, and parasites. It may also contain fats, oils, detergents, soaps, salt, nutrients, food, and hair derived from household and personal cleaning activities. These constituents can pose both grave health and environmental risks.

Soil or plants can process many of the contaminants in graywater if the system is carefully designed and managed, including organic material, nutrients, salt, and sediment. Nutrients can be beneficial in moderate concentrations, for example, on lawns. Some graywater contaminants are not capable of being treated or degraded in the soil. Principal among these is sodium chloride—common salt—which can be contributed in significant amounts by water softening and detergents and can cause soil degradation.

A treatment system will remove the bacterial load and chemical pollutants from graywater so that it can be stored. However, satisfactory treatment tends to be costly and impractical on a residential scale. Treatment processes can include filtering, settling of solids, anaerobic or aerobic digestion, and chemical removal of pollutants and disinfection. Graywater systems have the capability of reducing potable water use. However, this type of reuse system may have limited benefits for indoor water use savings as plumbing fixtures and appliances become more water efficient and reduce indoor residential water demand. Since a limited amount of graywater is available for outdoor reuse, the installation costs, energy requirements, and maintenance required for the graywater system may not be practical for most residential applications. Residences and other types of facilities with larger outdoor water demands are more likely to benefit from an onsite graywater system. In Wisconsin, graywater systems have not been widely accepted as a method of water conservation. The Wisconsin Department of Commerce regulations govern the use of graywater systems. Chapter Comm 82.70 allows the use of treated graywater for once through cooling water, surface irrigation, except food crops, vehicle washing, toilet and urinal flushing, air conditioning, soil compaction, dust control, washing aggregate, and making concrete. Each type of reuse must conform to the plumbing treatment standards put forth by the code, including, but not limited to: minimum requirements for pH, BOD_5, TSS, fecal coliform, and chlorine residual.

Cost Data

The costs of installing a graywater system, including pipes, valves, and tanks, at a single-family residential property ranges from several hundred to several thousand dollars, depending on the size of the system.

Dual Systems

Measures

Dual distribution systems may be used to provide reclaimed water for various nonpotable purposes in urban areas. In a dual distribution system, reclaimed water is delivered to customers by a parallel network of distribution mains separate from the potable water distribution system. A reclaimed water system can become an additional utility in the community. A dual distribution system may be operated, managed, and maintained like a potable water system. The oldest municipal dual distribution system in the United States is located in St. Petersburg, Florida. The facility has been in operation since 1977 and distributes reclaimed water to a combination of residential properties, commercial developments, industrial parks, a resource recovery power plant, a baseball stadium, and schools.[42]

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[42]*U.S. Environmental Protection Agency,* Guidelines for Water Reuse, *September 2004, Available at http://www.epa.gov/nrmrl/pubs/625r04108/625r04108chap2.pdf.*

The installation of a dual distribution system in newly developed areas may be expected to be significantly lower than the cost of retrofitting existing urban areas. In 1984, the city of Altamonte Springs, Florida, required that developers install reclaimed water lines so that all properties within a development would be provided service. This stipulation reduced the line sizes and looping requirements of the potable water system. Retrofitting a developed urban area with a dual distribution system can be relatively expensive. However, in some areas the benefits of conserving potable water can rationalize the cost, such as when additional water supplies are scarce or must be obtained from considerable distances.

Water reclamation facilities must provide the required level of treatment to meet appropriate water quality standards for the intended use. In addition to secondary treatment and disinfection, tertiary treatment is generally required for reuse in an urban setting. Urban reuse may involve irrigation of properties with unrestricted public access or other types of reuse where human exposure to the reclaimed water is likely. These circumstances require that reclaimed water is of a higher quality than may be necessary for other reuse applications. In cases where a single, large customer needs higher-quality reclaimed water, the customer may have to provide additional treatment onsite. A dual distribution system can include an extensive array of storage reservoirs, pump stations, and a distribution piping system. Reclaimed water in the dual distribution system can be made available upon demand by customers. It is typically delivered through separate service connections and meter facilities.

Dual distribution water systems transport reclaimed water from treatment plants to irrigation or industrial sites. In many areas, development of a wastewater reuse system provides reclaimed water at a lower cost than potable water. Substitution of reclaimed water for potable water for certain uses can reduce demands on groundwater supplies and can reduce or eliminate the amount of wastewater treatment plant effluent discharged to environmentally stressed surface waters.

Plumbing cross-connections, or the actual or potential connections between a potable and nonpotable water supply, may constitute a serious public health hazard if not implemented properly. The contamination of drinking water and the spread of disease are typical problems that are associated with this type of system. Once a cross-connection has been installed, careful management and monitoring of faucets and storage units must be performed to control possible hazards. Nonpotable water connections must be properly identified and labeled to avoid risk to public health. The U.S. Environmental Protection Agency established the Cross-Connection Control Manual as a tool for health officials, water-works personnel, plumbers, and others who may be directly or indirectly involved in the design and construction of water supply distribution systems. A contaminated source of water may enter the potable water system when the pressure of the polluted source exceeds the pressure of the potable source, which is commonly referred to as backsiphonage or backflow. In 1933, Chicago experienced an epidemic due to old, defective, and improperly designed plumbing fixtures that permitted the contamination of drinking water. This contamination resulted in the deaths of 98 individuals, and the contraction of amebic dysentery by 1,409 persons.[43]

Cost Data

The costs associated with dual distribution systems are highly variable, depending on the size of the facilities concerned and the site-specific characteristics of the distribution area and related uses. The cost of constructing a new distribution system may be expected to be similar to that for laying regular distribution pipelines. In effect, the installation of a dual distribution system approximately doubles the cost of construction of the distribution system, although some savings may be achieved if the two systems are installed at the same time. Operation and maintenance costs of the second system may also be expected to be similar to those incurred for a normal distribution system. For a community in southeastern Wisconsin with an average water use of 2.6 mgd and an approximate service area of seven square miles, the estimated costs associated with the installation of a dual

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[43]*Environmental Protection Agency,* Cross-Connection Control Manual, *2003. Available at: http://www.epa.gov/safewater/pdfs/crossconnection/crossconnection.pdf*

distribution system are summarized in Table VII-14. The costs include, but are not limited to, capital costs of upgrading the wastewater treatment facility to treat the water to a level required by the Wisconsin Department of Natural Resources and local authorities, of storage and pumping facilities, of transmission mains, and of plumbing retrofits within individual households.

Table VII-15

DUAL DISTRIBUTION SYSTEM COST DATA FOR MODEL SOUTHEASTERN WISCONSIN RESIDENTIAL COMMUNITY

Dual Distribution System Type	Cost per Square Mile
Retrofit of Existing Potable System	
Construction of New Nonpotable System in Parallel with Existing Potable	$3.24 million
Construction of New Potable and Conversion of Existing System to Nonpotable	3.32 million
New System	
Construction of New Dual Distribution System	$4.07 million

NOTE: The costs listed above are based on use of ductile iron, open-cut construction; the costs do not include: engineering, and legal and administration fees, rock excavation, contingencies, casing pipes, directional drilling, and erosion controls.

Source: Ruekert & Mielke, Inc.

[NOTE: THE REMAINDER OF THIS CHAPTER HAS BEEN REVISED FROM THE VERSION PROVIDED PREVIOUSLY. FOR CLARITY, NO TRACK CHANGES ARE INCLUDED.]

EXAMPLE WATER CONSERVATION PROGRAM—REGION OF WATERLOO, ONTARIO, CANADA

The Regional Municipality of Waterloo, Ontario, Canada, has been involved in implementing a comprehensive water conservation program since 1998. Because of the nature of the current water supply system, the climate, future options for water supply sources, and the cost of water, the Regional Municipality of Waterloo water conservation program is considered a comparable example for the situation in southeastern Wisconsin. The experience in the Waterloo area can serve as a useful example to consider in developing conclusions concerning potential water conservation program measures, costs, and effectiveness in southeastern Wisconsin.

Background

The Regional Municipality of Waterloo is located in Ontario, Canada. It consists of three cities and four townships. The area concerned is about 530 square miles in size, and had a resident population in 2006 of about 500,000 persons. That population is expected to increase to about 730,000 persons by the year 2031. In 1998, the Regional Municipality completed and began to implement a long-term water conservation plan[44] and in 2000, a long-term water supply strategy was completed.[45] During 2006, an update[46] to the 1998 water conservation plan was completed.

The primary water supply system serving the Waterloo area consists of large centralized integrated network of wells, water treatment plants, reservoirs, pumping stations, and water transmission mains. Prior to 1992, all of the Region's water supply was derived from groundwater wells. In 1992, a treatment plant using river water was added to tap another source of supply. The Regional Municipality operates a large centralized water supply system which provides about 41 million gallons per day on an average daily basis. About 75 percent of the water supply of the centralized system is from groundwater, and 25 percent is from surface water. In addition to the large centralized system, there are 16 smaller water supply systems serving township areas which are operated by the Regional Municipality. These systems utilize groundwater as a sole source of supply. These 16 water supply systems provide about 2.5 million gallons per day to the users concerned.

The capacity of the large centralized water supply systems serving the Regional Municipality of Waterloo in 2000 was about 68 million gallons per day (mgd). In 2006, water supply capacity was approximately 62 mgd. This reduction in capacity has been attributed to a loss in efficiency from some well fields, water quality issues in some systems, and regulatory issues that impact how the water sources have been operated. The Regional Municipality is working on a number of projects to reestablish the full capacity of its water supply systems and to add more capacity. These projects include aquifer storage and recovery, optimizing treatment processes at the surface water and groundwater treatment facilities, and new groundwater well development. A longer-term source of supply plan providing for the construction of a pipeline to either Lake Huron or Lake Erie is also being considered. Implementation of this plan is expected by 2035, with an estimated cost of about $400 million (expressed in

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[44]*Regional Municipality of Waterloo,* Water Efficiency Master Plan, *November 1998.*

[45]*Regional Municipality of Waterloo,* Council Report: Recommendations on the Long-Term Water Strategy, 2000.

[46]*United Utilities Canada Limited, Region of Waterloo,* Water Efficiency Master Plan Update Research Report, *May 2006.*

United States currency). That project is currently being reviewed as part of an ongoing update to the Regional Municipality's long-term plan.

The cost of water in the Region of Waterloo in 2005 was about $1.55 per 1,000 gallons on a wholesale basis and from $2.70 to $3.40 per 1,000 gallons, expressed in United States currency, plus a fixed charge which varies by community, on a retail basis.

Ongoing Region of Waterloo Water Conservation Program

The water conservation program adopted by the governing body of the Regional Municipality in 1998 established a goal of reducing water consumption by 1.8 million gallons per day by 2009. This equates to just over 4.0 percent of the average daily water use in the service area. In 2000, the governing body of the Regional Municipality adopted a long-term water strategy deigned to ensure an adequate water supply to the municipality through the year 2041. As previously noted, the strategy developed includes development of both surface and groundwater supplies, as well as a water conservation program component designed to potentially defer capital intensive capacity expansion-related projects. The following water conservation measures were included in the water conservation program developed under these two programs:

- Residential Public Awareness—These measures consisted of public informational and educational activities, including a speaker bureau; newsletters; the provision of fact sheets and other promotional materials; and a business education program.

- Residential Toilet Replacement—This measure provided rebates which varied from $35 to $65 per toilet, based upon toilet type and effectiveness. The plan provided for up to 5,000 rebates per year. (Note: The cost of installation for a toilet is reported to be only about $50 in the Waterloo area. Thus, if a toilet costs $100, the rebates cover from about 25 to 40 percent of the installed cost.)

- Rain Barrel Distribution—This measure was intended to distribute 25,000 rain barrels, at a nominal charge of $20, for use in the service area. That goal was achieved by 2005.

- Outdoor Water Use Restrictions—Areawide regulations were put in place that were intended to achieve a reduction in peak demand of 10 to 20 percent and to reduce the potential for water shortages during the summer high water use periods. These regulations included various stages of restrictions on outdoor water use based on the severity of the water supply situation. Mild restrictions would involve odd-even outdoor water rules, a moderate stage would restrict watering to once-per-week, while the most restrictive stage would prohibit outdoor watering altogether.

- Municipal Building Water Conservation—An evaluation of water use in public buildings was made with the objective of implementing water conservation measures, such as plumbing fixture replacement, when demonstrated as being cost-effective.

- Industrial, Commercial, Institutional Water Conservation—A program was instituted to encourage water conservation in industrial, commercial, and industrial buildings and facilities. Initial facility water audits and measures, such as changes in processes and in fixtures, were encouraged.

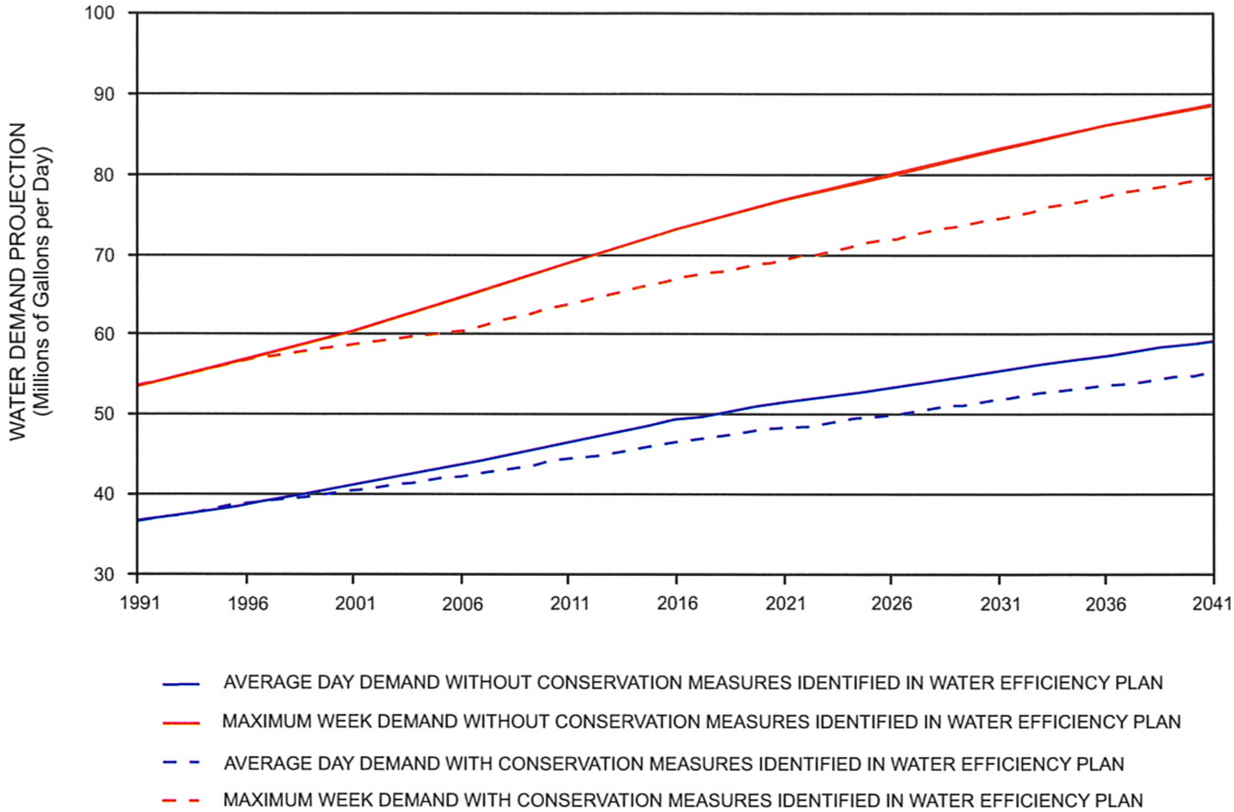
- School Curriculum Development—A school curriculum was developed, including an educational video for use in grades two through eight, and provided to schools.

- Promotion of Water-Efficient Washing Machines—A program promoting the use of water-efficient washing machines was initiated.

- Restaurant Pre-Rinse Spray Valve Efficiency Demonstration—A pilot program was initiated to demonstrate the value of more water-efficient pre-rinse spray valves in restaurants.

Figure VII-8

REGION OF WATERLOO WATER DEMAND FORECASTS: 1991-2041



Source: Great Lakes Commission, Regional Case Studies, Best Practices for Water Conservation in the Great Lakes-St. Lawrence Region, *June 2004.*

Water Conservation Plan Goals and Effectiveness

The Regional Municipality's planning efforts included the preparation of estimates of future water demand under the assumption of the institution of no new water conservation initiatives, and compared that demand to the estimated demand assuming implementation of the recommended water conservation program. The calculations of future water demand were based upon population and land use projections and unit water consumption and peaking factors. Figure VII-8 presents the alternative demand projections. The projections indicated a potential reduction in average daily and maximum weekly demands of 6.6 percent and 10.3 percent, respectively, over a 50-year period from 1991 though 2041.

The 2006 water supply plan update report[47] identified the estimated water conservation program savings associated with implementation of individual water conservation measures. Those data were compared to the water-saving targets established over the period 1998 through 2005. The comparisons are summarized in Table VII-16. The actual water savings over the period 1998 through 2005 was estimated at 1.46 mgd on an average day demand basis, which exceeded the target savings of 1.35 mgd. The savings of 1.46 mgd equates to about 3.5 percent of the total water demand on an average day demand basis.

[47]Ibid.

Table VII-16

REGION OF WATERLOO COMPARISON OF WATER CONSERVATION PROGRAM TARGETS VERSUS AVERAGE DAY DEMAND WATER SAVINGS: 1998-2005

Year	Target Toilet Replacement Program (gpd)	Actual Toilet Replacement Program (gpd)	Target Residential Public Education (gpd)	Actual Residential Public Education (gpd)	Target Commercial, Institutional, and Industrial Public Education (gpd)	Actual Commercial, Institutional, and Industrial Public Education (gpd)	Actual Rain Barrel Program (gpd)	Target Reduction	Actual Reduction	
								(mgd)	(mgd)	Percent
1998	70,806	72,391	0	0	0	0	0	0.07	0.07	0.2
1999	159,313	211,888	29,062	29,062	0	0	0	0.19	0.24	0.6
2000	265,521	297,489	86,922	86,922	43,329	45,178	0	0.40	0.43	1.1
2001	371,994	415,851	144,782	144,782	86,658	112,813	5,284	0.60	0.68	1.7
2002	478,466	547,422	202,641	202,641	130,251	112,813	10,568	0.81	0.87	2.1
2003	584,146	661,028	260,501	260,501	173,579	119,683	14,795	1.02	1.06	2.6
2004	690,619	816,114	290,092	318,625	217,172	143,461	19,022	1.20	1.30	3.2
2005	796,827	944,779	290,092	318,625	260,501	168,560	23,514	1.35	1.46	3.5

Source: United Utilities Canada Limited, Region of Waterloo, Water Efficiency Master Plan Update Research Report, *May 2006.*

Cost of Water Conservation Program

The cost of the capital and operation and maintenance costs for the Regional Municipality's water efficiency program was reported to be about $900,000 per year expressed in United States currency.

Future Water Conservation Program

In 2006, the Regional Municipality completed a water efficiency master plan update. The updated plan includes planning level estimates for three levels of water conservation as options for implementation in 2007 through 2015. The recommended aggressive program had an estimated program cost of $15,500,000 over nine years. The reduction in water use by the end of nine years was estimated at 8.6 mgd, or about 17 percent of the average daily water demand. The moderate-level program had an estimated cost of one-half of the cost of the more aggressive program, an estimated savings of 4.3 mgd, or about 9 percent, of the average water daily demand, by the end of the nine years. The enhanced status quo program was estimated to have program costs of $3,750,000, and the associated savings were estimated at 2.2 mgd, or about 5 percent of the average daily water demand, by the end of nine years. Table VII-17 highlights the estimated costs and water savings for each program. The estimated program costs include materials and external services, and were categorized as "capital costs." Regional Municipality staff costs and some educational costs were not included in the costs estimates and were categorized as "operating costs."

The water conservation program finally recommended to the Regional Council, in July of 2006, had a nine-year total cost of about $8,500,000, including all capital and operating costs and a target reduction in water use of about 2.2 mgd, or about 5 percent of total average daily water demand. Conservation measures included in the recommended program include: public education; outdoor water use restrictions; toilet replacement program; promotion of industrial, commercial, and institutional water conservation; and water system leak detection and reduction.

WATER CONSERVATION PROGRAM IMPACTS

Water conservation may be viewed primarily as a means for reducing water utility production, operation, and maintenance costs, and thereby increasing the efficiency of utility operations and reducing the cost of the water supplied to consumers. Water conservation programs may also be viewed as a means of preserving infrastructure capacity, reducing operation costs, and achieving sustainability in the source, or sources, of supply through reductions in demand. The institution of water conservation programs involves a level of commitment and resources which will vary depending upon several factors, including the level of conservation needed or desired, existing infrastructure, sources of supply, and the types of conservation measures to be applied. The measures to

Table VII-17

REGION OF WATERLOO ESTIMATES OF COSTS AND WATER SAVINGS AT VARIOUS PROGRAM LEVELS

Program Level	Estimated 2007 to 2015 Program Costs	2007 to 2015 Water Savings (mgd)	Estimated Maintenance, Monitoring, and Evaluation Costs
Aggressive	$15,500,000	8.6 or about 17 percent of average water use	$1,800,000
Moderate	$ 7,500,000	4.3, or about 9 percent of average water use	$ 900,000
Status Quo-Enhanced	$ 3,750,000	2.2, or about 5 percent of average water use	$ 450,000

Source: United Utilities Canada Limited, Region of Waterloo, Water Efficiency Master Plan Update Research Report, *May 2006.*

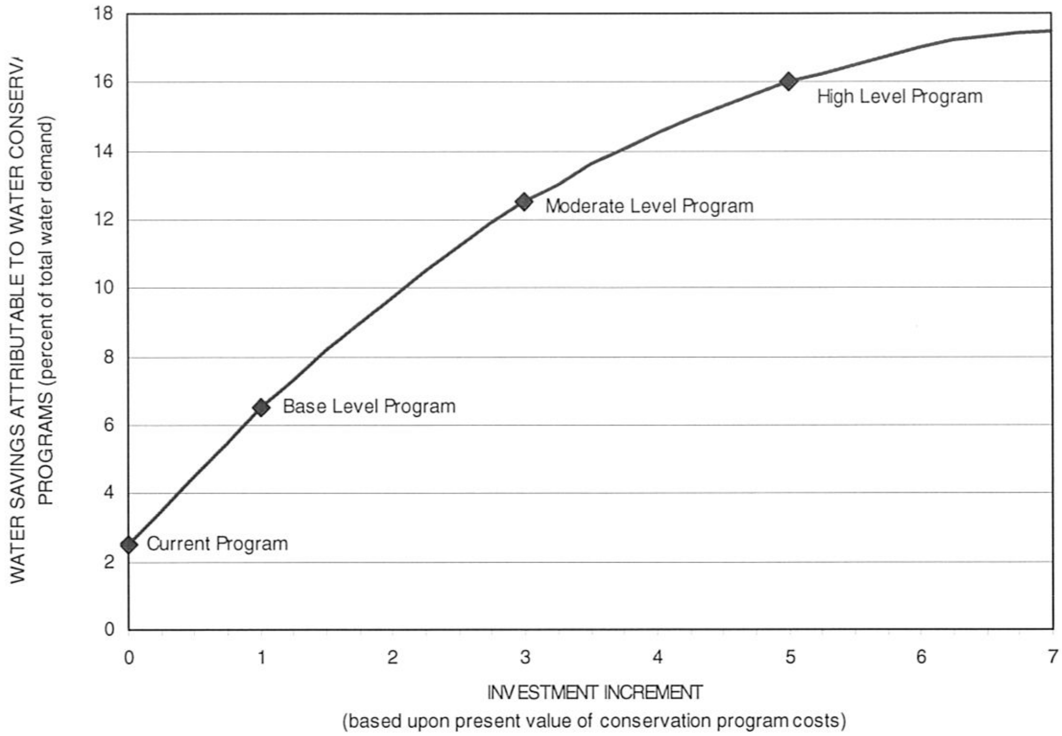
be considered may include those which impact both water supply system efficiency and reductions in water demand. Investments in water conservation programs are intended to translate into immediate savings in utility water production, operation, and maintenance costs. Such programs may also result in savings in, or deferment of, future capital costs for system expansion or improvement, and in reductions in wastewater system conveyance and treatment costs. The net costs of achieving such savings from water conservation programs will vary depending on the extent and success of the programs and on the potential reductions in operation and capital costs. When conservation programs are implemented properly, the municipal water and sewer utilities benefit through reductions in the amounts of water pumped to homes and businesses, as well as through reductions in the amounts of wastewater that must be conveyed to, and treated in, sewage treatment plants. Energy costs will be reduced, and water production and system operation and maintenance costs will be reduced to the extent that the conservation measures successfully lower water use. The conceptual conservation investment curve provided in Figure VII-9 portrays the relationship that may be expected between the costs of water conservation programs and attendant savings in water use. The actual conservation program levels and costs, as well as the attendant savings in water production costs and reductions in water use, will be utility-specific. In addition to the operational and infrastructure considerations related to water conservation, the sustainability of water supply is an important and, possibly, overriding consideration in designing a water conservation program.

In order to better understand the potential impacts of the use of conservation programs in communities throughout southeastern Wisconsin, three model conservation plans were formulated using basic utility data for three selected communities within the Region representing a range of community sizes. Data on water use and utility operation and maintenance costs for the three selected communities were collated from the year 2005 annual reports published by the Wisconsin Public Service Commission (PSC). The plans developed provide estimates of conservation program costs, potential water savings, and avoided costs attendant to the implementation of each of three levels of water conservation programs developed for the three communities. The data collated and cost calculations developed for the model programs are provided in Appendix VII-1. The estimated cost data, water savings, and related avoided costs for these model conservation programs are presented in Tables VII-18 and VII-19. These tables provide the information for base-level, intermediate-level, and advanced-level conservation programs. For each conservation program level, a range of estimated annual water savings, program costs, and avoided costs are provided, as shown in Table VII-18, and as summarized in Table VII-19.

The data presented are related to water demands on an average annual daily basis. That measure was selected since it is most directly related to source sustainability and is the most common measure reported upon in the references used to develop data for this chapter. It is recognized that water conservation program impacts will also affect water demands during maximum use periods such as the maximum week or daily demand basis. Typically, the reduction levels due to water conservation programs that can be achieved during the maximum use periods will be somewhat higher than the reduction levels determined on an average annual daily basis to the extent that outdoor water uses contribute to the maximum use periods and water conservation measures are designed to reduce outdoor water use. Such maximum use period water conservation impacts may be important in considering future infrastructure needs. Maximum water demands on a peak hourly or shorter time frame basis may not be

Figure VII-9

CONCEPTUAL RELATIVITY OF WATER CONSERVATION PROGRAM COSTS AND SAVINGS



Source: SEWRPC.

impacted by water conservation measures as such demands are typically governed by factors such as fire fighting needs.

Review of Tables VII-18 and VII-19, indicates that the savings in water use attendant to water conservation programs may range from less than 5 percent to over 10 percent of the average day water use, depending upon the level of conservation program developed and the community water use profile. If water conservation is effectively achieved by the industrial, commercial, and institutional water users concerned, a reduction in average day total water use of from 10 to 20 percent may be achievable with a high-level program. In this regard, it should be noted that all of the utilities operating within the Southeastern Wisconsin Region already engage in some water conservation practices. Those practices often include billing based upon metered water use, leak detection and correction programs, some outdoor water use restrictions, and water main maintenance and replacement. Thus, the benefits of water conservation programs in terms of percent reduction in water use achieved may be expected to be less than could be expected if no such actions were currently being taken. It should be noted that the maximum use period water demand levels may be expected to be reduced by somewhat greater percentages than noted above if outdoor water use restrictions are incorporated into the water conservation program. Based upon the findings of the model conservation plans, the cost of implementing a base-level water conservation program, which may be expected to achieve about a three to 6 percent reduction in average daily water demand, may be expected to be offset by the direct savings in operation and maintenance costs associated with a reduced level of water production. The cost of implementing an advanced-level water conservation program, which may be expected to achieve a 10 percent reduction in average daily water demand, may be expected to exceed the direct savings in operation and maintenance costs. The cost of implementing an intermediate-level water conservation program, which may be expected to achieve from five to 10 percent reduction in average daily water demand, may or may not be offset by savings in operation and maintenance costs.

Table VII-18

ESTIMATED CONSERVATION PROGRAM COST DATA AND ATTENDANT WATER SAVINGS OF MODEL CONSERVATION PLANS IN SOUTHEASTERN WISCONSIN

Community Population	Conservation Plan Level	Annual Water Savings (million gallons)		Annual Cost of Program		Cost of Program per 1,000 Gallons Saved		Net Annual Savings[a]	
		Low	High	Low	High	Low	High	Low	High
3,000	Base	1	2	$ 1,106	$ 1,106	$ 1.106	$0.460	$ -786	$ -338
	Intermediate	2	6	2,500	2,572	1.040	0.440	-1,732	-620
	Advanced	3	9	37,310	38,332	11.380	4.480	-36,262	-35,596
70,000	Base	105	258	$ 26,265	$ 26,265	$ 0.250	$0.102	$ 2,371	$ 43,962
	Intermediate	140	378	33,685	35,665	0.240	0.090	4,497	67,290
	Advanced	170	453	168,685	175,415	0.990	0.390	-122,245	-51,814
600,000	Base	1,125	2,780	$ 225,300	$ 225,300	$ 0.020	$0.080	$ -20,394	$278,575
	Intermediate	1,591	4,473	609,500	769,400	0.380	0.170	-321,130	41,309
	Advanced	2,018	5,527	1,279,500	1,439,400	0.630	0.260	-913,736	-437,653

NOTES: Assumptions: Energy and chemical expenses for model community of 3,000 estimated at $16,000 per year.
Energy and chemical expenses for model community of 70,000 estimated at $750,000 per year.
Energy and chemical expenses for model community of 600,000 estimated at $7,250,000 per year.

Water conservation measures included are focused on the residential water customers, excepting for rate structure modification, which would apply to all customers. Savings due to avoided capital costs are not included because of the variability of such costs from community to community. For each community, factors such as the need for increased infrastructure, the location of new water sources, the number and size of wells that must be constructed, and the cost of water that must be pumped from source waters outside community boundaries will vary.

[a]*Annual savings are based on avoided chemical and energy cost savings associated with pumping and treating water, less the cost of the conservation program.*

Source: Ruekert & Mielke, Inc.

Even though the costs of water conservation programs may exceed the attendant savings in operational costs, there may be sound reasons to develop higher-level water conservation programs in cases where avoided capital costs and water supply sustainability are important factors. Water conservation programs may extend the useful life of municipal water supply and treatment facilities, and defer needed capital investment in increased capacity. Figure VII-10 conceptually illustrates how water conservation can affect the timing of capital facilities and assist in delaying infrastructure investments. In the example shown, a 20 percent reduction in the design maximum demand period would permit needed capacity expansion to be delayed by approximately seven years. The resultant cost savings to the utility are represented by the difference in the present value of the costs associated with providing the needed capacity expansion in 2027 instead of 2020. The capital required for expansion of an existing water utility can be significant. For example, if a community were required to obtain a new source of groundwater supply, the associated cost of drilling the well, installing a transmission pipeline, and constructing a new pump station facility may be expected to approximate $1 million. In situations where groundwater supplies are being depleted, however, the development of high-level water conservation programs may be warranted to promote sustainability of the source of supply.

While the cost of water conservation programs can result in offsetting benefits, there are related potential impacts which also must be considered. As previously noted, the cost of the programs designed to achieve a relatively high level of water conservation may exceed the savings in costs associated with reduced water production. In addition, conservation program implementation goals may not be fully realized. If water conservation programs are successful, water rates may need to be increased, as in some cases, utility system savings may be expected to be less than revenue losses. In situations where water supply service areas are relatively fixed due to political or regulatory considerations, and where future infrastructure needs are minimal, an increase in water costs may be expected to be incurred by many users—particularly for those users who do not achieve a reduction in water use

Table VII-19

AVERAGE COST DATA AND WATER SAVINGS OF MODEL CONSERVATION PLANS IN SOUTHEASTERN WISCONSIN

Community Population	Conservation Plan Level	Average Annual Water Savings (million gallons)	Range of Percentage of Water Savings (percent)	Average Annual Cost of Program	Average Cost of Program per 1,000 Gallons Saved	Average Net Annual Savings[a]
3,000	Base	2	2-5	$ 1,106	0.78	$ -562
	Intermediate	4	5-12	2,536	0.73	-1,176
	Advanced	6	7-18	37,821	7.94	-35,929
70,000	Base	181	4-9	$ 26,265	0.18	$ 23,167
	Intermediate	259	5-14	34,675	0.17	35,893
	Advanced	312	6-16	172,050	0.69	-87,029
600,000	Base	1,953	3-7	$ 225,300	0.14	$128,591
	Intermediate	3,032	4-11	689,450	0.28	-139,910
	Advanced	3,722	5-14	1,359,450	0.45	-675,695

NOTES: Assumptions: Energy and chemical expenses for model community of 3,000 estimated at $16,000 per year.
Energy and chemical expenses for model community of 70,000 estimated at $750,000 per year.
Energy and chemical expenses for model community of 600,000 estimated at $7,250,000 per year.

Water conservation measures included are focused on the residential water customers, excepting for rate structure modification, which would apply to all customers. Savings due to avoided capital costs are not included because of the variability of such costs community to community. For each community, factors, such as the need for increased infrastructure, the location of new water sources, the number and size of wells that must be constructed, the cost of water that must be pumped from source waters outside community boundaries, etc., will vary greatly.

[a]*Annual savings are based on avoided chemical and energy costs associated with pumping and treating water less the cost of the conservation plan.*

Source: Ruekert-Mielke, Inc.

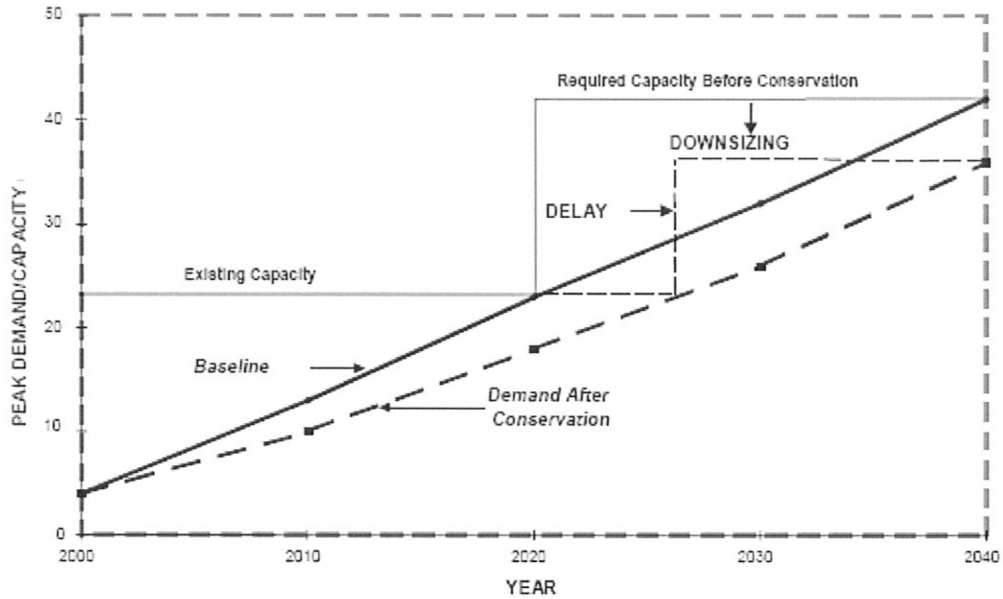
through conservation measures. Such users may include, among others, less affluent citizens who do not have the resources to retrofit older housing fixtures. The impact of high water bills on these customers may be significant. Other concerns to be considered relate to the need for more water main flushing in certain segments of the transmission and distribution system to minimize retention times and maintain water quality. In addition, there may be impacts on the sanitary sewer system resulting from spent water flows inadequate to properly move solid materials through the system. These concerns must be addressed as each utility considers the development of a water conservation program.

Another issue related to the impacts of implementing water conservation programs relates to the potential impact on large water use customers. Should municipal utility water conservation measures which place financial burdens on such users as a result of required process changes or increased rates, such users may seek alternative sources of water supply. Such sources could include new private self-supplied groundwater wells at existing or alternative facility locations. Such opt out actions could reduce the municipal utility water demand and potentially further increase water rates accordingly. The potential impacts of new groundwater well development associated with such decisions may, in turn, include environmental as well as additional financial costs.

Based upon the foregoing, it may be concluded that through implementation of a water conservation program, it may be possible to achieve a reduction from 3 to 5 percent in average daily water demand, with no significant increase in cost over and above the resultant savings in operational costs. Water conservation programs designed to achieve water use reductions over and above those levels will likely result in increased annual operational costs. Thus, consideration of such programs should be based upon evaluation of the potential avoided capital costs and the sustainability of the water supply source. Such considerations must be made on a water utility-specific basis. For purposes of the regional water supply planning program, assumptions on the level of water conservation are planned to be initially generalized for purposes of projecting probable future demand and formulating alternative system plans. The generalization is to be based upon existing and future infrastructure needs and water supply source sustainability considerations.

Figure VII-10

EXAMPLE OF DELAYING AND/OR DOWNSIZING A CAPITAL FACILITY



Source: *William Maddaus, et. al., "Integrating Conservation into Water Supply Planning,"* Journal American Water Works Association, *Volume 88, No. 11, 1996, pp. 57-67.*

SUMMARY AND CONCLUSIONS

Water conservation has become an issue of increasing concern within the United States, especially in areas of increasing water scarcity. Increased efficiency in water use and reductions in demand have the potential to protect the natural resource base, reduce the cost to individual water users and water suppliers, and positively affect the reliability and sustainability of water supplies. This chapter provides information on water conservation programs and measures potentially applicable within the Southeastern Wisconsin Region. It is important to note that there are two views that can be taken of water conservation. One view focuses on achieving efficiency in utility operations by minimizing the amount of water that must be produced and conveyed to meet user demand, primarily through the reduction of unaccounted-for water. The attendant practices include metering and system performance monitoring, leak detection and repair, and system operational refinements. Water supply efficiency programs and measures are well established but are system-specific in application. Water efficiency programs are a very effective and direct water conservation measure. The other view of water conservation is focused on achieving sustainability in the sources of supply, and reducing or delaying infrastructure needs. The attendant practices, include water rate modifications to discourage use, use of water-saving plumbing features, water recycling, and educational activities.

These two views, or concepts, of water conservation will have quite different applicability within the Southeastern Wisconsin Region. In areas of the Region which generally lie east of the subcontinental divide and which utilize Lake Michigan as a source of supply, the concept of water conservation is focused primarily on increasing the efficiency of the water supply system and reducing the cost of water production, and may often be expected to constitute the more rational of the two approaches. For Lake Michigan supplied utilities, the water supply is abundant and the spent water is largely returned to the source. There is no compelling need, therefore, to reduce water use in order to sustain the supply. The focus, then, of the water conservation programs is on reducing unaccounted for water as a part of the total system pumpage. This focus on system efficiency is further supported by the fact that some of the major water supply systems concerned are operating well below existing capacity, and the need to attract economic development to the core urbanized areas concerned by offering, among other inducements, an adequate water supply and attractive water rates. This approach provides water supply customers with the most favorable cost structure, an important consideration in the current era in which puplic officials are trying to minimize all municipal costs. However, in situations in which a Lake Michigan utility may be experiencing increasing demands that are approaching the existing infrastructure capacity, the second concept of reducing water use on the demand side will likely have merit. In areas of the Region which lie west of the subcontinental divide and which utilize groundwater as a source of supply, as well as other areas which lie east of the divide and utilize groundwater as a source, considerations related to the sustainability of that source and infrastructure needs, become the driving forces for the institution of water conservation programs designed to reduce use along with water system efficiency measures.

The level of water conservation program to be developed and implemented will be utility- or community-specific based upon a number of factors, including the composition of the community water users, the operational characteristics of the utility, the level of efficiency already being achieved, the water supply infrastructure in place, that needed to meet future demands, and the sustainability of the water supply. Another factor which must be considered is the need to develop water conservation programs which are consistent with current and anticipated future rules, regulations, and policies. For example, consideration should be given to consistency with the proposed Great Lakes Charter Annex and the Wisconsin Groundwater Quantity Act and the related activities of the Groundwater Advisory Committee. Any water conservation program developed should be flexible and adaptable to the requirements of such rules, regulations, and policies. In addition, the design and implementation of conservation plans will vary significantly due to the large combinations of measures and programs that each utility or community may utilize. Similar considerations apply to self-supplied water users.

The state-of-the-art of water conservation conducted under the regional water supply planning program as presented in this Chapter indicates that, for the purposes of the regional water supply system planning program, the level of reduction in water demand that may be anticipated in the preparation of demand forecasts can best be varied categorically by utility situation. Design year water demands typically are forecast by consideration of the existing water demand levels, projection of additional incremental demand based upon application of unit demand levels to population and land use projections, and consideration of potential reductions in demand through water conservation programs. In the later consideration, the reduction values set forth in Table VII-20 can provide initial assumptions in the development of demand forcasts.

The potential reduction values set forth in Table VII-20 were developed based upon the information presented in this chapter, including, particularly, the results of the model conservation plans, the composition of the typical residential water use components as related to potential water conservation measures, and the documented example water conservation program results. The levels vary from 4 to 10 percent on an average day demand basis, and 4 to 18 percent on a maximum week basis, depending upon the type utility water supply and existing infrastructure situation.

The initial water conservation levels selected are intended to be related to comprehensive water conservation programs, including both a supply side water supply system efficiency element and demand side water conservation measures. The selected levels are also intended to represent an increase in water conservation effectiveness over and above the current level which, as previously noted, is the result of a number of water efficiency and water conservation measures already in place at most municipal utilities in the Region. Thus, the selected levels may not appear as effective as would be the case in an area where no water conservation measures are in place. These initial water conservation level assumption levels may be revised following the development and evaluation of the alternative plans if cost, environmental impact, or other factors relating to the achievement of plan objectives would so dictate. Such revisions in water conservation levels would then be incorporated into the recommended regional water supply plan.

Table VII-20

PLANNED INITIAL ASSUMPTIONS CONCERNING EFFECTIVENESS OF WATER CONSERVATION PROGRAM LEVELS FOR USE IN ALTERNATIVE PLAN DEVELOPMENT FOR THE REGIONAL WATER SUPPLY SYSTEM PLANNING PROGRAM FOR SOUTHEASTERN WISCONSIN

Water Utility Category	Future Water Conservation Assumption Over and Above the Current Level[a]		Comments
	Average Day Demand Reduction (percent)	Maximum Week Demand Reduction (percent)	
• Lake Michigan Supply with Return of Spent Water • Adequate Water Supply Infrastructure in Place for 10 or More Years	4	4	• Assuming a current level of water conservation effectiveness of 4 percent, these values would equate to total reduction level of 8 and 12 percent • Total reduction levels of 8 percent • Cost of water conservation program may be offset by savings in operational cost
• Lake Michigan Supply with Return of Spent Water • Some Water Supply Infrastructure Needs Expected During the Next 10 Years	4	10	• Assuming a current level of 4 percent, these values would equate to total reduction levels of 10 and 14 percent • Cost of water conservation program may exceed savings in operating costs
• Groundwater Supply • Adequate Water Supply Infrastructure for 10 or More Years • No Major Aquifer Quality or Quantity Issues	6	12	• Assuming a current level of 4 percent, these values would equate to total reduction levels of 10 to 16 percent • Cost of water conservation program is expected to exceed savings in operating costs
• Groundwater Supply • Major Infrastructure Needs Expected During the Next 10 Years • No Major Aquifer Quantity or Quality Problems	8	16	• Assuming a current level of water conservation effectiveness of 4 percent, these values would equate to total reduction levels of 12 to 18 percent • Cost of the water conservation program will likely exceed the associated reduction in operational costs
• Groundwater Supply • Major Infrastructure Needs Expected During the Next 10 Years • Aquifer Quantity or Quality Problems	10	18	• Assuming a current level of water conservation effectiveness of 4 percent, these values would equate to total reduction levels of 14 to 22 percent • Cost of the water conservation program will likely exceed the associated reduction in operational costs

[a]*Initial assumptions which may be revised following development and evaluation of water supply alternative plans, if demonstrated as needed by cost, environmental impacts, or other factors related to the plan objectives.*

Source: SEWRPC.

SEWRPC Technical Report No. 43

STATE-OF-THE-ART OF WATER SUPPLY PRACTICES

Appendix VII-1

COST ANALYSIS FOR WATER CONSERVATION MODELS

PRELIMINARY DRAFT

Southeastern WI Community with Population 3,000

Calculations (Page 1)

Redesign of Water Bill & Limited Public Education Program:

High: Assume 5% reduction in residential water use (Burton & Associates, 1999).
Adjusted to 3% reduction in SE WI with 60% of residences effectively impacted.
40 MG/yr x 0.03 = **1.2 MG/yr savings**

Low: Assume 1% reduction in residential water use where bills have been redesigned.
40 MG/yr x 0.01 = **0.4 MG/yr savings**

Cost: $0.10 per bill + $1,000 initial consultant cost + $100/yr for educational materials.
($0.10 x 600) + $1,000 + $1,000 = $2,060/10 years = **$206/yr**

Distribution of Information:

High: Assume 5% reduction in residential water use (Burton & Associates, 1999).
Adjusted to 3% reduction in SE WI with 60% of residences effectively impacted.
40 MG/yr x 0.03 = **1.2 MG/yr savings**

Low: Assume 1.5% reduction in residential water use where current practice is to provide some information.
40 MG/yr x 0.015 = **0.6 MG/yr savings**

Cost: Estimate $1.50 per brochure for paper and printing.
$1.50 x 600 = **$900/yr**

Water Accounting:

Assume no direct water savings or cost as this is a current practice in most communities.

Plumbing Retrofits (at no cost to customers):

High: 50% participation rate due to lack of cost and distribution by mail (GDS Associates, 2001/Vickers, 2001).
Adjusted to 30% due to existing newer toilets in many homes where toilet displacement devices are not practical.
Assume that 100% of households who receive kits will install kit components and will not remove them later.
Assume 50% of residential use is from plumbing & fixture water use (Vickers, 2001).
Assume 20% reduction in residential plumbing & fixture water use (USEPA, 1998).
40 MG/yr x 0.50 x 0.30 x 0.20 x 1 = **1.2 MG/yr savings**

Cost: $12 per kit (Vickers, 2001) + fixed cost of $1,000 over 10 years (or $100/yr).
($12 x 600 x 0.30) + $1,000 = $3,160/10 years = **$316/yr**

Low: Assume 20% participation rate due to high level of prior retrofits.
Assume that 50% of households who receive kits will install kit components and will not remove them later.
Assume 50% of residential use is from plumbing & fixture water use.
Assume 20% reduction in residential plumbing & fixture water use.
40 MG/yr x 0.20 x 0.50 x 0.20 x 0.50 = **0.4 MG/yr savings**

Cost: $12 per kit (Vickers, 2001) + fixed cost of $1,000 over 10 years (or $100/yr).
($12 x 600 x 0.20) + $1,000 = $2,440/10 years = **$244/yr**

Water Conserving Rate Structure:

High: Assume 5% reduction in total water use (USEPA, 1998).
50 MG/yr x 0.05 = **2.5 MG/yr savings**

Low: Assume 2% reduction in total water use with less effective revised structure.
50 MG/yr x 0.02 = **1 MG/yr savings**

Cost: Assume 100 hours of labor + $5,000 for consulting services.
($65/hr x 100 hrs) + $5,000 = $11,500/10 years = **$1,150/yr**

Southeastern WI Community with Population 3,000

Example Conservation Plans by Level

Conservation Level	Conservation Measure	Water Savings* (MG/yr)		Estimated Cost per Year to Utility*		Description
		Low	High	Low	High	
Low	Redesign of Water Bill & Limited Public Education Program	0.4	1.2	$206	$206	Restructure water bill to be more understandable to the consumer and to include water usage in detail.
	Distribution of Information	0.6	1.2	$900	$900	Make pamphlets available to public and include bill inserts on importance of conservation.
	Water Accounting	N/A	N/A	N/A	N/A	Implement a basic system of water accounting to provide basis for loss control over time.
	Low Level Totals:	**2%**	**5%**	**$1,106**	**$1,106**	
Intermediate	Low Level Measures	1.0	2.4	$1,106	$1,106	Includes all low level measures.
	Plumbing Retrofits	0.4	1.2	$244	$316	Advertise plumbing retrofit kits to customers at a no cost.
	Water Conserving Rate Structure	1	2.5	$1,150	$1,150	Implement water conserving rate structure to promote efficient use of water.
	Intermediate Level Totals:	**5%**	**12%**	**$2,500**	**$2,572**	
Advanced	Intermediate Level Measures	2.4	6.1	$2,500	$2,572	Includes all intermediate level measures.
	Utility System Water Audit/Leak Detection & Repair	0.5	1.3	$4,500	$4,500	Audit to assist tracking of nonaccount water use and detect and repair obvious leaks.
	Landscape Watering Ordinance	0.3	1.2	$3,360	$3,360	Implement ordinance limiting days and/or times for customers to water outdoors.
	Toilet Replacement Rebate	0.1	0.3	$950	$1,900	Offer rebates to first 20 customers to install low-flow toilets.
	Conservation Related Staff	N/A	N/A	$26,000	$26,000	Staff to assist in updating and maintaining the conservation plan selected.
	Advanced Level Totals:	**7%**	**18%**	**$37,310**	**$38,332**	

Assumptions:
Total Water Consumption = 50 MG/yr
Total Residential Water Consumption = 40 MG/yr
Number of Residential Customers = 600
Energy & Chemical Operation & Maintenance Expenses = $16,000/yr
Miles of watermains in system = 15 miles
Life of conservation plan = 10 years

*Estimates of water savings and costs to utilities are variable and are only used for an estimate. High level water savings were estimated using values cited in literature research. Low level savings are conservative values based on the assumption that values located in literature are the maximum potential savings.

It is important to note that some communities may have conservation plans in effect to some degree, and costs may reflect this. Not all communities will select the same combination of conservation programs.

Southeastern WI Community with Population 70,000

Calculations (Page 1)

Redesign of Water Bill & Limited Public Education Program:

High: Assume 5% reduction in residential water use (Burton & Associates, 1999).
Adjusted to 3% reduction in SE WI with 60% of residences effectively impacted.
2,000 MG/yr x 0.03 = **60 MG/yr savings**

Low: Assume 1% reduction in residential water use where bills have been redesigned.
2,000 MG/yr x 0.01 = **20 MG/yr savings**

Cost: $0.10 per bill + $1,000 initial consultant cost + $100/yr for educational materials.
($0.10 x 16,500) + $1,000 + $1,000 = $3,650/10 years = **$365/yr**

Distribution of Information:

High: Assume 5% reduction in residential water use (Burton & Associates, 1999).
Adjusted to 3% reduction in SE WI with 60% of residences effectively impacted.
2,000 MG/yr x 0.03 = **60 MG/yr savings**

Low: Assume 1.5% reduction in residential water use where current practice is to provide some information.
2,000 MG/yr x 0.015 = **30 MG/yr savings**

Cost: Estimate $1.50 per brochure for paper and printing.
$1.50 x 16,500 = **$24,750/yr**

Water Conserving Rate Structure:

High: Assume 5% reduction in total water use (USEPA, 1998).
2,750 MG/yr x 0.05 = **138 MG/yr savings**

Low: Assume 2% reduction in total water use with less effective revised structure.
2,750 MG/yr x 0.02 = **55 MG/yr savings**

Cost: Assume 100 hours of labor + $5,000 for consulting services.
($65/hr x 100 hrs) + $5,000 = $11,500/10 yrs = **$1,150/yr**

Water Accounting:

Assume no direct water savings or cost as this is a current practice in most communities.

Plumbing Retrofits (at no cost to customers):

High: 50% participation rate due to lack of cost and distribution by mail (GDS Associates, 2001/Vickers, 2001).
Adjusted to 30% due to existing newer toilets in many homes where toilet displacement devices are not practical.
Assume that 100% of households who receive kits will install kit components and will not remove them later.
Assume 50% of residential use is from plumbing & fixture water use (Vickers, 2001).
Assume 20% reduction in residential plumbing & fixture water use (USEPA, 1998).
2,000 MG/yr x 0.20 x 1 x 0.50 x 0.30 = **60 MG/yr savings**

Cost: $12 per kit (Vickers, 2001) + fixed cost of $1,000 over 10 years (or $100/yr).
($12 x 16,500 x 0.30) + $1,000 = $60,400/10 years = **$6,040/yr**

Low: Assume 20% participation due to high level of prior retrofits.
Assume that 50% of households who receive kits will install kit components and will not remove them later.
Assume 20% reduction in residential plumbing & fixture water use.
Assume 50% of residential use is from plumbing & fixture water use.
2,000 MG/yr x 0.20 x 0.20 x 0.50 x 0.50 = **20 MG/yr savings**

Cost: $12 per kit (Vickers, 2001) + fixed cost of $1,000 over 10 years (or $100/yr).
($12 x 16,500 x 0.20) + $1,000 = $40,600/10 years = **$4,060/yr**

Southeastern WI Community with Population 70,000

Example Conservation Plans by Level

Conservation Level	Conservation Measure	Water Savings* (MG/yr)		Estimated Cost per Year to Utility*		Description
		Low	High	Low	High	
Low	Redesign of Water Bill & Limited Public Education Program	20	60	$365	$365	Restructure water bill to be more understandable to the consumer and to include water usage in detail.
	Distribution of Information/Campaigns for Water Conservation	30	60	$24,750	$24,750	Make pamphlets available to public and include bill inserts on importance of conservation. Include media (TV, radio, advertisements).
	Water Conserving Rate Structure	55	138	$1,150	$1,150	Implement a water conserving rate structure to promote efficient use of water.
	Water Accounting	N/A	N/A	N/A	N/A	Implement a basic system of water accounting to provide basis for loss control over time.
	Low Level Totals:	**4%**	**9%**	**$26,265**	**$26,265**	
Intermediate	Low Level Measures	105	258	$26,265	$26,265	Includes all low level measures.
	Plumbing Retrofits	20	60	$4,060	$6,040	Advertise plumbing retrofit kits to customers at no cost.
	Landscape Watering Ordinance	15	60	$3,360	$3,360	Implement ordinance limiting days and/or times for customers to water outdoors.
	Intermediate Level Totals:	**5%**	**14%**	**$33,685**	**$35,665**	
Advanced	Intermediate Level Measures	140	378	$33,685	$35,665	Includes all intermediate level measures.
	Utility System Water Audit/Leak Detection & Repair	28	69	$90,000	$90,000	Audit to assist tracking of nonaccount water use and repair obvious leaks.
	Toilet Replacement Rebate	3	7	$19,000	$23,750	Offer rebates to first 250 customers to install low-flow toilets.
	Conservation Related Staff	N/A	N/A	$26,000	$26,000	Staff to assist in updating and maintaining the conservation plan selected.
	Advanced Level Totals:	**6%**	**16%**	**$168,685**	**$175,415**	

Assumptions:
Total Water Consumption = 2,750 MG/yr
Total Residential Water Consumption = 2,000 MG/yr
Number of Residential Customers = 16,500
Energy & Chemical Operation & Maintenance Expenses = $675,000/yr
Miles of watermains in system = 300 miles
Life of conservation plan = 10 years

*Estimates of water savings and costs to utilities are variable and are only used for an estimate. High level water savings were estimated using values cited in literature research. Low level savings are conservative values based on the assumption that values located in literature are the maximum potential savings.

It is important to note that some communities may have conservation plans in effect to some degree, and costs may reflect this. Not all communities will select the same combination of conservation programs.

Southeastern WI Community with Population 600,000

Calculations (Page 1)

Redesign of Water Bill & Limited Public Education Program:

High: Assume 5% reduction in residential water use (Burton & Associates, 1999).
Adjusted to 3% reduction in SE WI with 60% of residences effectively impacted.
13,000 MG/yr x 0.03 = **390 MG/yr savings**

Low: Assume 1% reduction in residential water use where bills have been redesigned.
13,000 MG/yr x 0.01 = **130 MG/yr savings**

Cost: $0.10 per bill + $1,000 initial consultant cost + $100/yr for educational materials.
($0.10 x 145,000) + $1,000 + $1,000 = $16,500/10 years = **$1,650/yr**

Distribution of Information:

High: Assume 5% reduction in residential water use (Burton & Associates, 1999).
Adjusted to 3% reduction in SE WI with 60% of residences effectively impacted.
13,000 MG/yr x 0.03 = **390 MG/yr savings**

Low: Assume 1.5% reduction in residential water use where current practice is to provide some information.
13,000 MG/yr x 0.015 = **195 MG/yr savings**

Cost: Estimate $1.50 per brochure for paper and printing and $50,000 budget for media over 10 years.
($1.50 x 145,000) + $50,000/10 years = **$222,500/yr**

Water Conserving Rate Structure:

High: Assume 5% reduction in total water use (USEPA, 1998).
40,000 MG/yr x 0.05 = **2,000 MG/yr savings**

Low: Assume 2% reduction in total water use with less effective revised structure.
40,000 MG/yr x 0.02 = **800 MG/yr savings**

Cost: Assume 100 hours of labor + $5,000 for consulting services.
($65/hr x 100 hrs) + $5,000 = $11,500/10 yrs = **$1,150/yr**

Water Accounting:

Assume no direct water savings or cost as this is a current practice in most communities.

Plumbing Retrofits:

High: Assume 50% participation due to price and lack of distribution (Vickers, 2001).
Adjusted to 30% due to existing newer toilets in many homes where toilet displacement devices are not practical.
Assume that 100% of households who receive kits will install kit components and will not remove them later.
Assume 20% reduction in residential plumbing & fixture water use (USEPA, 1998).
Assume 50% of residential use is from plumbing & fixture water use (Vickers, 2001).
13,000 MG/yr x 1 x 0.20 x 0.30 x 0.50 = **390 MG/yr savings**

Cost: $12 per kit (Vickers, 2001) + fixed cost of $1,000 over 10 years (or $100/yr).
($12 x 145,000 x 0.30) + $1,000 = $523,000/10 years = **$52,300/yr**

Low: Assume 20% participation due to high level of prior retrofits.
Assume that 50% of households who receive kits will install kit components and will not remove them later.
Assume 20% reduction in residential plumbing & fixture water use.
Assume 50% of residential use is from plumbing & fixture water use.
13,000 MG/yr x 0.20 x 0.20 x 0.50 x 0.50 = **130 MG/yr savings**

Cost: $12 per kit (Vickers, 2001) + fixed cost of $1,000 over 10 years (or $100/yr).
($12 x 145,000 x 0.20) + $1,000 = $349,000/10 years = **$34,900/yr**

Southeastern WI Community with Population 600,000

Example Conservation Plans by Level

Conservation Level	Conservation Measure	Water Savings* (MG/yr)		Estimated Cost per Year to Utility*		Description
		Low	High	Low	High	
Low	Redesign of Water Bill & Limited Public Education Program	130	390	$1,650	$1,650	Restructure water bill to be more understandable to the consumer and to include water usage in detail.
	Distribution of Information/Campaings for Water Use Reduction	195	390	$222,500	$222,500	Make pamphlets available to public and include bill inserts on importance of conservation. Devote funds to media (TV, radio, etc.) education.
	Water Conserving Rate Structure	800	2,000	$1,150	$1,150	Implement a water conserving rate structure to promote efficient use of water.
	Water Accounting	N/A	N/A	N/A	N/A	Implement a basic system of water accounting to provide basis for loss control over time.
	Low Level Totals:	**3%**	**7%**	**$225,300**	**$225,300**	
Intermediate	Low Level Measures	1,125	2,780	$225,300	$225,300	
	Plumbing Retrofits	130	390	$34,900	$52,300	Advertise plumbing retrofit kits to customers at no cost.
	Landscape Watering Ordinance	300	1,200	$16,800	$16,800	Implement ordinance limiting days and/or times for customers to water outdoors.
	Toilet Replacement Rebate	36	103	$332,500	$475,000	Offer rebates to first 5,000 customers to install low-flow toilets.
	Intermediate Level Totals:	**4%**	**11%**	**$609,500**	**$769,400**	
Advanced	Intermediate Level Measures	1,591	4,473	$609,500	$769,400	
	Utility System Water Audit/Leak Detection & Repair	400	1,000	$600,000	$600,000	Audit to assist tracking of nonaccount water use and detect & repair leaks.
	Commercial/Industrial & Public Use Metering	27	54	$25,000	$25,000	Installation of meters on unmetered commercial & industrial customers to inform of water usage and to bill customers based on total use.
	Conservation Related Staff	N/A	N/A	$45,000	$45,000	Staff to assist in updating and maintaining the conservation plan selected.
	Advanced Level Totals:	**5%**	**14%**	**$1,279,500**	**$1,439,400**	

Assumptions:
- Total Water Consumption = 40,000 MG/yr
- Total Residential Water Consumption = 13,000 MG/yr
- Number of Residential Customers = 145,000
- Total Industrial & Commercial Water Consumption = 27,000 MG/yr
- Total Unmetered Commercial/Industrial Customers = 250
- Energy & Chemical Operation & Maintenance Expenses = $6,000,000/yr
- Miles of watermains in system = 2,000 miles
- Life of conservation plan = 10 years

*Estimates of water savings and costs to utilities are variable and are only used for an estimate. High level water savings were estimated using values cited in literature research. Low level savings are conservative values based on the assumption that values located in literature are the maximum potential savings.

It is important to note that some communities may have conservation plans in effect to some degree, and costs may reflect this. Not all communities will select the same combination of conservation programs.

Cost Data and Water Savings of Model Conservation Plans

Community Population	Conservation Plan Level	Water Savings per Year (MG)		Cost of Program per Year		Cost of Program per 1000 gal Saved		Net Annual Savings*		Cost to Pump Water per 1000 gal
		Low	High	Low	High	Low	High	Low	High	
3,000	Low	1	2	$1,106	$1,106	$1.106	$0.461	-$786	-$338	$0.320
	Intermediate	2	6	$2,500	$2,572	$1.042	$0.422	-$1,732	-$620	
	Advanced	3	9	$37,310	$38,332	$11.387	$4.483	-$36,262	-$35,596	
70,000	Low	105	258	$26,265	$26,265	$0.250	$0.102	$2,371	$43,962	$0.273
	Intermediate	140	378	$33,685	$35,665	$0.241	$0.094	$4,497	$67,290	
	Advanced	170	453	$168,685	$175,415	$0.991	$0.387	-$122,245	-$51,814	
600,000	Low	1,125	2,780	$225,300	$225,300	$0.200	$0.081	-$21,394	$278,575	$0.181
	Intermediate	1,591	4,473	$609,500	$769,400	$0.383	$0.172	-$321,130	$41,309	
	Advanced	2,018	5,527	$1,279,500	$1,439,400	$0.634	$0.260	-$913,736	-$437,653	

*Annual savings are based on avoided chemical and energy costs associated with pumping and treating water less the cost of the conservation program.

Assumptions: Energy & chemical costs for community of 3,000 = $16,000/yr
Energy & chemical costs for community of 70,000 = $750,000/yr
Energy & chemical costs for community of 600,000 = $7,250,000/yr

Note: Avoided capital costs are difficult to estimate since water systems differ from community to community. For each community, factors such as the need for increased infrastructure, the location of new water sources, the number and size of wells that must be constructed, the cost of water that must be pumped from source waters outside community boundaries, etc., will vary greatly.