Appendix 2-D:

Water Conservation Measures

APPENDIX 2-D
WATER CONSERVATION MEASURES

2-D.1 REGULATORY FRAMEWORK FOR WATER CONSERVATION

Federal

In the United States, governments on all levels have enacted legislation to promote or enforce water conservation measures. On the federal level, the National Appliance Energy Conservation Act of 1987 established energy and water efficiency standards for many appliances. The Energy Policy Act of 1992 (EPAct) required Federal agencies to implement all life-cycle cost-effective water conservation measures with payback periods of 10 years or less. In other words, agencies need to use a water conservation measure or product when it will take no more than 10 years to recover the cost of the project through savings on water bills (Executive Order 13123, 1992). The 1998 revisions to EPAct revised standards for water conservation devices approved for new construction and remodels (EPAct 1998).

"*Greening the Government through Efficient Energy Management*," further directs agencies to identify conservation opportunities and install cost-effective water-conserving fixtures and other equipment. Sections 207, 502(f), and 503(f) establish water conservation and energy use requirements. The legislation also encourages outside entities to implement water and energy conservation through Energy Savings Performance Contracts and other financing mechanisms.

Section 1455 of the 1996 Amendments to the Safe Drinking Water Act (SDWA) requires EPA to publish in the Federal Register guidelines for water conservation plans for public water systems of various sized and to take into consideration such factors as water availability and climate (EPA 2002). In 1998, the EPA announced the availability of final guidelines for conservation plans for water systems.

State

Washington State has been ahead of the Federal Government in legislating water conservation for some time. When EPA final guidelines for water system conservation plans were announced in 1998, Washington State had already required the preparation of water conservation plans as an element in water system plans since the adoption of the Water Use Efficiency Act of 1989. Municipal water conservation legislation is briefly summarized as follows:

RCW 19.27.170 *Water Conservation Performance Standards – Fixtures that meet standards – Marketing and Labeling Fixtures* – This legislation establishes state low flow plumbing requirements for all new construction and remodels, whether residential or multi-unit hotels.

RCW 35.67.020 *Sewerage Systems – Authority to Construct Systems and Fix Rates and Charges* - Authorizes cities and towns to consider the achievement of water conservation goals and the discouragement of wasteful practices when setting sewer rates.

RCW 35.92.010 *Municipal Utilities – Authority to Acquire and Operate Waterworks – Classification of Services for Rates* - Authorizes cities and towns to consider the achievement of water conservation goals and the discouragement of wasteful practices when setting water rates.

RCW 43.20.235 *Water Conservation – Water Delivery Rate Structures* – Requires water purveyors who develop water systems plans to evaluate the feasibility of adopting and implementing water delivery rate structures that encourage water conservation.

RCW 43.27A.090 – *Powers and Duties of Department* – Directs Ecology to adopt policies to insure water is "used, conserved, and preserved" for the best interests of the state.

RCW 43.70.310 – *Cooperation with Department of Ecology* – Directs Department of Health, where feasible, to integrate efforts and endorse policies in common with Ecology.

RCW 90.03.005 – *State Water Policy – Reduction of Wasteful Practices* – Instructs Ecology to reduce wasteful practices in the exercise of water rights "to the maximum extent practicable."

RCW 90.03.400 – *Crimes Against Water Code* – The willful or negligent waste of water to the detriment of another shall be a misdemeanor.

RCW 90.44.110 – *Waste of Water Prohibited* – No public ground waters that have been withdrawn shall be wasted without economical beneficial use. The Department of Ecology shall require both flowing and non-flowing wells to be constructed and maintained as to prevent the waste of public groundwater through leaking pipes.

RCW 90.48.495 – *Water Conservation Measures to be considered in Sewer Plans* – The Department of Ecology is to require sewer plans to include a discussion of water conservation measures considered or underway and their impact on public sewer service.

RCW 90.54.020 – *General Declaration of Fundamentals for Utilization and Management of Water of the State* – Directs Ecology to encourage Federal, State, and local governments to carry out practices of conservation. Also indicates that improved water use efficiency and conservation shall be emphasized in the management of the state's water resources and in some cases will be a potential new source of water to meet future needs.

RCW 90.54.180 – *Water Use Efficiency and Conservation Programs and Practices* – Provides that increased water use efficiency should receive consideration as a potential source of water in state and local water resource planning processes and stipulates that water use efficiency programs should mix incentives and regulation. In determining cost-effectiveness and alternate water sources, consideration should be given to the benefits of conservation, wastewater recycling and impoundments. Entities receiving state financial assistance for construction of water source expansion and acquisition of new sources shall develop, and implement if cost effective, a water use efficiency and conservation element of a water system plan. State programs to improve water use efficiency shall focus on areas where water is over appropriated. State agencies should educate the public concerning the wise and efficient use of water.

Senate Joint Resolution 8210 – *Amendments to state constitution to encourage water use efficiency (Passed by voters in 1989)* – permits every local government to finance increased water use efficiency.

WAC 246-290 – *Group A Public Water Systems – Water System Plans* – Requires public water systems to address several elements including a "conservation program" in their water system pland. Public water systems are also required to specifically address water demand forecasting, water use data collection, and enhance water conservation planning where water rights will be needed within twenty years.

2-D.2. STRATEGIES FOR RESIDENTIAL WATER CONSERVATION

Conservation Oriented Rate Structures

In 1995, The Washington State Department of Health released a report to the legislature entitled *Conservation-Oriented Rates for Public Water Systems in Washington* to fulfill its obligations legislated in 2ESHB 1309. The report advocates that "customers respond to price and make a decision to consume or not to consume water based on price signals they receive as a result of the rate structure that is in place." Many water systems across the nation have found that higher water rates lead to reduced consumption (DOH 1995). The document summarizes the rate structure DOH considers to be conservation-oriented. Their findings are summarized below:

Inclined or inverted rate structures

An inverted block rate structure separates consumption levels into two or more blocks, with rates increasing with ascending consumption. This type of rate structure puts a larger portion of the water system's expense on the larger user, those who use more water and thus more infrastructure.

Seasonal Rate Structure

A seasonal rate structure varies rates based on the season. Typically, seasonal rate structures are designed to reduce summer water use to reflect constraints on water supplies and the higher costs associated with water withdrawal at that time. Seasonal rates can be a summer surcharge, higher base rate during summer months, or an increase in commodity charges during the low water months.

Time of Use Structure

Time of use rate structures separate charges based on various time periods beyond seasons. Often times, a utility will price water higher during peak demand times and provide a discount for off-peak water use. Rates may also change throughout the week instead of time of day. Seasonal rates are generally incorporated with hourly or weekly rate structures.

Individualized Goal Billing Structures

Individualized goal billing structures are similar to an inverted block rate structure, except that the block sizes are set for each customer based on a usage “goal.” The usage goal is based on the public water system’s own philosophy or goals. For example, the initial block may be the winter water use for the customer. Anything used above and beyond this may be priced at a higher unit cost. Other goals may include consumption for a given month during a previous year with low consumption or consumption levels tied to the number of residents in a household. Customers that meet their goals may receive a discount on their water bill.

Excess Use Rate Structure

Excess use rates are similar to goal billing, but instead of receiving a discount or being rewarded for low consumption, the customer receives a penalty for excessive water consumption.

Education

School Outreach

School Outreach measures increase awareness of local water resources and encourage water conservation practices by children. The theory is that the children will internalize water conservation values and practices at an early age and use them throughout their lives. Children who learn water conservation practices may also have an effect on the adults they live with or encounter. Activities for school outreach include school presentations, preparation of new curriculum material, distribution of new and existing materials, and tours of water utility facilities. Groups such as American Water Works Association, the Environmental Protection Agency (EPA), and various municipalities have created their own school outreach materials that are available online and through the mail. Some school districts have combined water conservation education with computer classes to create programs that educate the students on computer skill while studying water conservation. This approach has the added bonus of promoting conservation via the internet. Websites created by these schools supply water use facts and water conservation tips. Some even go so far as to set up a program for households to estimate daily water consumption based on formulas that automatically calculate usage after answering some simple questions. The effectiveness of school education has not been formally calculated, but many municipalities claim to have reduced the amount of per capita water consumption after instituting a water conservation curriculum.

Adult Education

Educating adults on water conservation employees a multi-faceted approach. No single method will reach everyone, nor be comprehensible to everyone. Some approaches used for adult education are as follows.

Brochures: Many handouts exploring different aspects of water conservation are available. These brochures can be set out in the water utility’s office, stuffed in water bills, distributed in informational packets or used in theme shows or fairs. The brochures typically concentrate on a single aspect of conservation and contain suggested changes to conserve water.

Speakers Bureau: A speaker's bureau makes knowledgeable presenters available to different citizen groups and other organizations. By actively seeking speaking opportunities and making speakers available to a wide cross-section of service, community, and other groups, the public water system or purveyor can educate adults about water conservation. To be most effective, speakers should be provided with audio and visual aids for presentations and should also be aware of the target audience for the event.

Water System Employee Education: Another aspect of customer assistance and program promotion is training all water system employees about water conservation so that they will be prepared to do public outreach. Water system employees meet with the public daily, so in a sense public outreach is a routine part of their job. Training at the onset of employment for customer service representatives should integrate water conservation information to be passed along to the customers. Meter readers also can be trained to answer water conservation questions and even hand out brochures encouraging conservation or retrofit kits.

A special outreach effort should be considered in times of peak use or drought. In critical shortage periods, if water system employees observe wasteful water practices they may be able to provide input and advice to landowners on the spot, both about better practices and about the critical water shortage. Under water curtailment, during severe drought, fines may be levied for some water uses.

Program Promotion: Public water systems should promote the concept of water conservation, including the reasons to conserve and means of water conservation. Water conservation can be publicized in the media (newspaper, radio, television), as well as on utility bill inserts. Messages should help consumers recognize the need for conservation and understand how they can integrate conservation practices into their lifestyles. Effective messages show how conservation measures can save money (e.g., by converting lawns to low water landscapes, or changing from conventional plumbing fixtures to low-flow devices).

"Selling" the idea and advantages of water conservation to customers is often overlooked by water systems. Informing water users of the savings they can realize on their water, sewer, and electric bills is a great incentive to conserve. Individuals will often not invest in conservation unless they can realize a return on their investment in a short period of time. Fortunately, most conservation devices do pay for themselves quickly. For example, a very water efficient showerhead, retailing for about twenty dollars, will pay for itself in water and energy costs in about six months. This rate of return (equal to a simple annual return of 200%) is significantly greater than the rate of return for traditional investments (Ecology 1991). Offering a rebate for customers to purchase such devices, coupled with savings information, is a very effective means of promotion.

Customer Assistance: Some of the more common types of customer assistance programs include designating staff to answer customer inquires, establishing a hotline with conservation information, and bringing in specialists to offer specific conservation assistance such as workshops on low water use landscape or increased indoor efficiency.

<u>Indoor Residential Uses</u>

Interior water use in older homes equipped with traditional, non-water saving plumbing fixtures is typically about 80 gallons per capita per day (gpcd), while newer homes use may use less than 50 gpcd, a water savings of up to 39 percent (AWWA 1993). Offering incentives for more energy efficient fixtures and supplying customers with retrofit kits can bring this number down even further. Customer participation in retrofit kit programs is generally high, with programs achieving participation rates of 65 to 80 percent of the targeted population (Vickers 2001). The reduction of indoor water use not only saves on consumer energy costs (water heating constitutes about 15 percent a home's total energy requirements, AWWA 1993), it also can reduce infrastructure and purification costs for water purveyors.

Toilets

Flushing toilets is typically the largest indoor residential water demand, averaging 18.5 gallons per capita per day (gpcd), or 26.7 percent of indoor use in a typical non-conserving home (Vickers 2001). The average person flushes the toilet five times per day (as quoted by Vickers 2001). Restroom toilets in office buildings are estimated to be used about three times per workday.

Water Use efficiency standards adopted in Washington State in 1993, for both new construction and remodels, require no more than 1.6 gallons per flush for toilets and 1 gallon per flush for urinals. Non-conserving toilets commonly in use before 1980 used about five to seven gallons per flush (AWWA 1993). Overall, the average residential toilet uses 3.48 gallons per flush (Vickers 2001).

Waterless toilets: Waterless toilets include composting or incineration units that require no water for flushing. Oil-flush, chemical and vacuum toilets are also available, but are used far less frequently.

Composting (or "biological") toilets are not flushed and need virtually no water to convert human waste into humus, and do not require any sort of connection to a wastewater main. These toilets can be self-contained or a part of a larger composting system. Composting toilets operate by collecting wastes into a tank and mixing it with organic bulk material, such as wood shavings, mulches, sawdust, grass clippings, or leaves. Adequate temperatures and air circulation are required to evaporate water from waste (65 degrees or higher is preferred). These toilets require no water, other than the amount used to clean the systems so water savings would be close to 100 percent over traditional toilets (Vickers 2001). Composting toilets require careful management to operate properly and safely, and have yet to capture the attention of the average American consumer.

Incinerator toilets use high temperature electric or propane heat to burn wastes, leaving a fine ash product. These toilets consist of a box-like unit with a fan to control temperatures and to vent gases and moisture outside through a pipe. Waste is deposited to a plastic liner inside the unit, and a button or switch is activated to begin the process after each use (Vickers 2001). These systems also require no water, but entail tradeoffs in energy use and air quality effects.

Low Flush Toilets: These toilets use a maximum of 3.5 gallons per flush (AWWA 1993) and are readily available throughout the country. They offer the traditional gravity tank as well as dual flush, low volume flushometer (pressurized), flapperless, vacuum assisted, electromechanical hydraulic, and pump assisted models.

Ultra Low Flush Toilets: ULF toilets typically use only 1.6 gallons of water per flush (AWWA 1993). This type of toilet is now readily available from manufacturers, and Washington State requires their use in all new construction and remodels. Water savings are in the range of 16-23 gpcd where they are required in new buildings or are voluntarily installed in old homes (AWWA 1993). Retrofitting with these fixtures can be promoted by regulation, financial incentive, or public education that encourages voluntary use. These toilets are still somewhat unfamiliar to most consumers and are slightly more expensive that low flush models, so voluntary retrofitting is not common. Several cities across the nation have started incentive programs involving $50-$100 rebates on these devices. Regulatory action may require installation of these toilets as a condition of home resale. The use of these devices may significantly reduce wastewater treatment volumes as well (AWWA 1993).

Toilet Tank Displacement Devices: These devices reduce the amount of water used to flush in traditional or low flush toilets. Toilet displacement devices such as bags and bottles are commonly used in gravity-tank toilets because they are easy to install, generally reliable, and inexpensive (Vickers 2001). Displacement devices save water by occupying a part of the tank that would otherwise be filed with water, thereby reducing the amount of water held in the tank and used for the flush.

A standard nonconserving toilet fitted with a tank displacement dam uses about one gallon less per flush than a nonfitted toilet (Konen 1992). Toilet tank bags save less, about 0.7 gallons per flush, but are easier to install (Konen 1992). Utilities can encourage voluntary use of these devices or can institute device giveaway programs. Because these devices can be easily removed by the resident, their long-term effectiveness is questionable. They also have a limited life, estimated at 3-5 years (AWWA 1993), so maintaining water savings may require periodic redistribution.

Variable Flush Devices: These devices operate by altering the force acting on the toilet flapper valve. When the toilet is flushed, the early closure device uses the pressure from the full tank of water to force the flapper to close early, releasing a reduced amount of water, but with enough velocity for a complete flush (Vickers 2001). These devices commonly use a float attached to a flapper valve. They are relatively easy to install but require field adjustment by the installer to maximize water savings while providing a satisfactory flush. They are suitable for retrofitting kits. Laboratory tests indicate savings of one gallon per flush (Konen 1992).

Dual-Flush Devices: Dual flush devices can be installed in many gravity-tank fixtures to provide alternative low- and high- volume flushes. The full volume flush is used for solid waste, while the lower volume is used for liquid or paper waste. Although most dual flush adapters are used to retrofit traditional high-volume toilets, they are also available for 1.6 gpf toilets. They are somewhat complicated to install and require behavioral changes and education to be effective. If the user is confused as to which flush volume to select, double flushing may end up using more water than is conserved. Project savings are expected to be about 1 gallon per flush with proper education and behavioral changes (AWWA 1993).

Diaphragm Retrofit Kits for Flushometer-Valve Toilets and Urinals: The flush volumes of some older 3.5 to 5.0 gpf flushometer-valve toilets (and urinals) can be reduced by about one gallon per flush by installing a valve replacement kit inside the flush valve. A "marriage" of the valve and the bowl is required so that a bowl designed for high volume fixture can accommodate reduced flows without clogging; some can do this successfully, others can not (Vickers 2001).

Efficiency Adjustments for Flush Valves: Water use by high-volume, flush-valve toilets may be lowered by turning the screw under the cap located on the horizontal portion of the valve. This adjustment can save 0.5 to 1.0 gpf and should not adversely affect flushing performance (Vickers 2001). These types of adjustments require some experimentation to determine minimum acceptable flush volume.

Toilet Leak Repair: Toilet leaks present a common but potentially large source of undetected water loss. Leakage may amount to 9.5 gpcd in an average non-conserving single-family home, according to the 1999 REUS study, most of which is due to toilet leaks. Water losses from toilet leaks can vary from several gallons to more than 250 gpd (Ryan 2002). Up to twenty-five percent of toilets in US homes are estimated to leak, although surveys indicate that the amount of leakage may be related to the type of toilet installed (Vickers 2001). The more water a toilet uses to flush, the more likely it is that the toilet will leak. Dye kits can be useful in detecting toilet leaks. Tablets are dropped into the toilet tank; if the tank leaks, a bright colored dye will appear in the toilet bowl. The amount of savings for toilet leak detection will vary directly with the amount of leaks in the target area.

Urinals

EPAct requires urinals sold, installed, or imported in the United States be low volume fixtures that use less than 1.0 gpf (EPAct 1992). Washington State standards also require the use of 1.0 gallon per flush urinals. Low-volume, waterless or composting urinals and retrofit devices generally render excellent performance and customer satisfaction (Vickers 2001).

Low volume urinals: Low volume urinals use 1.0 gpf or less. They can often be installed to replace high-volume, flush-valve fixtures with no modifications to wall or floor connections (Vickers 2001). Replacement of a conventional urinal with a low volume urinal would save approximately 2 gallons per flush (Vickers 2001).

Waterless urinals: The waterless urinal was designed in the 1890's and has been gaining popularity ever since. It has been installed in the United States more frequently than in any other country (Vickers 2001). Waterless urinals require no water for flushing and can replace conventional fixtures connected to 2-inch drainlines. These no-flush urinals are designed to have no odor and to minimize bacterial growth on dry surfaces by utilizing a drain insert that lasts around 1,500 uses. An evaluation of 20 No-Flush urinals installed in 1993 at various schools in San Diego Union High School District found annual water savings of 45,000 gallons per urinal, yearly cost savings of $122 per fixture in parts and labor for repairs, and $144 per fixture in reduced water costs (Vickers 2001).

Composting urinals: Composting urinals require no water and are connected to composting toilet systems. Urine deposited in a composting urinal is conveyed by gravity through a vertical drain directly to the composter, where it is decomposed. The fan used to vent the composter created a negative pressure that continually draws air from the urinal drain, preventing the escape of odor and gases through the fixture (Vickers 2001).

Urinal maintenance: Urinals should be checked for leaks every six months (Vickers 2001). Water losses from flush valve urinals are more likely due to malfunctions than leaks (e.g. the valve gets stuck in the open position and flushes continually until it is unlocked), but seepage should be checked at the valve and all connections (Vickers 2001).

Showerheads

Water use by showerheads is typically the third largest source of indoor residential water demand, averaging 11.6 gpcd; this represents 16.8% of indoor use in a typical single-family home. A 1984 study found the average use by showerheads in a non-conserving home to be 16.3 gpcd, an actual flow of 3.4 gpm (Vickers 2001). Many improvements to showerhead efficiency and installation have been made since this time. A 1999 REUS study reported that the shower and bath are used about 0.75 times per day by each person in an average single-family home (in other words, three showers or baths every four days). The study also reported an average shower water use rate of 11.6 gpcd and an average flow rate of 2.2 gpm (meaning that the average person takes a shower that lasts slightly longer than five minutes). Other surveys suggest that the average shower lasts eight minutes and uses 17.2 gallons of water (Mayer 1999).

The quality and water efficiency of showerheads has improved significantly since the early 1980’s due to state and national legislation and conservation programs initiated by a number of energy and water utilities. EPAct requires that showerheads sold, installed, or imported in the United States be low-volume fixtures that use no more than 2.5 gallons per minute (gpm) at 80 psi. An amendment to EPAct in March of 1998 revised the maximum flow for showerheads to 2.2 gpm when measured at 60 psi (Vickers 2001). Washington State also requires no more than 2.5 gpm for new construction or remodels.

Low-Volume Showerheads: The terms low-volume, low-flow, low-consumption, and high efficiency are all used interchangeably to refer to fixtures that use less than 2.5 gpm (at 80 psi) (Vickers 2001). Low volume showerheads improve water-use efficiency from the traditional 5 or 7 gpm fixtures through such features as improved spray patterns, better mixing of air and water, and narrower spray areas to give the illusion of a higher volume spray (Vickers 2001).

Showerhead Flow Restrictors (Disk Inserts): Disk inserts are typically inexpensive plastic or metal disks used to couple with older fixtures to reduce the flow of water. For several reasons, disk inserts have a poor rate of acceptance by consumers and are typically not used by experienced conservation managers (Vickers 2001). The lack of customer satisfaction with a disk insert has led to removal of most devices by the consumers and may have adversely affected perception of low-flow showerheads and other water conservation devices.

Retrofit Kits: Retrofitting showerheads can provide conservation savings in single-family dwellings, multi-family units, commercial buildings, and even some industrial sites. Residential retrofit kits should provide at least two low-volume showerheads or disk inserts. Low flow showerheads designed for future retrofit programs are available in the screw-on, fixed position, or the hand held styles. Aerating spray showerheads use an aerator to mix air and water droplets, enabling the spray to wet more surface area with less water. Atomizing showerheads create small, misty droplets to wet large surface areas. Pulsating showerheads have variable spray and flow patterns, pausing the flow and releasing water in spurts for a massaging effect. Temporary shutoff buttons on showerheads slow the water flow to a trickle and allow the user to save additional water while shampooing or soaping. A good shutoff valve maintains the same temperature water before and after shutoff. These shutoff valves require a change in behavioral patterns to be effective for water conservation benefits.

Acceptance of low-flow showerheads is normally excellent when the customer is provided with a high quality showerhead and choice of fixture's spray pattern. More than 50 percent of consumers targeted in a retrofit program are normally willing to install a low-volume showerhead (Vickers 2001).

The life cycle for a showerhead is 10 to 15 years so retrofit programs will need to be continual or combined with purchase incentives to have a long-term conservation benefit. Disk inserts last five to ten years, depending on the material and amount of particle build-up, although most customers can be expected to remove disk inserts that deliver lower quality sprays (Vickers 2001).

Faucets

Combined water use of kitchen and bathroom faucets is typically the fourth largest source of indoor residential demand (Vickers 2001). It represents 15.7 % of indoor water consumption in an average single-family, non-conserving household, according to a 1999 REUS study. Non-conserving faucets have a rated flow capacity of between 2.75 and 5 gpm (AWWA 1993).

Low-volume faucets: Low-flow kitchen and lavatory faucets use 2.5 gpm at 80 psi, or 2.2 gpm at 60 psi, as required by EPAct 1998. Reduced flows are achieved through aeration or flow control devices, spray features, or a combination of these options.

Faucet retrofit devices: The flow-control devices found in low-volume faucets are also available as retrofit devices to reduce flows of most high volume faucets. In most cases, retrofitting provides a less expensive, yet similarly effective way of conserving water at faucets. Faucet retrofit devices are usually aerators or metered or self-closing valves.

Faucet aerators are circular screen disks, usually made of metal, that are screwed on to the head of the faucet. They reduce flow by mixing air with the spray to provide ample spray with reduced flows. They are simple, economic, and work, but can generally be taken off if the customer is dissatisfied with performance.

Metered or self-closing faucets allow a certain amount of water to be used in a given time period. Metering faucets installed after 1994 must use no more than 0.25 gallons per second and usually have a 10-second operating cycle. The water use efficiency of these devices varies depending on the flow rate and the length of time they are set to run. Generally, they tend to be more efficient than conventional devices because they operate only as long as they are needed.

Faucet maintenance: Faucet leaks are a common source of wastewater. A steadily dripping faucet can send 180 gallons of water down the drain each day (Ryan 2002). Faucets should be checked regularly for leaks at the faucet head for seepage at the base and at its connections. Faucet leak repairs should include replacing worn washers, tightening or repacking faucet, and adjusting flows.

Clothes Washers

The design of residential clothes washers has been changing in the US since the mid-1990s. Consumers now may choose between conventional, high-volume, top-loading, vertical-axis washers, and more water- and energy-efficient “tumble” washers. Conventional washers installed since 1990 are estimated to use 39 to 43 gallons per load (gpl), compared to 48 to 55 gpl from 1980 to 1990, and roughly 56 gpl prior to 1980. High efficiency residential clothes washers use an average of 27 gpl. Some use as little as 16 gpl. Currently, about ten percent of the washers in use in this country are high efficiency, as opposed to over ninety percent of the clothes washers in Europe (Vickers 2001)

Dishwashers

Water use by dishwashers typically comprises one of the smallest portions of indoor residential water demand, averaging 1.0 gallon per capita per day, or representing 1.4% of indoor residential water use. Two measures are available to reduce water use by residential dishwashers: water efficient dishwashers and efficient water use practices for dishwashers. Conventional dishwashers use seven to fourteen gallons per load, whereas residential water-efficient dishwashers use a maximum of 7 gpl. As with many devices, the efficiency of dishwashers is contingent on appropriate use by the operator. Simple behavioral changes, such as operating the dishwasher with full loads only, scraping food before loading, and using shorter cycles for less soiled dishes can reduce water consumption in any dishwasher.

<u>Residential Landscape Uses</u>

The volume of water used for lawn and landscape maintenance in the United States is not well documented, but is believed to be significant. In *Estimated Use of Water In the United States in 1995*, the United States Geologic Survey (USGS) found residential water demand in the United States to average more than 26 billion gallons per day (bgpd), with about 30 percent of that (around 7.8 bgpd) devoted to outdoor use, primarily lawn car. Thats about 31.7 gpcd. The percentage of outdoor water use decreases significantly in cooler regions, such as the Pacific Northwest. The City of Seattle is estimated to use less than one-third of water consumed for outdoor use, whereas cities in the southwest, like Scottsdale, Arizona, use almost eighty percent of their water outside (Vickers 2001). Educating landowners on more effective outdoor water use can reduce then amount of water consumed overall. New approaches to landscape design, better choices in turf and plant selection and improvements in irrigation technology can promote landscape irrigation efficiency.

Water-wise landscape planning and design

Several landscape design and management approaches have become popular over the last couple of decades. Xeriscape (pronounced zera-scape) is a concept that incorporates proper planning and design, soil analysis, plant selection, practical turf areas, efficient irrigation, use of mulches, and maintenance to reduce excessive water use. The xeriscape principle has gained popularity since its introduction in the early 1980's by the Denver Water Department (Vickers 2001). Many water utilities have promoted xeriscape programs through rebates or tax incentives. Some areas have gone so far as to pass initiative mandating some sort of xeriscape program for new residences. Studies have shown that implementing water-wise or xeriscape landscaping practices can achieve at least a fifty percent reduction in water compared to conventional landscape practices (University of Georgia, as quoted in Vickers 2001). In addition to reduced water bills, water-wise or xeriscape landscapes typically require less maintenance than conventional lawns.

Native and low-water turf and plants

Selecting native and low-water turf or plants can often eliminate the need for additional irrigation. Plants that are natural to any given area have adapted to the conditions of the area, without the aid of irrigation. These plants have often formed beneficial relationships with the soil type as well, and may even be useful in thwarting the invasion of noxious weeds (NPS as quoted on Vickers 2001).

Educating landowners on the benefits of planting native vegetation can reduce the amount of water consumed for irrigation. Some local governments have hired staff to teach residents how to choose and manage native landscapes and have adopted ordinances to reduce the amount of high-water plants in the area. For example, Marin Municipal Water District (CA) allows a maximum of 35 percent of the total landscape to be high water-use turf plants. Other areas require all newly established or renovated landscaped to use native or low-water plants. Albuquerque, New Mexico ,requires developments to devote no more than 20 percent of the landscape to high water-use plants, or establish a water budget to pay an additional amount of money for each unit of water consumed. At least a 20 percent reduction can be expected from instituting or encouraging the use of low-water native plants (Vickers 2001).

Irrigation Water Conservation

Water-efficient landscape irrigation practices assure that water gets used only where it is needed and reduces the amount of street runoff and safety hazards created by wet roads and stormwater. Options to reduce water use include landscape irrigation scheduling, soil improvements, the use of mulches, and maintenance of water efficient landscapes.