

## Best Available and Emerging Technologies

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Water demand can be more efficiently managed through technological and structural approaches such as altering existing systems to encourage better control over water demand, retrofitting equipment, reducing leaks, metering, and recycling. Water efficiency can also be improved through advances in water-use technology or by changing the physical nature of a system, such as by replacing high water-use plants with more efficient landscaping that better matches climate and water availability. (Gleick et al., 2003)

The following summaries are intended to provide an overview of the best available water-use and conservation technologies. For this discussion, it is important to recognize the difference between Best Available Technology (BAT) and Best Practical Technology (BPT). BAT is the best proven commercial technology that is available for reducing the amount of water used to accomplish a specific task. For example, a composting toilet, which is capable of meeting disposal needs without the use of water, is commercially available and, since it uses no water, has been proven to provide a maximum of savings. BPT is defined as the best technology available for reducing water use that meets current legislative and societal norms. While making a subjective judgement on social acceptability, this definition involves a more realistic estimate of maximum practical technical potential. An example of BPT for toilets in the United States is the ULFT, which meets existing national standards of 1.6 gallons (6 liters) per flush<sup>14</sup>. (Gleick et al., 2003)

**Public Water Distribution Systems** – The regulation of water distribution through the remote operation of motor valves uses information obtained from pressure gauges and flow meters installed within distribution pipes to observe water pressure and flow conditions within the system. This information is relayed via telephone lines to a central water distribution control center, where these conditions can be monitored on a 24-hour basis. These data are then used to calculate appropriate values for pressure and flow, which are then used in operating the motorized valves to adjust water flow and pressure within the system. This type of technology helps to prevent leakage from distribution systems and promotes the effective use of water. (Shinoda, 2000)

**Water Meters** – Meters can also be used as an incentive to conserve water. Meters provide the homeowner or business owner with an accurate account of how much water they use. Studies show that unmetered residences tend to use more water than those on meters because metered customers are paying for all of the water they use. Problems like dripping taps and running toilets are also quickly fixed and more conservative water use on lawns and gardens is usually achieved. Where municipalities have introduced water meters (switching from flat rate pricing to volumetric pricing), water demand dropped. Meters provide indirect water savings by telling the homeowner how much water is being used, identifying opportunities to reduce unnecessary water uses, and identifying leaks and water losses. (Government of Alberta, 2004)

Many water utilities are now installing AMR technologies to facilitate the collection and increased accuracy of water use data. Specifically, AMR allows for the remote collection of

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<sup>14</sup> “Dual-flush” toilets, which use less water than the current U.S. standard of 1.6 gpf (6 liters), are the norm in Australia and Japan. It is expected that this technology will become more common in the U.S. over time.

data from utility meters using telephone line, radio frequency, power-line, and satellite communications technologies. Many AMR systems use a radio frequency transmitter to send out signals containing the meter identification number and current reading as the meter reader approaches the property. This information is then downloaded from the handheld device or truck-mounted computer to the computerized billing system.

Communities such as Calgary in Alberta, Canada; Pasadena, Texas; and Peoria, Ariz., have all recently switched to AMR systems. These water utilities have found that the detailed water-use data helps planners to compare and contrast the water use of metered and flat-rate customers, learn how and when residents are using water, define leakage or UAW, and identify long-term needs. The installation of flow meters on water mains and sewer pipes, as well as rain gauges, can also provide data on the volume of water entering and leaving a certain neighborhood or community. A detailed list of AMR products and service providers can be found on the Automatic Meter Reading Association website at [www.amra-intl.org/products/index.cfm](http://www.amra-intl.org/products/index.cfm).

Water-Efficient Toilets – Flushing toilets is the largest single use of water inside the home. Depending on whether leaks from toilets are included, it has been estimated that toilet use ranges from 28 percent to almost 40 percent of total indoor water use. There are four ways to reduce water use by toilets. These include:

- Installing low-flow or low-volume toilets (using 1.6 gallons or less),
- Installing waterless or composting toilets (require no water to flush),
- Leak repair measures (replacement of deteriorated flapper valves and valve seals, worn or broken ball cocks, refill valves, lift chains, and handle rods), and
- Installing retrofit devices to reduce flush volume on standard flush toilets (typically use displacement devices such as bottles, bags or bladders to displace water for flushing, or toilet dams).

High priority has been placed on improving the water efficiency of new toilet models. Based on recent technological advances in the field, toilets can use 6 gallons (22 liters) of water, 3.5 gallons (13 liters), or 1.6 gallons (6 liters) per flush, or even no water at all. By focusing attention on using the minimum amount of water to eliminate toilet contents, water can be conserved. Consequently, federal<sup>15</sup> and many state water-efficiency laws now require new toilets to meet standard flush volumes of 1.6 gpf or less. These are commonly referred to as ULFTs.



The advent of water-saving toilets led to the development of new technologies which aim to provide full performance at 1.6-gallons. Pressurized-tank (PT), pressure-assisted, or flushometer-tank toilets resemble regular gravity-flush (i.e., tank-and-bowl) toilets, but the porcelain tank contains a metal or plastic tank which holds water under pressure,

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<sup>15</sup> In 1992, the National Energy Policy Act reduced the maximum flushing volume of new toilets sold in the United States to 1.6 gpf (approximately 6 liters), effective January 1994.

pressurized by the building's own water pressure. When flushed, the pressurized water provides a rapid and powerful flush.

Although the use of 1.6-gallon toilets is mandated in the U.S. and parts of Canada, it is not uncommon for them to flush with considerably more or less water. This is true even though virtually all ULFTs are designed and marketed as flushing with 1.6 gallons. Generally, a change in water supply pressure will affect toilet flush volume. This is especially important in high-rise apartment buildings where water pressures can change from floor to floor. It is important that toilets are set to flush with their design volumes (regardless of supply pressures) such that water savings and performance are maximized.

In other countries, a more efficient technology has been tested and installed extensively. For example, the Caroma Caravelle 305 is a dual-flush toilet that is used widely in countries such as Australia. Dual-flush toilets have a two-button mechanism designed for different volume flushes to meet various needs in flushing liquid and solid wastes. Liquid waste can be flushed with the 0.9 gallon (3.4 liters) flush and solid waste can be flushed at the standard 1.6 gpf. Based on tests by the Save Water and Energy Education Program (SWEET) in Oregon, this design offers an additional 2,000 to 2,500-gallon (7,570 to 9,460 liters) savings per home per year over the standard 1.6-gallon toilet (Sullivan et al., 2001). These models are fairly common in other countries, but are not yet widely used within the North American market. (Gleick et al., 2003)

**Plumbing Fixtures** – An effective method to reduce water use of an older-style toilet at a low cost is to install an early closure device, also known as an adjustable flapper. These devices close the flapper valve inside the toilet tank sooner, thereby cutting down on the amount of water needed to flush but maintaining the same flushing effectiveness. Early closure flappers are readily available where plumbing parts are sold. (City of Calgary, 2004)

One aspect to consider is the erodibility of the toilet flapper (the device closing the flush valve). It is estimated that the normal life of a toilet is at least 20 years, whereas the flapper may fail within five years due to the corrosive effects of certain cleaners, the leading cause of flapper decay. Flapper deterioration can ultimately lead to failure of the flush valve seal and a continuing flow of water through the flush valve into the bowl, and through the bowl trapway into the drain (Koeller, 2002). Therefore, without maintaining a proper flapper seal, water-efficient toilets may not sustain their optimum efficiency over the life of the toilet fixture. To remedy this problem, toilet flapper manufacturers are working to develop durable flappers that can withstand toilet bowl cleaning chemicals.

Another concern is that toilet flappers that are designed to function at 1.6 gpf are being fitted with after-market replacement flappers that cause the fixture to flush at volumes in excess of 1.6 gpf (Koeller, 2002). Most consumers, upon discovering a leak in their toilet, will generally purchase a replacement flapper without contacting the original equipment manufacturer to obtain the exact replacement part that is designed for their toilet fixture. Thus, consumers may not be able to discern whether the flapper meets the 1.6 gallon criteria or may even prefer a flapper that allows for larger-volume flushes.

Toilet fill tube diverter or displacement devices can also add significant water savings. The diverter fits into the toilet's refill tube and diverts 25 percent of the water into the bowl while directing the rest of it into the tank. This process causes the two to fill at similar rates and prevents excess water from flowing out of the bowl and into the drain. These types of devices have been found to save from one-half of one gallon to one gallon (2 liters to 4 liters) per flush and do not alter the dynamics of the flush.

**Toilet Flush Volume Meters** – To accurately measure the flush volume within a toilet, hand-held toilet flush volume meters have been developed. One such example, the T5 Flushmeter, uses an inflated bladder gasket to seal the trap opening by pumping the trigger on the handle before flushing. A digital display located at the top of the meter then shows the current flush volume in either gallons or liters. The average flush volume can also be calculated over multiple flushes. (Strategic Instruments Inc., 2004)

**Shower and Bath Fixtures** – Water used for showers and baths is typically the second- or third-largest category of indoor residential water use. Standard showerheads can use between 2.6-8 gpm (10-30 liters). Consequently, current U.S. federal standards now require that new faucets not exceed a flow rate of 2.5 gpm (9.5 liters), whereas prior to 1994, the standard rate had been 5 gpm (19 liters). Therefore, changing 5 gpm showerheads to 2.5 gpm low-flow units reduces the average shower water use by approximately 9 percent and will save about 17 gallons (64 liters) per shower, or over 4,000 gallons (15,140 liters) per person per year. (Gleick et al., 2003)

Low-volume showerheads use a mix of air and water to provide the effect of wetness over a greater surface area. Some showerheads use increased flow velocity to offset the reduction in water volume; still others use a narrower spray area than standard showerheads. In addition, some low-flow models even have a shut-off setting to let you slow or stop the water flow while you lather up or shampoo. Switching to a low-flow showerhead also saves substantial amounts of energy by reducing the amount of water that requires heating, which adds to the cost-effectiveness of replacing inefficient showerheads. (Government of Alberta, 2004)



***Did You Know?***

*Shortening your shower by even 1 or 2 minutes can save up to 700 gallons of water a month.*

*(City of Providence, Rhode Island)*

**Clothes Washing Machines** – The use of water-efficient washing machines can save an average household up to 7,000 to 9,000 gallons (26,500 to 34,000 liters) of water per year, resulting in water savings of approximately 40 percent to 50 percent. Within the United States, many conventional residential washing machines are high-volume, top-loading models which spin around a vertical axis. Front-loading, horizontal-axis models, however, use a tumbling action where the washer tub is only partially filled with water, requiring far less water, energy, and detergent. High-efficiency, front-loading models are widely used throughout Europe but have only recently been introduced to the United States. (Gleick et al., 2003)

Recognizing the value of these machines in terms of reduced pollution, wastewater, energy, and water use, the U.S. Department of Energy (U.S. DOE) has worked with the Consortium for Energy Efficiency, manufacturers, and energy conservation advocates to

establish national energy-efficiency standards for residential clothes washers, effective in 2007. In addition, the Energy Star<sup>®</sup> label is now used to identify products that use less energy. This collaborative campaign between the U.S. DOE, U.S. Environmental Protection Agency (U.S. EPA), and other companies, helps to raise consumer awareness about the environmental and economic benefits of energy-efficient products. In order for one of these products to receive an Energy Star<sup>®</sup> rating, it must exceed the minimum Federal standards by a certain amount, which varies from product to product. To reference the U.S. DOE's extensive list of washer models that qualify for the Energy Star<sup>®</sup> rating, see [www.energystar.gov/products/clotheswashers/calculator.phtml](http://www.energystar.gov/products/clotheswashers/calculator.phtml). (Gleick et al., 2003)



### ***Did You Know?***

*You can save as much as 12 gallons of water per week by adjusting the water level of a clothes washer to correspond to the load size.*

*([www.sahra.arizona.edu](http://www.sahra.arizona.edu))*

Similarly, in September 2003 the U.S. EPA announced its intentions to explore a water-efficient product labeling program based on the successful Energy Star<sup>®</sup> program to help raise awareness of the importance of water conservation and the growing demands placed on water supplies and water infrastructure systems. This proposed program has won support from a broad range of stakeholders, including water systems, manufacturers, retailers, municipalities, states, water industry organizations and environmental groups.

In Canada, Natural Resources Canada's Energuide provides resources to help consumers choose water and energy-efficient appliances for the home. For more information, see <http://oee.nrcan.gc.ca/appliances/index.cfm?PrintView=N&Text=N>.

Consumers can also change their practices to get the most benefit from their current clothes washer. These include:

- Wash full loads only
- Use the least amount of water for washers that have variable water settings
- Pretreat stains to avoid the need for a second wash
- Use short wash cycles for lightly soiled loads, since they tend to use less water than permanent press or normal cycles
- Check hoses for cracks that can lead to leaks (Government of Alberta, 2004)

Dishwashers – Approximately 54 percent of housing units in the United States are equipped with dishwashers, which account for less than 2 percent of total residential water use. Based on data from manufacturers and water use studies, dishwashers that use greater than six gpl are considered to be inefficient. Fortunately, manufacturers have paid considerable attention to energy and water efficiency in developing new models and most manufacturers now carry at least one high-efficiency model in their product line. These energy and water savings are achieved by reducing the length of the washing cycles. Machines that use 4.5 gallons and 5.3 gallons (17 and 20 liters, respectively) for a normal-sized load are currently available within the United States. (Gleick et al., 2003)

In addition, water-efficient dishwashing practices may contribute more to water savings than purchasing a new dishwasher. For example, homeowners should:

- Wash full loads only
- Scrape off food with a utensil or napkin, not water
- Avoid pre-rinsing dishes except in cases of sticky or burned on food
- Load the dishwasher so water can reach all surfaces of the items being washed; incorrect loading increases the need to rewash dishes
- Use the shortest cycle for lightly soiled loads - using a setting that uses more water will not clean the dishes any better and wastes water  
(Government of Alberta, 2004)

Faucets – Faucet use is currently the fourth-largest use of water in the home. Effective January 1994, the U.S. federal standard for faucet flow rates is 2.5 gpm (9.5 liters). Prior to 1994, the standard flow rates ranged from 2.75 to 7.0 gpm (10.4 to 26.5 liters). When considering faucet flow and water conservation, kitchen faucets normally need higher flows for filling pots and basins, whereas bathroom faucets used mostly for hand washing require smaller volumes. High-volume faucets can also be retrofitted with aerators and restrictors in the form of small screens that screw on to taps and add air to the flowing water to reduce flow rates.

Other advances in conservation technology for faucets exist but have not been widely used to date. For example, one fairly new product is an automatic shutoff device for sinks, such as the Aqua-Lean,<sup>TM</sup> which consists of a bar mounted in front of the sink at hip level so that the user must press or lean against the bar to turn on the faucet. This device also has a locking device and constant flow option. According to company estimates, this device can cut faucet water use in the kitchen and bathroom (excluding leaks) by about 83 percent.

In many instances, individual behavioral changes would also aid in conserving water. For example, turning the faucet off while brushing your teeth could result in a significant decrease in residential water use per person. For this reason, other types of water-saving devices such as the self-closing faucet, are commonly used in commercial sites or restrooms. These either involve a spring-loaded lever that closes the faucet a prescribed period of time after it is opened or an infrared sensor that turns on the water when it detects hands under the faucet. (Gleick et al., 2003)

Leak Detection and Repair – Faulty faucets and toilets can be responsible for significant leaks and water losses within a home. For example, a dripping faucet leaking one drop per second can add up to 6.6 gallons (25 liters) per day or more than 2,640 gallons (10,000 liters) per year (Government of Alberta, 2004). Therefore, leak detection repair is an area that warrants evaluation.



### **Did You Know?**

*A dripping faucet leaking one drop per second uses enough water over one year to...*

*wash 65 loads of laundry,  
take 140 five-minute showers,  
or wash 40 cars.*

*(Government of Alberta, Canada)*

Generally, leak detection does not require an investment in new equipment and can be performed by the homeowner with guidance from the water utility. However, leak detection and repair programs should cover all water uses and connections, including meters, water distribution lines, connections for plumbing fixtures, appliances, and landscape irrigation systems. The American Water Works Association's "Water Wiser" Drip Calculator ([www.awwa.org/waterwiser/](http://www.awwa.org/waterwiser/)) can be used to measure and estimate the amount of water wasted due to leaks.

The potential savings from reducing leaks can be high, resulting in estimated savings of approximately 8 gpd (30 liters) for each repaired leaking toilet and an additional 12.4 gpd (47 liters) for other household leak repairs. Leak rates are highly variable and leak-reduction programs are most effective when targeted at homes with the highest leakage rates. This can be done by targeting homes in the top tier of water use, which may have higher usage rates due to leaks, or by analyzing water-use data to identify accounts with dramatic increases in use patterns. Audits can then be performed at these sites to identify the cause of the change. (Gleick et al., 2003)

Leaks that occur in water distribution systems before reaching a home are typically considered UAW and can be a problem resulting in significant water loss. These types of leaks most often require an investment to fix or replace existing equipment.

Water softeners – DIR and exchange-type water softeners can be used to replace less efficient timer models. These types of water softener units only regenerate soft water when the existing soft water runs out instead of at automatic intervals, by using sensors or valves to determine when to regenerate. These models consume up to 50 percent less salt and water than do preset timed automatic softeners.

Water Heaters – Hot water demand systems save water by either eliminating the need to drain cold water from the pipe between the water heater and the plumbing fixture, or by reducing the distance between the heater and the fixture. Demand systems are designed in two basic configurations: central storage tank and tankless systems. Central storage tank systems are based on traditional water heater and plumbing systems, modified with the addition of a valve to open a loop back to the hot water tank, and a pump to push the cold water back to the water heater while drawing hot water into the pipe. When hot water reaches the fixture, the loop closes and the hot water exits the fixture.

Tankless systems, also known as instantaneous or on-demand water heaters, heat water only when needed. They can be located near the plumbing fixture to reduce the amount of cold water that must be displaced for hot water to reach the fixture. Because they do not store hot water, tankless systems save energy by eliminating standby losses. A 1996 study of potential water savings in Southern California showed that hot water demand systems could save approximately 30 gpd (113 liters) per unit. (California Department of Water Resources, 1998)

Landscape Irrigation – Water demand for outdoor uses tends to increase during the warmer seasons of the year when homeowners are tending to lawns and gardens. In areas where the climate is hot and dry, utilities often are forced to restrict outdoor water uses during periods of the summer to maintain an adequate supply of water for human consumption,

maintain adequate water pressure throughout the distribution system, and for fire protection. (Government of Alberta, 2004)

Watering too often and for too long is the largest source of landscape water waste. Poor watering practices are all too common during the summer months. Watering sidewalks, driveways, roadways, and other non-turf areas wastes water and contributes to pollution by carrying chemicals, fertilizers, and other pollutants directly to sewers. Problems with irrigation systems include: poor maintenance resulting in leaks, inefficient watering (by not being properly directed to turf areas), and improper timing so watering occurs during the hottest part of the day. It is most efficient to water in the early part of the morning when winds tend to be light, temperatures cool, and the humidity is higher (Government of Alberta, 2004).



### ***Did You Know?***

*Watering a lawn for one hour uses as much water as...*

*10 toilet flushes, 5 dishwasher loads, 4 five-minute showers, and 2 loads of laundry.*

*(City of Calgary, Canada)*

Other forms of landscape watering tools include timer devices, auto-shutoff hose nozzles, automatic sprinkler timers, and rain gauges. Timer devices can be installed on outdoor taps to regulate lawn watering to certain times of the day. Auto-shutoff hose nozzles can be purchased with multiple precision spray patterns and instant on/off control mechanisms, and typically save an estimated 10 percent to 30 percent of water used outdoors. These can be used to spray plants or shrubs directly, which saves water by not covering additional area. Automatic sprinkler timers that turn on manually and shut off automatically after a set time can also save water. These attach between the faucet and hose to shut water off automatically. Rain gauges can also be used to determine how much precipitation has fallen and can reduce the occurrence of over-watering lawns and plants. (City of Calgary, 2004)

Drip-irrigation systems apply water efficiently and precisely to plants, with flow rates adjustable to meet specific plan needs. Using these systems, optimum irrigation can be achieved while using 75 percent less water. Drip systems save time and work over watering by hand or moving sprinklers, and can also help to eliminate runoff and soil erosion. Drip systems can also be buried underground or placed under a layer of mulch to apply water directly to plant roots, helping to keep the soil in the root zone moist.

Garden Bores – Since the late 1970s, many people in Western Australia have installed garden bores to shift from potable water use to under-utilized groundwater resources for watering gardens and lawns. A garden bore is a narrow, lined hole drilled to withdraw groundwater from an aquifer. Typically, an underground pump is also installed within the bore to bring water that lies in shallow groundwater sources to the surface. Garden bores are useful in areas with relatively shallow and reliable groundwater resources that are recharged by local rainfall. Garden bores can be installed by the homeowner for individual use or for shared use by multiple homeowners. Choosing the appropriate pump for a bore is determined by the depth below the surface at which the water lies. A centrifugal pump can be used for reaching shallow waters, ranging in cost from \$300 to \$600 AUD (approximately \$208 to

\$417 USD), whereas submersible pumps, ranging in cost from \$900 to \$1,400 AUD (approximately \$626 to \$974 USD), are more efficient for deeper water sources.

**Soil Moisture Sensors and Probes** – Soil moisture can be monitored in many ways to determine when and how long landscapes and gardens may need to be watered. This can help to eliminate the unnecessary use of water and help prevent the occurrence of over-watering. Subsurface soil samples can be taken and visually inspected to estimate the moisture status. Soil moisture can also be estimated with mechanical devices such as tensiometers or with electrical resistance devices such as gypsum blocks that rely on the change in electrical conductivity of water in the device. A neutron probe, another moisture-sensing device, measures the amount of neutrons reflected from water molecules in the soil. Moisture content can also be estimated by dielectric sensors, devices that measure the dielectric content of a soil. (California Department of Water Resources, 1998)

Using a soil-moisture monitoring system that precisely determines moisture content at the root zone, researchers in Australia were able to accurately set an irrigation schedule and reduce water used for turf irrigation by up to 63 percent (Moller et al., 1996).

**Landscape Design** – In addition to changing watering practices, different types of landscape design can also be implemented such as natural landscaping and Xeriscaping.<sup>TM</sup> Natural landscaping uses plants that are naturally hardy for the climatic zone they are in and need only rainwater to maintain their appearance. Xeriscaping,<sup>TM</sup> or water-wise landscaping, is a commercial gardening concept that emphasizes water conservation and protecting the environment, and includes ensuring proper planning and design, soil analysis, appropriate plant selection, practical turf areas, efficient irrigation, use of mulches, and proper maintenance to ensure continuing appearance. Proper landscape layout involves controlling the area and perimeter of turf, minimizing narrow paths or steep areas that cannot be irrigated efficiently, and grouping plants with similar irrigation needs. (Government of Alberta, 2004)

In addition to saving water and money, Xeriscaping<sup>TM</sup> is low-maintenance landscaping, requiring less watering, less weeding, less fertilizing, less pruning, less mowing, and less pesticides than landscapes with non-native plants. The main principles of Xeriscaping<sup>TM</sup> are quite simple:

- *Design for water conservation*  
Group plants with the same watering needs together in areas of the garden that best suit their needs. Grading the garden will help direct water to the plants that have the highest water needs
- *Reduce your lawn*  
Where possible, replace grassed areas of your lawn with tiered gardens, rock gardens, low water-use shrubs or flowering trees and groundcover
- *Select appropriate plants*  
Opt for native and low water-use plants that thrive in the local climate

- *Water wisely*  
Understand the water needs of low water-use plants in your gardens and water them accordingly
- *Mulch*  
Barks, wood chips, or stones will reduce the evaporation from the soil, inhibit weed growth, and minimize soil erosion
- *Improve your soil*  
Heavy-clay soils drain slowly while sandy or stony soils drain too quickly. Add peat moss or compost to improve the absorption and water-holding capacity or the drainage of the soil  
(City of Calgary, 2004)

Rainwater Collection – Rainwater collection is another type of water conservation approach that captures and diverts rainwater for other uses such as watering lawns and gardens. Using rainwater is actually better for plants because it doesn't contain chlorine and is warmer than tap water. Most rainwater can be considered a lost resource because it simply runs off hard surfaces like roofs, sidewalks, driveways, and patios. However, with rainwater collection water can be collected from rooftops and diverted into barrels (either plastic or wood) or large storage tanks directly from the downspout. The amount of rainwater collected from a rooftop can be significant; a 1,000-square-foot rooftop (93 square meters) can catch 150 gallons (568 liters) of water from a rainfall of just one-quarter of an inch of water (6 millimeters) (Government of Alberta, 2004). To avoid pests that might be attracted to standing water, mesh or screen can be used to cover the opening in the top of the barrel where the downspout connects to the rain barrel.

Graywater Systems – Graywater is wastewater that comes from the bath, shower, bathroom sink, clothes washing machine, and kitchen sink. Graywater can contain some contamination, bacteria, parasites, and viruses washed from the body and clothes; therefore, graywater must be properly managed to minimize health risk and degradation of the environment. Home plumbing systems can be redesigned and a graywater system installed, which permits replacing potable water use outdoors with household water that has been used once for some other purpose. This can potentially eliminate the use of all potable water for landscape needs. Graywater reuse systems range from those that coarsely screen oils, greases, and solids via small trenches, to more expensive systems that treat and disinfect the graywater via spray or drip systems. (Our Water Future Website, 2004)

Aerobic Treatment Units – For properties that cannot be connected to a sewerage main, self-contained electrical wastewater treatment systems called aerobic treatment units may be used to receive and treat wastewater from the toilet, bathroom, kitchen, and clothes washing machines for reuse. These units consist of a series of treatment chambers combined with an irrigation or drain disposal system. The first chamber is similar to a conventional septic tank in that the wastewater enters the chamber and the solids settle to the bottom, where they undergo anaerobic digestion by bacteria and form a layer of sludge on the chamber floor. Scum, consisting of oils, grease, etc., floats to the surface of the liquid and the partially clarified wastewater flows into a second chamber. Here the liquid is mixed with air to assist bacteria to break down more of the finer suspended organic

material. A third chamber allows additional clarification through the settling of suspended solids, which are returned to the first chamber. The clarified effluent in the third chamber can then be disinfected, usually by chlorination, in a fourth chamber. This water can then be used for irrigation systems. (Our Water Future Website, 2004)

Recycling Water - Different water demands can be met with waters of differing quality. For example, in the United States, water delivered to a home is treated to the highest drinking water standards in order to maintain human health free of water-related diseases. However, only a tiny fraction of domestic water use is used for drinking. Recycled water can be used by commercial, industrial, and institutional water users for toilet flushing, and for watering landscapes, washing cars, cooling power plants, and many other uses that do not require potable water. (Gleick et al., 2003)

Areas of the world where water is scarce (such as the Middle East, Australia, and the southwest regions of the United States), or where severe restrictions on the disposal of treated wastewater effluents exist (such as Florida, the coastal or inland areas of France and Italy, and densely populated European countries such as England and Germany), water reuse and recycling is becoming increasingly common (Marsalek et al., 2002). For example, in Fukuoka City, Japan, on-site water reuse systems are installed in apartment complexes and in other buildings throughout the city to reuse reclaimed wastewater for flushing toilets. In some Japanese cities, such as Fukuoka and Tokyo, dual distribution systems are mandated for newly constructed buildings of a certain floor space to accommodate increased water supply demands and wastewater flows and treatment in large cities. However, within the United States extensive recycling of water has not occurred, mainly due to the separation of water and sewerage service functions between separate agencies.



## Emerging Issues in Water Supply

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Water quality and the ability to transport and store water are three critical factors in determining the usability and reliability of water sources. Generally, the best available quality sources of water are used for human consumption; however, in areas where available water supplies are less than pristine, greater reliance must be placed on treatment technology.

**Water Purification** – The adoption of new water purification techniques can help to increase the utility of new sources of water, such as salty water, wastewater, or other impaired waters. In areas where the natural groundwater is too salty and unusable for human consumption, desalination technologies could offer a more affordable and drought-proof alternative to pumping water from sources miles away.

Activated Carbon Adsorption is one such technology that exists to remove organic contaminants. Activated carbon in granular or powdered form is brought in contact with the contaminated water to allow for the adsorption of contaminants into the carbon. This type of treatment is widely used for the removal of volatile organic chemicals (VOCs) and synthetic organic chemicals.

Air-stripping is a treatment technique that removes VOCs from contaminated water. Countercurrent air-stripping in a packed tower is the most common process, consisting of a tower with water inflow at the top and air inflow at the bottom. As clean air moves upward, the VOCs transfer from the water phase into the air phase. Treated water exits from the bottom and the air containing the VOCs is discharged from the top of the tower, either into the atmosphere or into a gas treatment system.

Advanced oxidation processes are used to destroy organic contaminants rather than transferring them from one medium to another. Examples of such processes include treatment with ultraviolet light waves (UV), ozone/hydrogen peroxide, and ozone/UV. These processes provide more powerful oxidation and at faster rates than conventional oxidants such as chlorine.

Membrane technologies such as reverse osmosis, electrodialysis, microfiltration, ultrafiltration, and nanofiltration, are pressure-driven processes of barrier separation. Membrane processes have been used for desalting, removal of dissolved organic materials, softening, liquid-solid separation, pathogen removal, and heavy metals removal. Reverse osmosis membranes allow water to flow through them while rejecting the passage of dissolved contaminants. Electrodialysis causes contaminant ions to migrate through a membrane, removing them from the water. Microfiltration, ultrafiltration, and nanofiltration operate similarly to reverse osmosis, but at lower pressures. More stringent drinking water regulations coupled with diminishing sources of pristine waters have stimulated interest in the use of membrane technologies in drinking water treatment.

Ion-exchange is the process that passes contaminated water through a packed bed of anion or cation resins. The resin type is selected based on the contaminant to be removed. The treatment process exchanges ions between the resin bed and contaminated water. By displacing ions in the resin, contaminant ions become part of the resin and are removed from the process water.

Chemical precipitation is used for removing heavy metals from water. Contaminants are precipitated from solution and removed by settling. Several types of chemical addition systems include ones using carbonates, hydroxides, and sulfides.

Biological treatment uses microorganisms to remove contaminants in water through metabolic processes. The process can be a suspended growth system, where the microorganisms and nutrients are introduced in an aeration basin as suspended material in a water-based solution, or a fixed-film system, where the microorganisms attach to a medium which provides inert support. Biological treatment is often used for remediation of leaking fuel tank sites.

Disinfection treatment inactivates pathogens in water. The most common disinfection treatment is chlorination, often used to treat wastewater and drinking water. Two relatively new disinfection processes include UV radiation and ozonation. (California Department of Water Resources, 1998)

According to the International Desalting Association's inventory of worldwide desalting plants, the United States is second in usage of desalting in the world, with almost 325.8 billion gallons per year (1.2 trillion liters) of installed capacity. (Only Saudi Arabia has more installed capacity). Common feedwater sources for desalting plants include brackish groundwater, municipal and industrial wastewater, and seawater. New water desalination plants, such as the proposed plant in New Mexico, are taking advantage of the decreasing cost of water purification technologies – the price tag for turning salty water into potable water is down from \$14 to \$2 per 1,000 gallons. But the energy costs for producing the water and disposing of the brine are still high enough to be a major hurdle to widespread use of the technology.

Canal Lining – Within the United States and other countries, water storage and delivery facilities developed decades ago by past water use pioneers are still being used to try to meet today's water supply needs. In some instances, canals can lose up to 50 percent of their water through seepage in unlined canals (U.S. Department of the Interior, 2003). However, tests in various irrigation districts have shown that properly-lined canals can minimize seepage losses by eliminating leaks, costly blowouts, and unaccounted water loss. Based on research by the U.S. Bureau of Reclamation, for every \$1 spent on canal modernization (such as rehabilitating canal gates), an expected return of \$3 to \$5 in conserved water can be achieved. Further, for every \$1 spent on maintaining an existing canal lining, a return of up to \$10 in conserved water can be achieved.

There are several types materials that are commonly used for canal lining: modified polyvinyl chloride (PVCs), polypropylene laminates, heavy PVC laminates, high density polyethylene (HDPE), and polyurethane. Econolime™ (lime by-products generated during lime-production



Fig. 26. Canal lining

manufacturing and by some pulp and paper mills) and bentonite are soil additives that can be used to stabilize soils at a lower cost to achieve the necessary strength and permeability needed in lining irrigation canals. When considering what type of material to use, the effects of exposure to ultraviolet radiation, weather, and general aging must be considered. Reinforced or plain concrete was once widely used for lining canals; however, cracking from settling, thermal cycles, deteriorated expansion joints, and chemicals have resulted in great amounts of leakage. Remediation projects to replace these types of linings are now common.

**Water Banks** – Water banks and markets are used in the western U.S. to store excess water in a “bank” during times when it can be spared so that it can be used during times of need. This arrangement facilitates a voluntary shift of water between existing water users and is based on a recognition of the validity of existing rights. The use of water banks and markets is sometimes a source of concern to agricultural areas and the communities that support them, but they can also provide a mechanism for preserving irrigated agriculture and meeting other water supply needs. Water banks have been essential in avoiding crises in critical areas and have helped to reduce the conflict, crisis, and heartache that results when water uses are changed through regulatory or other means. (U.S. Department of the Interior, 2003)

A form of water bank has been in operation in northern Colorado for over 50 years. Water delivered from the federal Colorado-Big Thompson Project can be rented on an annual basis between agricultural water users and municipalities within the project. Costs are agreed upon by the buyer and seller before the water is transferred; the process generally takes months, not years, to complete with transaction costs of a few thousand dollars. Over the years, municipalities have acquired additional project water to meet the needs of their growing populations during droughts. In normal years, a substantial amount of the municipally held water supplies are often rented back to farmers. This combination of transfers and rentals has allowed the region to meet the needs of a growing population while protecting the agricultural economy. (U.S. Department of the Interior, 2003)

A similar example is the Central Valley of California’s innovative Environmental Water Account (EWA), which provides a mechanism for state and federal governments to purchase water from willing sellers in order to meet important ecological restoration goals in the San Francisco Bay Delta region. The EWA adds flexibility to the state’s water delivery system and is designed to provide water at critical times to meet environmental needs without water supply impacts on cities, farms, and businesses.

**ASR Technology** – In areas of the world with high evaporation rates, methods such as ASR are being explored to store excess water during rainy seasons as alternative water supplies for use during dry seasons. Wells are being designed to inject excess treated water during the rainy season into underground aquifers. Typically, water is collected in a reservoir or lake, pumped from the area, treated, and injected into underground aquifers as storage. In coastal areas where brackish water exists within the subsurface aquifer, the injected freshwater forms a “bubble” within the aquifer’s heavier, brackish water. These same wells are then used to withdraw only the freshwater during dry seasons. (Comprehensive Everglades Restoration Program, 2002)



## Informing Decisions within the Great Lakes-St. Lawrence River Basin

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### Great Lakes Charter Annex

On a regional level, the Great Lakes governors and premiers have recognized the importance and utility of water conservation in managing Great Lakes water resources. In 2001, the governors and premiers developed and adopted the Great Lakes Charter Annex, a supplementary agreement to the Great Lakes Charter of 1985. In agreeing to this Annex, the governors and premiers committed to further implement the water management principles of the Great Lakes Charter in order to protect, conserve, restore, and improve the biological and hydrologic resources of the Great Lakes-St. Lawrence River basin.

The Great Lakes Charter Annex calls for the development of a decisionmaking standard to assess water withdrawal proposals. As the Great Lakes governors and premiers continue to develop and refine a decisionmaking standard through the Charter Annex process, the methods of conservation described in the previous case studies, their approaches toward implementing conservation strategies and initiatives, and the variety of best available and emerging technologies discussed in this report will be a valuable tool to inform this discussion.

### Application of Case Studies

Although the water conservation strategies and initiatives presented in these case studies are different in their stages of implementation and audiences to which they are directed, each program or initiative is part of a greater effort to manage local, state, regional, or national water resources wisely. The elements of each water conservation strategy are summarized in the table below. Full descriptions of these programs are included in the body of the report.

Water Conservation Strategies							
	City of Albuquerque, New Mexico	SW Florida Water Management District	State of California	City of Calgary, Canada	Fukuoka City, Japan	State of Western Australia	Israel
Comprehensive Management Plan	X	X	X		X	X	X
Public Education or Media Campaigns	X	X	X	X		X	X
Water Meters	X	X	X	X			X
Water Conserving Rate Structures	X	X	X		X	X	X
Water Audits or Leak Detection Programs	X	X	X	X			
Indoor Retrofit Programs	X	X	X	X	X	X	X
Performance Contracting		X				X	
Outdoor Watering Restrictions	X	X	X	X		X	X
Outdoor Irrigation Retrofit Programs	X	X	X	X		X	X
Plant Selection or Other Landscaping Plans	X		X				X
Rainwater Collection	X			X		X	
Community Recognition Programs		X		X			
Financial Incentives (Rebate Programs)	X	X	X	X		X	
Ordinances and Resolutions	X	X	X	X			

### Comprehensive Management Plan

To meet the city of Albuquerque’s long-range water conservation goals, a conservation program was initiated in 1995 that targeted public education, water rates, residential use, landscaping/outdoor water use, and institutional/commercial/industrial water use.

In 1994, the Southwest Florida Water Management District developed a water management plan to serve as a comprehensive guide for the district in carrying out its water resource management responsibilities. This plan must undergo updates every five years to maintain relevancy and consistency for the district.

The California Water Plan is the state’s strategic plan for managing and developing water resources statewide. The plan was first published by the CDWR in 1957 and is updated every

five years, with the last published update in 1998. The state is currently undergoing a public consultation period for the 2003 update to the plan. In conjunction with this update, water planners are considering broader stakeholder needs in developing more inclusive, innovative and diversified plans.

In 1979, Fukuoka City, Japan, established a plan for comprehensive and systematic water conservation and usage. While making continuous efforts to achieve a stable level of supply, the plan also emphasized the need to raise water conservation consciousness among city residents.

In February 2003, Western Australia launched its State Water Strategy based on public input that was gathered by a water task force during forums to establish a sustainable future for Western Australia's water resources. The main objectives of this strategy are to improve water use efficiency in all sectors; achieve significant advances in water reuse; plan and develop new sources of water in a timely manner; foster innovation and research; and protect the value of the region's water resources.

In 1959, Israel's comprehensive General Water Code declared all water resources of the country to be public property and available for use by consumers, as directed by the Water Commissioner. This was followed by the Water Pollution Prevention Law, the Water Drilling Law, the Water Metering Law, and other relevant regulations, which enabled the authorities to implement a necessary legal and institutional framework to meet demands.

### **Public Education and Media Campaigns**

The analysis of case studies shows that public education and media campaigns play an important role in laying the foundation for comprehensive water conservation strategies at all levels of implementation. It is essential to promote public awareness of water resource limitations and the factors that influence current and future water resource management related to public water supply. Since water use habits must often be targeted to achieve significant changes in water demand, it is believed that practices learned by school children can best influence and reinforce sensible water use habits of other generations. Thus, incorporating in-school programs on topics related to where drinking water comes from and why it is important to use water wisely are an important step in targeting change within communities. Teaching materials and other resources should be made available for teachers, when possible.

In addition to targeting schools and children, media campaigns can also be used to educate a broader audience. Beyond water or water or utility bill inserts, radio, newspaper, and television advertisements and public service announcements have proven to be effective mechanisms for spreading awareness on particular issues. Providing staff to make public appearances on local news programs, speak to community groups or businesses, and provide technical assistance on water conservation practices and demand management issues is also an important addition to many water conservation strategies. In addition, websites and newsletters can be utilized to distribute information on suggested water use practices, water-efficient home appliances, rebate or incentive programs, and new voluntary or regulatory measures for the community. By making water conservation and awareness a way of life, community members will be more likely to think twice before using water with impunity.

## **Water Meters**

Studies have shown that customers with metered water tend to use less water than flat-rate customers (City of Calgary, 2004). Universal metering programs can be an effective tool for utilities and customers to detect hidden leaks and measure water usage. Gathering such data is critical for improving the efficiency of water systems and for identifying long-term needs. For consumers, comparing current and historical water-use data can help them make more informed decisions regarding water use, track the effectiveness of their own water conservation efforts, monitor water use patterns, and help uncover unusual water uses that can indicate leaks or other problems. For water providers, new automated meter-reading technologies can help decrease operational costs and improve customer service. However, as with any water conservation initiative, educating consumers on the benefits of metering is a key component of a successful program.

## **Water Conserving Rate Structures**

Rate structure information may encourage customers to alter their water use to avoid higher cost block charges or penalties for excessive use, whereas non-conserving pricing for water provides no incentives for customers to reduce use. Thus, billing based on actual water use reinforces the concept that using less water reduces individual costs. Rates per unit can be based on the number of household residents, landscape area, drought or other weather conditions, or ET (evapotranspiration). Rate structures, combined with well-developed public outreach and education programs, can help water customers to identify why they might fall into more expensive blocks and how they can cut back their use to save money.

## **Water Audits and Leak Detection Programs**

Residential water audits and leak detection programs can be implemented by homeowners with minimal technical assistance or by qualified inspectors. It is suggested that audits should consist of a review of the home's water use patterns and billings, a leak check using the home's water meter (if present), a leak check of toilets, an outdoor landscape and sprinkler assessment, and installation of high efficiency devices where existing fixtures are less efficient. Typical fixtures might include 2.5 gallon (9.5 liter) per minute showerheads, high-efficiency faucet aerators, auto-shutoff hose nozzles, and toilet fill tube diverter or displacement devices.

Several utilities in California have used a targeted approach to identifying homes with potential water leaks from toilets, faucets, or other household water uses. For example, the city of San Diego has experimented with mailing letters and brochures to the highest 36 percent of residential water users, with follow-up phone calls to the highest 10 percent. The city's water department then investigates abnormal or exceptional water use with a specific software program that can recommend a field audit for accounts with possible leaks.

## **Indoor Retrofit Programs**

Demand management efforts in California, Israel, and other regions of the world have produced convincing results using water conservation kits and promoting retrofits through rebate and other incentive programs. The incentive programs and the kits, which often include toilet flush volume reduction or regulation devices, regulated showerheads, flow regulators in kitchen and bathroom sink taps, and leakage control, have achieved demand reductions of 10 percent to 15 percent in some households (sometimes even 20 percent to 40 percent).

### **Performance Contracting**

Performance contracting is a relatively new initiative that was observed during this analysis. The objective of performance contracting is to encourage independent licensed contractors to achieve a specified percentage of water savings through the installation of water-efficient fixtures. Contractors are paid an incentive based on their demonstrated performance in achieving the specified water savings. These types of programs will also help reduce staff time for water providers or other conservation entities by encouraging retrofits by licensed contractors.

### **Outdoor Watering Restrictions**

Depending on the region, seasonal outdoor water use can increase daily water demand by 50 percent or more. In some regions, watering restrictions have been put in place to limit the watering of gardens and lawns to two days per week, with no watering during specified daytime hours when evaporation rates are highest. Water budgets, or allocations have also been developed for gardens or lawns of certain sizes.

### **Outdoor Irrigation Retrofit Programs**

Similar to the indoor retrofit programs, these demand management efforts offer water conservation kits that often include garden hose nozzles, automatic sprinkler timers, rain gauges, and soil moisture sensors or probes.

### **Water Efficient Plant Selection and Other Landscaping Plans**

Installing water-saving devices alone does not ensure that less water will be used outdoors. To achieve a reduction in outdoor water use, efficient landscape management is required. Water efficiency with respect to outdoor usage can be achieved through appropriate plant selection and by creating functional landscapes. Xeriscaping is a type of landscaping that applies the principles of planning and design, appropriate plant selection, soil analysis, practical turf areas, efficient irrigation, use of mulches, and appropriate maintenance to achieve increased water-efficiency. Converting landscapes to Xeriscape™ has been shown to save about one-third of the water that a traditional yard might use by utilizing turf areas of manageable sizes, shapes, and appropriate grasses, and by selecting and grouping plants of similar water needs together. Using native and other drought-tolerant plants can reduce water use; time spent watering, fertilizing, and mowing; and money, by lowering water bills and reducing maintenance costs. Water providers and communities can provide information in the form of brochures to help homeowners in planning and constructing a water-efficient landscape. In areas of the United States, technical assistance has also been incorporated into conservation programs through individual County Cooperative Extension Services. Other ways to decrease excessive water use are to incorporate plant and landscaping restrictions for all new landscapes, public parks, and public and private golf courses.

### **Rainwater Collection**

Rain barrels can be an effective mechanism for reducing the amount of potable water used on lawns and gardens. Rain barrels typically consist of a barrel or other container (plastic, wood, etc.) that is connected to a downspout which collects water flowing from the roof. Approximately 1,000 square feet (93 square meters) of collection surface on a roof with an inch (25 millimeters) of rain can yield 600 gallons (2,270 liters) of water. This water can then be reused on lawns and gardens as an alternative to potable supplies and is actually better for plants because it doesn't contain chlorine and is warmer than tap water.

### **Community Recognition Programs**

To help reinforce positive actions within a community, several jurisdictions that were analyzed chose to spotlight new and retrofitted water-conserving landscapes through community recognition programs. Community awards were used to acknowledge the efforts of businesses, agencies, educational institutions, individuals, and community groups that have worked on a project that has benefited the water resources of a particular community.

As an incentive to reduce outdoor water use, the city of Calgary, Canada, offers water customers the option of obtaining Water Managed Site certification. A Water Managed Site is a property with an in-ground sprinkler system certified by the city for water efficiency. Properties must have an in-ground sprinkler system that uses either climatic or historical weather data to set watering schedules.

The Waterwise Plumber Program was developed in Western Australia in 2003 in conjunction with the Master Plumbers Association. Plumbers endorsed under this initiative have undergone training in the latest water-efficient plumbing practices. Similarly, the Waterwise Garden Irrigator Program was developed in conjunction with the Irrigation Association of Australia and was launched in November 2003. Irrigators endorsed under the program are qualified to design and install water-efficient garden watering systems to an industry standard. Irrigators must have two years of experience and pass a written test to be endorsed by the program.

### **Financial Incentives**

Financial incentives in the form of water bill credits or other rebates have proven to be successful mechanisms for encouraging public action related to water conservation and efficiency. Based on the case study analysis, rebates have been offered, with varying restrictions, for ULFTs (ultra-low-flow toilets), showerheads, clothes washing machines, hot water recirculating systems, sprinkler timers, rainwater collection barrels, tap flow regulators and timers, garden bores (a narrow, lined hole drilled to withdraw groundwater from an aquifer), water reuse systems, and soil wetting agents (used to break down the water resistance that soils and lawns build up and allow water to penetrate to the roots).

### **Ordinances and Resolutions**

The following is a summary of the ordinances and resolutions discussed during this case study analysis. Additional sample language for conservation ordinances, provided by the Minnesota Department of Natural Resources, is available in Appendix G.

In 1994, the city of Albuquerque finalized Resolution 40-1995 (see Appendix D), related to the long-range water conservation strategy for the city of Albuquerque and the Water Conservation Landscaping and Water Waste Ordinance.

In 1995, the city of Albuquerque adopted a Water Conservation Landscaping and Water Waste Ordinance, which includes strict requirements for landscaping around new developments. For example, all new properties except single-family residences are required to landscape; the use of high-water-use grasses on more than 20 percent of the landscaped area is now prohibited; and all new city properties must be landscaped with 100 percent low and medium water-use plants in all new landscapes except parks and golf courses. Water budgets have also been set for public parks and public and private golf courses to help them conserve water.

In 2000, the Southwest Florida Water Management District passed a Xeriscape Incentive Rule which allows qualifying local governments to receive technical assistance and information on the merits of Xeriscape™ landscaping (see Appendix E). This information may be in the form of brochures, demonstrations, memos, technical publications, technical assistance, or communications with district staff. To qualify, a local government must submit a draft Xeriscape ordinance to the district.

Effective September 15, 2003, the Southwest Florida Water Management District now enforces mandatory year-round conservation measures, based on amendments to Chapter 40D-22 of the Florida Administrative Code. Key components of this rule are “time of day” watering restrictions between the hours of 10 a.m. - 4 p.m., and a twice-per-week watering schedule based on even and odd addresses. Other portions of the year-round rule apply to agriculture, golf courses, and other irrigation water users.

To encourage the efficient use of water, California Assembly Bill 325 (the Water Conservation in Landscaping Act of 1990) required that the CDWR develop a Model Water Efficient Landscape Ordinance for communities to adopt or to use as a model to develop similar standards (see Appendix F). Completed in 1993, the model ordinance requires landscapes greater than 2,500 square feet (232 square meters) to establish a water allowance based on 80 percent of  $ET_0$ . This water allowance is then applied to the use of technology, planning, and management techniques to ensure water efficiency in maintaining landscapes. Cities and counties in the state have the option of adopting this model ordinance, adopting their own ordinance, or issuing findings that no ordinance is necessary.

In September 2002, the Calgary City Council passed changes to the city’s Water Utility Bylaw which include mandatory water restrictions guidelines. With the updated bylaw in place, the city can evoke watering restrictions in times of water shortages. There are four stages of mandatory restrictions that are implemented in turn, depending on the severity of the water shortage. Failure to comply with the restrictions can result in fines.

## **Application of Best Available and Emerging Technologies**

It is estimated that one-third of current urban water use can be saved with existing technologies, and at least 85 percent of this can be saved at costs below what it would cost to tap into new sources of supply (Gleick et al., 2003). With the utilization of the best available and emerging technologies discussed in this analysis, increased water efficiency and conservation can be achieved. Capturing wasted water will require better use of available technology, expanding existing conservation programs, developing new approaches and policies, and educating consumers and policymakers.

## **Emerging Issues for Consideration**

Recycled water and shallow non-potable groundwater can be put to efficient use for landscaping, groundwater recharge, industrial processing, cooling, or crop irrigation. Fukuoka City, Japan, has been active in promoting systems to reuse reclaimed wastewater for flushing toilets and some apartment complexes are equipped with their own treatment facilities that recirculate reclaimed water within the complexes. While recycled water is not classically

considered water conservation and efficiency, recycling water with these techniques will enable more efficient use of potable water and can help offset existing and future demands on limited water supplies.

Desalting brackish surface or groundwater, agricultural and municipal wastewater, and seawater is another emerging source of water. The primary desalination technology in use today is reverse osmosis, which filters salty water under pressure through a semi-permeable membrane, leaving the salts behind. Currently, energy constitutes about 50 percent of the costs of reverse osmosis desalination. However, there are numerous research efforts underway to develop more effective and less costly desalination methods. Recent developments in low-pressure membranes show promise for reducing the energy requirements of desalination, and significant opportunities remain for further technology improvements.

In areas with high evaporation rates, ASR (aquifer storage and recovery) technology can be explored as a feasible alternative to surface water reservoirs for storing excess water during rainy seasons so that it may be available later when needed. Wells are designed to inject excess treated water during the rainy season into underground aquifers and then withdraw this same water during the dry season.

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## Appendix B: Growing Global Water Shortages

### Growing Water Shortages: Population Size and Growth and Renewable Freshwater Availability in Water-Short Countries, 1995 and 2025

Water Scarcity in 1995 and 2025					
Country	Population 1995 (millions)	Water Per Capita 1995 *	Estimated Population 2025 (millions)	Estimated Water Per Capita 2025 *	Estimated % Population Growth Rate
Algeria	28.1	527	47.3	313	2.4
Bahrain	0.6	161	0.9	104	2
Barbados	0.3	192	0.3	169	0.5
Burundi	6.1	594	12.3	292	2.5
Cape Verde	0.4	777	0.7	442	2.9
Comoros	0.6	1,667	1.3	760	2.7
Cyprus	0.7	1,208	1	947	0.7
Egypt	62.1	936	95.8	607	2.2
Ethiopia	56.4	1,950	136.3	807	2.5
Haiti	7.1	1,544	12.5	879	2.1
Iran	68.4	1,719	128.3	916	1.8
Israel	5.5	389	8	270	1.5
Jordan	5.4	318	11.9	144	2.5
Kenya	27.2	1,112	50.2	602	2
Kuwait	1.7	95	2.9	55	2.3
Libya	5.4	111	12.9	47	3.7
Malawi	9.7	1,933	20.4	917	1.7
Malta	0.4	82	0.4	71	0.6
Morocco	26.5	1,131	39.9	751	1.8
Oman	2.2	874	6.5	295	3.9
Qatar	0.5	91	0.8	64	1.7
Rwanda	5.2	1,215	13	485	2.1
Saudi Arabia	18.3	249	42.4	107	3.1
Singapore	3.3	180	4.2	142	1.1
Somalia	9.5	1,422	23.7	570	3.2
South Africa	41.5	1,206	71.6	698	1.6
Tunisia	9	434	13.5	288	1.9
United Arab Emirates	2.2	902	3.3	604	2.2
Yemen	15	346	39.6	131	3.3

Water Stress in 1995 and 2025					
Country	Population 1995 (millions)	Water Per Capita 1995 *	Estimated Population 2025 (millions)	Estimated Water Per Capita 2025 *	Estimated % Population Growth Rate
Afghanistan	19.7	2,543	45.3	1,105	2.5
Belgium	10.1	1,234	10.3	1,217	0.1
Burkina Faso	10.5	2,672	23.5	1,194	2.9
Eritrea	3.2	2,775	6.5	1,353	3
Ghana	17.3	3,068	36.3	1,464	2.9

India	929	2,244	1,330.20	1,567	1.9
Lebanon	3	1,854	4.4	1,261	1.6
Lesotho	2	2,565	4	1,290	2.1
Mauritius	1.1	1,970	1.5	1,485	1
Niger	9.2	3,552	22.4	1,452	3.4
Nigeria	111.7	2,506	238.4	1,175	3
Peru	23.5	1,700	35.5	1,126	2.2
Poland	38.6	1,458	40	1,406	0.1
South Korea	44.9	1,472	52.5	1,258	1
Tanzania	30.7	2,964	62.4	1,425	2.5
Togo	4.1	2,938	8.8	1,370	3.6
Uganda	19.7	3,352	45	1,467	2.7
United Kingdom	58.1	1,222	59.5	1,193	0.2
Zimbabwe	11.2	1,787	19.3	1,034	1.5

Water-stressed countries are those with annual water resources of between 1,000 and 1,700 cubic meters per person, shown in italics. Countries suffering from water scarcity are those with annual supplies of less than 1,000 cubic meters per person, shown in dark type.

\* In cubic meters per year

Source: Gardner-Outlaw & Engelman, *Sustaining water, easing scarcity: A second update*, Washington, D.C., Population Action International, 1997 (69). Gardner-Outlaw and Engelman base their calculations on UN Population Division population estimates. The growth rate data come from: Population Reference Bureau, *World Population Data Sheet*, 1998, Washington, D.C., 1998.

## Appendix C: Estimated Loss of Groundwater Infiltration

To illustrate the magnitude of potential groundwater infiltration losses, a recent study by American Rivers, the Natural Resources Defense Council, and Smart Growth America compares the level of imperviousness from 1982 to 1997 in areas of extensive development. According to this study, in all cases except one, the top 20 metropolitan areas within the United States that have experienced the greatest development over the last 20 years have been developed at a rate that exceeded the rate of population growth for the metro area. The following table illustrates the potential amount of water lost to infiltration annually for these top 20 metro areas. (American Rivers, Natural Resources Defense Council, and Smart Growth America, 2002)

### Estimated Loss of Groundwater Infiltration

Metropolitan Area <sup>a</sup>	Acres Developed <sup>b</sup> (1982-1997)	Avg. Yearly Infiltration Loss <sup>c</sup> (billions of gallons of water)
Atlanta, GA	609,500	56.9 to 132.8
Boston-Brocton-Nashua, MA – NH	433,000	43.9 to 102.5
Washington, DC	343,300	23.8 to 55.6
Dallas, TX	302,400	6.2 to 14.4
Houston, TX	291,400	12.8 to 29.8
Minneapolis-St. Paul, MN – WI	286,100	9.0 to 21.1
Chicago, IL	250,000	10.2 to 23.7
Charlotte-Gastonia-Rock Hill, NC – SC	246,200	13.5 to 31.5
Philadelphia, PA – NJ	238,800	25.3 to 59.0
Riverside-San Bernardino, CA	232,500	Model does not apply <sup>d</sup>
Orlando, FL	222,600	9.2 to 21.5
Nashville, TN	216,000	17.3 to 40.5
Raleigh-Durham-Chapel Hill, NC	207,000	9.4 to 21.9
Pittsburgh, PA	201,800	13.5 to 31.5
Tampa-St. Petersburg-Clearwater, FL	199,800	7.3 to 17.0
Detroit, MI	187,200	7.8 to 18.2
Greenville-Spartanburg-Anderson, SC	166,300	12.7 to 29.5
Greensboro-Winston-Salem-Highpoint, NC	148,100	6.7 to 15.7
Phoenix-Mesa, AZ	145,600	Model does not apply <sup>d</sup>
Seattle-Bellevue-Everett, WA	141,000	10.5 to 24.6

**a** Metropolitan Statistical Areas and Primary Metropolitan Statistical Areas as defined by the Office of Management and Budget (OMB) in guidance effective June 30, 1999 (OMB Bulletin 99-04). Northeastern county metropolitan areas are based on townships and were defined in the same OMB memorandum.

**b** Source: United States Natural Resources Inventory, Natural Resources Conservation Service, United States Department of Agriculture (USDA), 1997 (revised December 2000). Available at: [www.nrcs.usda.gov/technical/NRI/1997/](http://www.nrcs.usda.gov/technical/NRI/1997/)

**c** Gallons of lost infiltration of rainwater, rounded to the nearest 0.1 billion gallons. According to the United States Geological Survey (USGS), the average American uses between 80-100 gallons of water every day. Using 100 gallons per day, a billion gallons of water per year would be enough to fulfill the daily usage of approximately 27,397 people.

**d** The model does not apply to metro areas in arid regions because low rainfall and very high rates of evaporation remove much of the available rainfall before it infiltrates and replenishes groundwater.

(American Rivers, Natural Resources Defense Council, and Smart Growth America, 2002)



## Appendix D: City of Albuquerque Water Conservation Resolution

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Long-Range Water Conservation Strategy Resolution  
CITY of ALBUQUERQUE  
ELEVENTH COUNCIL

COUNCIL BILL NO. R-173  
ENACTMENT NO. 40-1995  
SPONSORED BY: Angela M. Robbins

### RESOLUTION:

#### ADOPTING A LONG-RANGE WATER CONSERVATION STRATEGY FOR THE CITY OF ALBUQUERQUE AND THE PROPERTIES SERVED BY THE CITY'S WATER UTILITY.

WHEREAS, the adopted "Albuquerque/Bernalillo County Comprehensive Plan" requires that "The water resources of the metropolitan area shall be managed to ensure permanent adequate supply;" and

WHEREAS, recent findings of the U.S. Geological Survey and the New Mexico Bureau of Mines and Mineral Resources indicate that the City is pumping local ground water at a rate that cannot be sustained; and

WHEREAS, conservation can extend the City's supply at a fraction of the cost of other alternatives; and

WHEREAS, active water conservation is a condition of State Engineer consideration of requests to obtain additional water supply; and

WHEREAS, conservation will be a prerequisite for state or federal permits necessary to begin using City surface water resources in more effective ways; and

WHEREAS, protection of the limited ground water resources is a regional issue since all ground water used in the Middle Rio Grande Basin is from the same aquifer; and

WHEREAS, an aggressive strategy which achieves a 30% reduction in water usage in six to ten years will reduce the current average 250 gallons per capita per day to 175 gallons per capita per day and is estimated to reduce water demand in the year 2004 by 37 million gallons a day and water demand in the year 2060 by 57 million gallons a day; and

WHEREAS, Albuquerque's usage averages 250 gallons per capita per day while other southwestern cities of comparable size and climate have successfully reduced their usage to less than 180 gallons per capita per day; and

WHEREAS, City Council Resolution Bill No. R-58, Enactment No. 49-1992, calls for the development of a long-term water conservation strategy for the City of Albuquerque; and

WHEREAS, the aggressive strategy was validated and strengthened by the Mayor's and City Council's Town Hall meetings on Water Conservation on September 9th and 10th of 1994; and

WHEREAS, raising the price of water is probably the most effective method for reducing its usage; and

WHEREAS, low and fixed income residents of Albuquerque and customers using reasonable amounts of water should be protected from excessive increases in water rates; and

WHEREAS, voluntary compliance with most recommended water conservation measures for single family residences is preferable and may be modified to mandatory compliance in the future if desired reductions in usage are not achieved.

**BE IT RESOLVED BY THE COUNCIL, THE GOVERNING BODY OF THE CITY OF ALBUQUERQUE:**

**Section 1.** That the City's Long-Term Water Conservation Strategy, as described in the following sections of this Resolution, is hereby adopted and implementation will be initiated in January or February of 1995.

**Section 2. PLANNING AND OVERALL APPROACH.** The City shall initiate the following measures.

- (A) Promote the regional awareness and planning that is essential to ground water resource management in the Middle Rio Grande Basin and includes the following:
  - 1. A long-range water resource planning process which incorporates the goal of sustainable growth;
  - 2. Inclusion of other city, county, and tribal governments and water users in the planning process;
  - 3. Addressing water quality and quantity issues as well as conservation.
  
- (B) In general, encourage voluntary water conservation for existing single family residences while requiring conservation for other properties.
  
- (C) Apply more stringent requirements to City-owned facilities to set an example within the City.
  
- (D) Set the example for water conservation in the Middle Rio Grande Basin and strive to involve other communities and water users in the conservation effort.
  
- (E) Determine the best use of San Juan-Chama water and reuse of effluent to reduce aquifer depletion.
  
- (F) Embrace the natural and cultural environment of Albuquerque in the water conservation effort.

(G) Evaluate existing land use planning and zoning laws affecting water use and revise them to be consistent with the conservation strategy.

(H) Create a water resources intern program in cooperation with the University of New Mexico's Master of Water Resource Administration program.

**Section 3. REDUCTION GOALS.** The City shall adopt the following water use reduction goals.

(A) Reduce current overall per capita usage of 250 gallons per capita per day by 30% to achieve 175 gallons per capita per day by the year 2004.

(B) Reduce current summer outdoor usage by 25%

(C) Reduce current year-round indoor usage by 33%.

(D) Reduce peak day usage by 20% within six to ten years.

(E) Set parcel-specific goals for all customers by the year 1998.

(F) Measure and evaluate the effectiveness of the elements of the Water Conservation Strategy on an ongoing basis: revise the Strategy annually, as necessary, to reflect and enhance the effectiveness of its various elements.

**Section 4. RATES.** The City shall implement the following measures related to rates.

(A) Allow sufficient lead time for extensive public education prior to implementation of higher excess use surcharges.

(B) Retain average residential winter median by meter size for meter sizes up to and including two inch meters.

(C) Utilize excess use surcharge revenues to offset declining revenues resulting from decreased demand. The Mayor shall not increase the excess water use surcharge prior to April 1996. Before any increase in the excess water use surcharge, the Mayor shall authorize a thorough analysis of alternative surcharge rates, their impact on different categories of water customers in terms of current use, family size, income, etc., and their reasonableness and fairness with regard to financial penalties for individual households failing to meet their water conservation goals. As conservation is achieved and surcharge revenues decrease significantly, alternative funding sources will be necessary.

**Section 5. EDUCATION/PUBLIC AWARENESS.** The City will initiate or continue the following to educate and get feedback from the community about conservation issues.

(A) Establish a citizens Water Conservation Advisory Committee.

(B) Continue the water conservation marketing and awareness program and provide adequate funding to effectively inform the public of the need for water conservation and of the ways that they can conserve.

(C) Include a bar chart of the previous month's usage and the current month's usage on the monthly bill, in addition to conservation tips and information.

(D) Cooperatively, with the Albuquerque Public Schools, fund a K-12 environmental education specialist in 1995 to develop and implement an ongoing ecological program for water conservation and related environmental issues in our schools.

(E) Continue the annual education programs offered in all public schools.

(F) Collaborate with existing community organizations to promote water conservation.

**Section 6. RESIDENTIAL USE/PLUMBING.** The City shall implement the following measures to reduce interior/plumbing uses.

(A) Adopt a Plumbing Code amendment requiring low-volume plumbing fixtures for all customers (now mandatory for only residential customers).

(B) Initiate a voluntary residential fixture retrofit program to install, without charge to customers, water-saving retrofit devices in existing residential development.

(C) Implement a 1.6 gallon-per-flush, low-volume toilet rebate program with rebates of up to \$100 per toilet for replacement of three gallons or more per flush toilets for all residential and commercial customers.

(D) Actively encourage owners to replace high volume toilets with low-flow toilets whenever a building permit is obtained.

(E) Promote voluntary, City provided water use surveys and retrofit kits for residential customers to reduce both indoor and outdoor usage; target the highest 25% of users but make available to all customers.

(F) Encourage plumbing fixture wholesalers and retailers to sell only low-flow plumbing fixtures.

**Section 7. LANDSCAPING/WATER WASTE.** The City shall implement the following measures to reduce landscaping water use and water waste.

(A) Adopt the proposed "Water Conservation Landscaping and Water Waste Ordinance" which makes compliance with water conservation measures a condition of water service from the Albuquerque water utility system and requires the following:

1. No watering of City properties in April through September between 10:00 a.m. and 5:00 p.m.; voluntary for private sector;
2. Water even/water odd watering on City properties; voluntary for private sector;
3. No water waste or fugitive water in the public right-of-way, onto adjacent property, or into storm or sanitary sewers;

4. Water waste fees applied to water bill; increasingly higher fees for repeat violations; installation of flow-restriction device at water meter with the eighth violation to provide only enough water for basic drinking and sanitation needs;
5. No more than 20% of landscaped area in high water use plants for new private development or as allowed through water budget formula to achieve comparable low use; voluntary for existing single family residential;
6. No high water use plants for new City development, excepting parks and golf courses, or as allowed through water budget formula to achieve comparable low use;
7. Surcharge on parks or golf course usage above annual allowance; allowance goes down over time;
8. No high water use turf in medians, on slopes steeper than 6:1, or in areas less than ten feet in any dimension; voluntary for existing single family residential;
9. Efficient new irrigation systems;
10. Installation of new sprinkler heads at least eight inches from the curb.

(B) Initiate irrigation system water use surveys on new properties with one acre or more turf area, beginning in the year 1996; voluntary for single family residential.

(C) Combine all City of Albuquerque requirements regarding landscaping into one manual; eliminate conflicts with the conservation strategy.

(D) Initiate Xeriscape landscape retrofit and rebate program offering five cents per square foot rebate or credit, with a customer limit of \$150, for replacement of high water use turf and landscape plants with low or medium water use turf and plants.

(E) Initiate efficient irrigation system retrofit and rebate program offering rebates or credits of up to \$150 for replacement of old, inefficient irrigation systems with approved water-efficient systems.

(F) Initiate a Xeriscape education program including:

1. Creation of additional Xeriscape demonstration gardens;
2. Expansion of Parks and General Services irrigation efficiency weather network;
3. Sponsoring an irrigation auditor training and certification program;
4. Promotion and participation in Xeriscape research projects;
5. Initiation or cooperation with other agencies on public workshops, tours, videos, newsletters, events, etc.

(G) Improve the effectiveness of water waste enforcement:

1. Escalate fees for repeat offenders; install flow restriction device with eighth violation;
2. Assess fee on first violation observed by enforcement officers;
3. Apply fees to water bill;
4. Hire an irrigation specialist to supervise unit.

**Section 8. EVALUATION.** After this Resolution has been in effect for approximately nine months from the date of publication, a comprehensive evaluation and analysis shall be conducted by the Public Works Department in which input is received from residents, businesses, and others. This report shall be forwarded to the City Council.

**Section 9. INSTITUTIONAL, COMMERCIAL, AND INDUSTRIAL USE (ICI).** The City shall implement the following measures to reduce water use in the Institutional, Commercial, and Industrial billing classifications.

(A) Prepare, through a public process, and adopt a Large Water Users Policy specific to institutional, commercial, and industrial water uses and including, but not limited to, these provisions:

1. Require new customers using over 50,000 gallons per day to prepare and implement a Water Conservation Plan;
2. Prohibit use of City water for the purpose of diluting customer's effluent.
3. Initiate periodic surveys of new customers using more than 300,000 gallons per day; require implementation of auditor's recommendations defined through negotiations with the City;
4. Retrofit existing large water users to reduce use by 2000, in proportion to their growth or downsizing, unless longer period agreed to by the City.

(B) Adopt ordinance prohibiting once-through cooling systems.

(C) Promote City-provided water use surveys and retrofit for the highest 25% of the ICI customers to address both indoor and outdoor usage.

(D) Initiate a City and school building plumbing fixture retrofit program; costs to be shared by the customer and the City.

(E) Implement a strategy for reducing excess water use for City facilities or services.

(F) Initiate a Water Utility unaccounted-for-water loss reduction program including:

1. Water loss reduction program to audit and repair system water losses on a continuous basis;
2. Meter maintenance and replacement program to identify, repair, and/or replace inaccurate or malfunctioning meters;
3. Installation of meters in all unmetered City parks;
4. Development and implementation of strategy to reduce and use well wash water and water system discharge water.

**Section 10.** Conservation requirements, as they apply to new construction, shall take effect six months after the effective date of this legislation.

## Appendix E: Southwest Florida Water Management District Xeriscape Incentive Program

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### RULES OF THE SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT CHAPTER 40D-24 XERISCAPE INCENTIVE PROGRAM

- 40D-24.001 Policy and Purpose
- 40D-24.010 Definitions
- 40D-24.020 Incentive Program
- 40D-24.030 Incentive Program - Qualifying

#### **40D-24.001 Policy and Purpose**

(1) The Governing Board finds that water conservation is critical to ensure an adequate water supply for the citizens of the District. The Governing Board further finds that the implementation and use of Xeriscape landscaping, as defined in section 373.185, F.S., significantly contributes to the conservation of water. The Governing Board further supports adoption of local government ordinances as a significant means of achieving water conservation through Xeriscape landscaping.

(2) The Governing Board intends for the program created by this chapter to encourage all local governments within the District to adopt new ordinances or amend existing ordinances, as expeditiously as possible, to require Xeriscape landscaping for development permitted after the effective date of the new ordinance or amendment.

Specific Authority: 373.044, 373.113, 373.185 F.S.

Law Implemented: 373.185 F.S. History--New 8-23-92.

#### **40D-24.010 Definitions.**

(1) As used throughout this chapter:

(a) "Local government" means any county or municipality of the state whose seat of government is located within District boundaries,

(b) "Xeriscape Landscape" means a type of quality landscaping that conserves water and protects the environment by using site appropriate plants, an efficient watering system, proper planning and design, soil analysis, practical use of turf, the use of mulches (which may include the use of solid waste compost) and proper maintenance,

(c) "Xeriscape ordinance" means any new ordinance, landscape code or amendment to an existing ordinance or code that requires all development permitted after the effective date of the new ordinance, code or amendment to use Xeriscape landscaping.

Specific Authority: 373.044, 373.113, 373.185 F.S.

Law Implemented: 373.185 F.S. History--New 8-23-92.

#### **40D-24.020 Incentive Program.**

(1) Any local government within the District which is considering adopting a Xeriscape ordinance is eligible for the District's incentive program.

(2) The District's incentive program consists of the following:

(a) Providing information on the merits of Xeriscape landscaping - The District shall provide to each local government that qualifies for the District's Xeriscape Incentive Program information on the merits of Xeriscape landscaping. This information shall explain the principles of Xeriscape landscaping which include planning and design, appropriate choice of plants, soil analysis which may include the use of solid waste compost, efficient irrigation, practical use of turf, appropriate use of mulches, and proper maintenance. This information may be in the form of brochures, demonstrations, memos, technical publications, technical assistance or oral communication with District staff. To the greatest extent possible, this information will be tailored to the specific problems and environmental conditions of the local government.

(b) Cost-benefit analysis - Sections 125.568 and 166.048, F.S., require the governing body of every local government to consider enacting a Xeriscape ordinance by October 1, 1992. If the governing body of a local government within the District determines that the benefits of adopting a Xeriscape ordinance outweigh the costs, sections 125.568 and 166.048, F.S., require that local government to adopt a Xeriscape ordinance. For each local government that qualifies for the District's Xeriscape Incentive Program, the District will assist that local government in determining whether the benefits of requiring Xeriscape landscaping outweigh the costs within that local government's jurisdiction. The District's assistance to the local government may consist of technical information on the costs and benefits of Xeriscape landscaping, or referral to other agencies that can provide information the local government may need to perform its cost-benefit determination.

(c) The amount, type, and form of the information on the merits of Xeriscape landscaping and the cost-benefit analysis assistance the District provides to the local government shall be determined by District staff based on the needs of the local government and the availability of District resources.

(d) For those local governments which have a water use permit which requires the preparation of a Water Conservation Plan, the District will provide an incentive to encourage these local governments to adopt a Xeriscape ordinance by allowing these local governments to adopt a Xeriscape ordinance as part of their Water Conservation Plan.

Specific Authority: 373.044, 373.114, 373.185 F.S.

Law Implemented: 373.185, F.S. History--New 8-23-92.

#### **40D-24.030 Incentive Program - Qualifying.**

(1) To qualify for the District's Xeriscape Incentive Program, a local government must submit to the District a draft Xeriscape ordinance along with a letter from an authorized member of that local government's governing body stating that the local government is considering adopting the draft Xeriscape ordinance and requesting that the local government be qualified under the District's Xeriscape Incentive Program.

(2) The draft Xeriscape ordinance the local government submits to the District to qualify for the District's Xeriscape Incentive Program must include, at a minimum, the following:

(a) Landscape design, installation, and maintenance standards that result in water conservation. Such standards shall address the use of site specific plants based on adaptability to the site's climate, soils, geology, and topography, the use of plant groupings based on watering needs, soil analysis including the promotion of the use of solid waste compost, efficient irrigation systems or methods, mulching where compatible with plants and soil type, and other water-conserving practices.

- (b) Identification of plant species that are prohibited or have been designated as "invasive" plant species.
- (c) Identification of controlled plant species, accompanied by the conditions under which such plants may be used.
- (d) A provision specifying the maximum percentage of turf and the maximum percentage of impervious surfaces allowed in a Xeriscape landscape area and addressing the practical selection, installation and irrigation of turf. A program to encourage the preferential use of pervious surfaces and drought resistant turf grass over impervious surfaces and traditional turf grasses.
- (e) Specific standards for land clearing and requirements for the preservation of existing native vegetation as a priority over the installation of irrigated turf areas.
- (f) A monitoring program for ordinance implementation and compliance.

(3) The District has developed a model landscape code which incorporates the principles of Xeriscape landscaping. A draft Xeriscape ordinance submitted by a local government which contains substantially the same requirements as the District's model code shall be presumed to satisfy the requirements of subsection 40D-24.030 (2), F.A.C., and qualify the local government for the District's Xeriscape Incentive Program.

(4) District staff shall determine whether the letter submitted by the local government satisfies the requirements of subsection 40D-24.030 (1), F.A.C., and whether the draft Xeriscape ordinance submitted by the local government complies with subsection 40D-24.030 (2), F.A.C.

Specific Authority: 373.044, 373.113, 373.185 F.S.

Law Implemented: 373.185 F.S. History--New 8-23-92.



## Appendix F: State of California Model Landscape Ordinance

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### MODEL LANDSCAPE ORDINANCE

Model Water Efficient Landscape Ordinance Text of Proposed Regulations  
In Division 2, Title 23, California Code of Regulations, add Chapter 2.7, Sections 490 through 495, inclusive to read as follows:

#### SECTION 490. PURPOSE

**The State Legislature has found:**

- that the limited supply of state waters are subject to ever increasing demands;
- that California's economic prosperity depends on adequate supplies of water;
- that state policy promotes conservation and efficient use of water;
- that landscapes provide recreation areas, clean the air and water, prevent erosion, offer fire protection, and replace ecosystems displaced by development; and
- that landscape design, installation, and maintenance can and should be water efficient.

**Consistent with the legislative findings, the purpose of this model ordinance is to:**

- promote the values and benefits of landscapes while recognizing the need to invest water and other resources as efficiently as possible;
- establish a structure for designing, installing, and maintaining water efficient landscapes in new projects; and
- establish provisions for water management practices and water waste prevention for established landscapes.

Authority cited: Sections 65591.5, 65594, Gov. Code. Reference: Sections 65591, 65591.5, 65597, Gov. Code.

#### SECTION 491. DEFINITIONS

**The words used in this ordinance have the meaning set forth below:**

"anti-drain valve" or "check valve" means a valve located under a sprinkler head to hold water in the system so it minimizes drainage from the lower elevation sprinkler heads.

"application rate" means the depth of water applied to a given area, usually measured in inches per hour.

"applied water" means the portion of water supplied by the irrigation system to the landscape.

"automatic controller" means a mechanical or solid state timer, capable of operating valve stations to set the days and length of time of a water application.

"backflow prevention device" means a safety device used to prevent pollution or contamination of the water supply due to the reverse flow of water from the irrigation system.

"conversion factor (0.62)" means a number that converts the maximum applied water allowance from acre-inches per acre per year to gallons per square foot per year. The conversion factor is calculated as follows:

- $(325,851 \text{ gallons} / 43,560 \text{ square feet}) / 12 \text{ inches} = (0.62)$
- $325,851 \text{ gallons} = \text{one acre foot}$

- 43,560 square feet = one acre
- 12 inches = one foot

To convert gallons per year to 100-cubic-feet per year, another common billing unit for water, divide gallons per year by 748. (748 gallons = 100 cubic feet.)

"ecological restoration project" means a project where the site is intentionally altered to establish a defined, indigenous, historic ecosystem.

"effective precipitation" or "usable rainfall" means the portion of total precipitation that is used by the plants. Precipitation is not a reliable source of water, but can contribute to some degree toward the water needs of the landscape.

"emitter" means drip irrigation fittings that deliver water slowly from the system to the soil.

"established landscape" means the point at which plants in the landscape have developed roots into the soil adjacent to the root ball.

"establishment period" means the first year after installing the plant in the landscape.

"Estimated Applied Water Use" means the portion of the Estimated Total Water Use that is derived from applied water. The Estimated Applied Water Use shall not exceed the Maximum Applied Water Allowance. The Estimated Applied Water Use may be the sum of the water recommended through the irrigation schedule, as referenced in Section 492 (c) (3).

"Estimated Total Water Use" means the annual total amount of water estimated to be needed to keep the plants in the landscaped area healthy. It is based upon such factors as the local evapotranspiration rate, the size of the landscaped area, the types of plants, and the efficiency of the irrigation system, as described in Section 492 (c) (4).

"ET adjustment factor" means a factor of 0.8, that, when applied to reference evapotranspiration, adjusts for plant factors and irrigation efficiency, two major influences upon the amount of water that needs to be applied to the landscape. A combined plant mix with a site-wide average of 0.5 is the basis of the plant factor portion of this calculation. The irrigation efficiency for purposes of the ET Adjustment Factor is 0.625. Therefore, the ET Adjustment Factor  $(0.8) = (0.5/0.625)$ .

"evapotranspiration" means the quantity of water evaporated from adjacent soil surfaces and transpired by plants during a specific time.

"flow rate" means the rate at which water flows through pipes and valves (gallons per minute or cubic feet per second).

"hydrozone" means a portion of the landscaped area having plants with similar water needs that are served by a valve or set of valves with the same schedule. A hydrozone may be irrigated or non-irrigated. For example, a naturalized area planted with native vegetation that will not need supplemental irrigation once established is a non-irrigated hydrozone.

"infiltration rate" means the rate of water entry into the soil expressed as a depth of water per unit of time (inches per hour).

"irrigation efficiency" means the measurement of the amount of water beneficially used divided by the amount of water applied. Irrigation efficiency is derived from measurements and estimates of irrigation system characteristics and management practices. The minimum irrigation efficiency for purposes of this ordinance is 0.625. Greater irrigation efficiency can be expected from well designed and maintained systems.

"landscape irrigation audit" means a process to perform site inspections, evaluate irrigation systems, and develop efficient irrigation schedules.

"landscaped area" means the entire parcel less the building footprint, driveways, non-irrigated portions of parking lots, hardscapes- such as decks and patios, and other non-porous areas. Water features are included in the calculation of the landscaped area. Areas dedicated to edible plants, such as orchards or vegetable gardens are not included.

"lateral line" means the water delivery pipeline that supplies water to the emitters or sprinklers from the valve.

"main line" means the pressurized pipeline that delivers water from the water source to the valve or outlet.

"Maximum Applied Water Allowance" means, for design purposes, the upper limit of annual applied water for the established landscaped area as specified in Section 492 (c) (2). It is based upon the area's reference evapotranspiration, the ET Adjustment Factor, and the size of the landscaped area. The Estimated Applied Water Use shall not exceed the Maximum Applied Water Allowance.

"mined-land reclamation projects" means any surface mining operation with a reclamation plan approved in accordance with the Surface Mining and Reclamation Act of 1975.

"mulch" means any material such as leaves, bark, straw or other materials left loose and applied to the soil surface for the beneficial purpose of reducing evaporation .

"operating pressure" means the pressure at which a system of sprinklers is designed to operate, usually indicated at the base of a sprinkler.

"overhead sprinkler irrigation systems" means those with high flow rates (pop-ups, impulse sprinklers, rotors, etc.)

"overspray" means the water which is delivered beyond the landscaped area, wetting pavements, walks, structures, or other non-landscaped areas.

"plant factor" means a factor that when multiplied by reference evapotranspiration, estimates the amount of water used by plants. For purposes of this ordinance, the average plant factor of low water using plants ranges from 0 to 0.3, for average water using plants the range is 0.4 to 0.6, and for high water using plants the range is 0.7 to 1.0.

"rain sensing device" means a system which automatically shuts off the irrigation system when it rains.

"record drawing" or "as-builts" means a set of reproducible drawings which show significant changes in the work made during construction and which are usually based on drawings marked up in the field and other data furnished by the contractor.

"recreational area" means areas of active play or recreation such as sports fields, school yards, picnic grounds, or other areas with intense foot traffic.

"recycled water," "reclaimed water," or "treated sewage effluent water" means treated or recycled waste water of a quality suitable for nonpotable uses such as landscape irrigation; not intended for human consumption.

"reference evapotranspiration" or "ET<sub>o</sub>" means a standard measurement of environmental parameters which affect the water use of plants. ET<sub>o</sub> is given in inches per day, month, or year as represented in Section 495, and is an estimate of the evapotranspiration of a large field of four- to

seven-inch tall, cool-season grass that is well watered. Reference evapotranspiration is used as the basis of determining the Maximum Applied Water Allowances so that regional differences in climate can be accommodated.

"rehabilitated landscape" means any relandscaping project that requires a permit.

"run off" means water which is not absorbed by the soil or landscape to which it is applied and flows from the area. For example, run off may result from water that is applied at too great a rate (application rate exceeds infiltration rate) or when there is a severe slope.

"soil moisture sensing device" means a device that measures the amount of water in the soil.

"soil texture" means the classification of soil based on the percentage of sand, silt, and clay in the soil.

"sprinkler head" means a device which sprays water through a nozzle.

"static water pressure" means the pipeline or municipal water supply pressure when water is not flowing.

"station" means an area served by one valve or by a set of valves that operate simultaneously.

"turf" means a surface layer of earth containing mowed grass with its roots. Annual bluegrass, Kentucky bluegrass, Perennial ryegrass, Red fescue, and Tall fescue are cool-season grasses. Bermudagrass, Kikuyugrass, Seashore paspalum, St. Augustinegrass, Zoysiagrass, and Buffalo grass are warm-season grasses.

"valve" means a device used to control the flow of water in the irrigation system.

"water conservation concept statement" means a one-page checklist and a narrative summary of the project as shown in Section 492 (c) (1).

Authority cited: Section 65594, Gov. Code. Reference: Section 65597, Gov. Code.

## **SECTION 492. PROVISIONS FOR NEW OR REHABILITATED LANDSCAPES**

### **Applicability**

**Except as provided in Section 492 (a) (3), this section shall apply to:**

- all new and rehabilitated landscaping for public agency projects and private development projects that require a permit; and
- developer-installed landscaping in single-family and multi-family projects.
- Projects subject to this section shall conform to the provisions in Section 492.

**This section shall not apply to:**

- homeowner-provided landscaping at single-family and multi-family projects;
- cemeteries;
- registered historical sites;
- ecological restoration projects that do not require a permanent irrigation system;
- mined-land reclamation projects that do not require a permanent irrigation system; or
- any project with a landscaped area less than 2,500 square feet.

### **Landscape Documentation Package**

A copy of the landscape documentation package conforming to this chapter shall be submitted to the city or county. No permit shall be issued until the city or county reviews and approves the landscape documentation package.

A copy of the approved landscape documentation package shall be provided to the property owner or site manager along with the record drawings and any other information normally forwarded to the property owner or site manager.

A copy of the Water Conservation Concept Statement and the Certificate of Substantial Completion shall be sent by the project manager to the local retail water purveyor.

**Each landscape documentation package shall include the following elements, which are described in Section 492 (c):**

- Water Conservation Concept Statement
- Calculation of the Maximum Applied Water Allowance
- Calculation of the Estimated Applied Water Use
- Calculation of the Estimated Total Water Use
- Landscape Design Plan
- Irrigation Design Plan
- Irrigation Schedules
- Maintenance Schedule
- Landscape Irrigation Audit Schedule
- Grading Design Plan
- Soil Analysis
- Certificate of Substantial Completion. (To be submitted after installation of the project.)
- If effective precipitation is included in the calculation of the Estimated Total Water Use, then an Effective Precipitation Disclosure Statement from the landscape professional and the property owner shall be submitted with the Landscape Documentation Package.

### **Elements of Landscape Documentation Package**

#### **Water Conservation Concept Statement**

Each landscape documentation package shall include a cover sheet, referred to as the Water Conservation Concept Statement similar to the following example. It serves as a check list to verify that the elements of the landscape documentation package have been completed and has a narrative summary of the project.

#### **SAMPLE WATER CONSERVATION CONCEPT STATEMENT**

Project Site: \_\_\_\_\_ Project Number: \_\_\_\_\_

Project Location: \_\_\_\_\_

Landscape Architect/ Irrigation Designer/ Contractor: \_\_\_\_\_

Included in this project submittal package are:

(Check to indicate completion)

\_\_\_ 1. Maximum Applied Water Allowance:

\_\_\_ gallons or cubic feet/year

\_\_\_ 2. Estimated Applied Water Use:  
\_\_\_ gallons or cubic feet/year

\* \_\_\_ 2.(a) Estimated Amount of Water Expected from Effective Precipitation:  
\_\_\_ gallons or cubic feet/year

\_\_\_ 3. Estimated Total Water Use:  
\_\_\_ gallons or cubic feet/year

Note: \* If the design assumes that a part of the Estimated Total Water Use will be provided by precipitation, the Effective Precipitation Disclosure Statement in Section 494 shall be completed and submitted.

- \_\_\_ 4. Landscape Design Plan
- \_\_\_ 5. Irrigation Design Plan
- \_\_\_ 6. Irrigation Schedules
- \_\_\_ 7. Maintenance Schedule
- \_\_\_ 8. Landscape Irrigation Audit Schedule
- \_\_\_ 9. Grading Design Plan
- \_\_\_ 10. Soil Analysis

#### Description of Project

(Briefly describe the planning and design actions that are intended to achieve conservation and efficiency in water use.)

Date: \_\_\_\_\_ Prepared By: \_\_\_\_\_

#### The Maximum Applied Water Allowance

A project's **Maximum Applied Water Allowance** shall be calculated using the following formula:

- $MAWA = (ET_o)(0.8)(LA)(0.62)$  where:
- MAWA = Maximum Applied Water Allowance (gallons per year)
- $ET_o$  = Reference Evapotranspiration (inches per year)
- 0.8 = ET Adjustment Factor
- LA = Landscaped Area (square feet)
- 0.62 = conversion factor (to gallons per square foot)

Two example calculations of the Maximum Applied Water Allowance are:

#### PROJECT SITE ONE: Landscaped area of 50,000 sq. ft. in Fresno

$$\begin{aligned} MAWA &= (ET_o)(.8)(LA)(.62) \\ &= (51 \text{ inches})(.8)(50,000 \text{ square feet})(.62) \\ \text{Maximum Applied Water Allowance} &= 1,264,800 \text{ gallons per year} \\ &(\text{or } 1,691 \text{ hundred-cubic-feet per year: } 1,264,800/748 = 1,691) \end{aligned}$$

#### PROJECT SITE TWO: Landscaped area of 50,000 sq. ft. in San Francisco

$$\begin{aligned} MAWA &= (ET_o)(.8)(LA)(.62) \\ &= (35 \text{ inches})(.8)(50,000 \text{ square feet})(.62) \\ \text{Maximum Applied Water Allowance} &= 868,000 \text{ gallons per year} \\ &(\text{or } 1,160 \text{ hundred-cubic-feet per year}) \end{aligned}$$

Portions of landscaped areas in public and private projects such as parks, playgrounds, sports fields, golf courses, or school yards where turf provides a playing surface or serves other recreational purposes are considered recreational areas and may require water in addition to the Maximum Applied Water Allowance. A statement shall be included with the landscape design plan, designating recreational areas to be used for such purposes and specifying any needed amount of additional water above the Maximum Applied Water Allowance.

### **Estimated Applied Water Use**

The Estimated Applied Water Use shall not exceed the Maximum Applied Water Allowance. A calculation of the Estimated Applied Water Use shall be submitted with the Landscape Documentation Package. It may be calculated by summing the amount of water recommended in the irrigation schedule.

### **Estimated Total Water Use**

A calculation of the Estimated Total Water Use shall be submitted with the Landscape Documentation Package. The Estimated Total Water Use may be calculated by summing the amount of water recommended in the irrigation schedule and adding any amount of water expected from effective precipitation (not to exceed 25 percent of the local annual mean precipitation) or may be calculated from a formula such as the following:

The Estimated Total Water Use for the entire landscaped area equals the sum of the Estimated Water Use of all hydrozones in that landscaped area.

$$EWU (\text{hydrozone}) = [(ET_o)(PF)(HA)(.62)]/(IE)$$

EWU (hydrozone) = Estimated Water Use (gallons per year)

ET<sub>o</sub> = Reference Evapotranspiration (inches per year)

PF = plant factor

HA = hydrozone area (square feet)

(.62) = conversion factor

IE = irrigation efficiency

If the Estimated Total Water Use is greater than the Estimated Applied Water Use due to precipitation being included as a source of water, an Effective Precipitation Disclosure Statement such as the one in Section 494 shall be included in the Landscape Documentation Package.

### **Landscape Design Plan**

A landscape design plan meeting the following requirements shall be submitted as part of the landscape documentation package.

#### **Plant Selection and Grouping**

- Any plants may be used in the landscape, providing the Estimated Applied Water Use recommended does not exceed the Maximum Applied Water Allowance and that the plants meet the specifications set forth in (ii), (iii) and (iv).
- Plants having similar water use shall be grouped together in distinct hydrozones.
- Plants shall be selected appropriately based upon their adaptability to the climatic, geologic, and topographical conditions of the site. Protection and preservation of native species and natural areas is encouraged. The planting of trees is encouraged wherever it is consistent with the other provisions of this ordinance.

- Fire prevention needs shall be addressed in areas that are fire prone. Information about fire prone areas and appropriate landscaping for fire safety is available from local fire departments or the California Department of Forestry.

#### Water Features

- Recirculating water shall be used for decorative water features.
- Pool and spa covers are encouraged.

#### Landscape Design Plan Specifications

- The landscape design plan shall be drawn on project base sheets at a scale that accurately and clearly identifies:
- Designation of hydrozones.
- Landscape materials, trees, shrubs, groundcover, turf, and other vegetation. Planting symbols shall be clearly drawn and plants labeled by botanical name, common name, container size, spacing, and quantities of each group of plants indicated.
- Property lines and street names.
- Streets, driveways, walkways, and other paved areas.
- Pools, ponds, water features, fences, and retaining walls.
- Existing and proposed buildings and structures including elevation if applicable.
- Natural features including but not limited to rock outcroppings, existing trees, shrubs that will remain.
- Tree staking, plant installation, soil preparation details, and any other applicable planting and installation details.
- A calculation of the total landscaped area.
- Designation of recreational areas.

#### Irrigation Design Plan

An irrigation design plan meeting the following conditions shall be submitted as part of the Landscape Documentation Package.

#### Irrigation Design Criteria

- **Runoff and Overspray.** Soil types and infiltration rate shall be considered when designing irrigation systems. All irrigation systems shall be designed to avoid runoff, low head drainage, overspray, or other similar conditions where water flows onto adjacent property, non-irrigated areas, walks, roadways, or structures. Proper irrigation equipment and schedules, including features such as repeat cycles, shall be used to closely match application rates to infiltration rates therefore minimizing runoff.
- Special attention shall be given to avoid runoff on slopes and to avoid overspray in planting areas with a width less than ten feet, and in median strips.
- No overhead sprinkler irrigation systems shall be installed in median strips less than ten feet wide.
- **Irrigation Efficiency.** For the purpose of determining the maximum applied water allowance, irrigation efficiency is assumed to be 0.625. Irrigation systems shall be designed, maintained, and managed to meet or exceed 0.625 efficiency.

#### Equipment

- **Water meters.** Separate landscape water meters shall be installed for all projects except for single family homes or any project with a landscaped area of less than 5,000 square feet.

- **Controllers.** Automatic control systems shall be required for all irrigation systems and must be able to accommodate all aspects of the design.
- **Valves.** Plants which require different amounts of water shall be irrigated by separate valves. If one valve is used for a given area, only plants with similar water use shall be used in that area. Anti-drain (check) valves shall be installed in strategic points to minimize or prevent low-head drainage.
- **Sprinkler heads.** Heads and emitters shall have consistent application rates within each control valve circuit. Sprinkler heads shall be selected for proper area coverage, application rate, operating pressure, adjustment capability, and ease of maintenance.
- **Rain Sensing Override Devices.** Rain sensing override devices shall be required on all irrigation systems.
- **Soil Moisture Sensing Devices.** It is recommended that soil moisture sensing devices be considered where appropriate.

#### Recycled Water

- The installation of recycled water irrigation systems (dual distribution systems) shall be required to allow for the current and future use of recycled water, unless a written exemption has been granted as described in the following section (B) (ii).
- Irrigation systems shall make use of recycled water unless a written exemption has been granted by the local water agency, stating that recycled water meeting all health standards is not available and will not be available in the foreseeable future.
- The recycled water irrigation systems shall be designed and operated in accordance with all local and state codes.

#### Irrigation Design Plan Specifications

- Irrigation systems shall be designed to be consistent with hydrozones.
- The irrigation design plan shall be drawn on project base sheets. It shall be separate from, but use the same format as, the landscape design plan. The scale shall be the same as that used for the landscape design plan described in Section 492 (c) (5) (C).
- The irrigation design plan shall accurately and clearly identify:
  - Location and size of separate water meters for the landscape.
  - Location, type, and size of all components of the irrigation system, including automatic controllers, main and lateral lines, valves, sprinkler heads, moisture sensing devices, rain switches, quick couplers, and backflow prevention devices.
  - Static water pressure at the point of connection to the public water supply.
  - Flow rate (gallons per minute), application rate (inches per hour), and design operating pressure (psi) for each station.
- Recycled water irrigation systems as specified in the Section 492 (c) (4) (B).

#### Irrigation Schedules

Irrigation schedules satisfying the following conditions shall be submitted as part of the Landscape Documentation Package.

An annual irrigation program with monthly irrigation schedules shall be required for the plant establishment period, for the established landscape, and for any temporarily irrigated areas.

The irrigation schedule shall:

- include run time (in minutes per cycle), suggested number of cycles per day, and frequency of irrigation for each station; and
- provide the amount of applied water (in hundred cubic feet, gallons, or in whatever billing units the local water supplier uses) recommended on a monthly and annual basis.

The total amount of water for the project shall include water designated in the Estimated Total Water Use calculation plus water needed for any water features, which shall be considered as a high water using hydrozone.

Recreational areas designated in the landscape design plan shall be highlighted and the irrigation schedule shall indicate if any additional water is needed above the Maximum Applied Water Allowance because of high plant factors (but not due to irrigation inefficiency.)

Whenever possible, irrigation scheduling shall incorporate the use of evapotranspiration data such as those from the California Irrigation Management Information System (CIMIS) weather stations to apply the appropriate levels of water for different climates.

Whenever possible, landscape irrigation shall be scheduled between 2:00 a.m. and 10:00 a.m. to avoid irrigating during times of high wind or high temperature.

### **Maintenance Schedules**

A regular maintenance schedule satisfying the following conditions shall be submitted as part of the Landscape Documentation Package:

Landscapes shall be maintained to ensure water efficiency. A regular maintenance schedule shall include but not be limited to checking, adjusting, and repairing irrigation equipment; resetting the automatic controller; aerating and dethatching turf areas; replenishing mulch; fertilizing; pruning, and weeding in all landscaped areas.

Whenever possible, repair of irrigation equipment shall be done with the originally specified materials or their equivalents.

### **Landscape Irrigation Audit Schedules**

A schedule of landscape irrigation audits, for all but single family residences, satisfying the following conditions shall be submitted to the city or county as part of the Landscape Documentation Package.

At a minimum, audits shall be in accordance with the State of California Landscape Water Management Program as described in the Landscape Irrigation Auditor Handbook, the entire document, which is hereby incorporated by reference. (See Landscape Irrigation Auditor Handbook (June 1990) version 5.5 [formerly Master Auditor Training].)

The schedule shall provide for landscape irrigation audits to be conducted by certified landscape irrigation auditors at least once every five years.

## Grading Design Plan

Grading design plans satisfying the following conditions shall be submitted as part of the Landscape Documentation Package.

A grading design plan shall be drawn on project base sheets. It shall be separate from but use the same format as the landscape design plan.

The grading design plan shall indicate finished configurations and elevations of the landscaped area, including the height of graded slopes, drainage patterns, pad elevations, and finish grade.

## Soils

A soil analysis satisfying the following conditions shall be submitted as part of the Landscape Documentation Package.

Determination of soil texture, indicating the percentage of organic matter.

An approximate soil infiltration rate (either measured or derived from soil texture/infiltration rate tables.) A range of infiltration rates shall be noted where appropriate.

Measure of pH, and total soluble salts.

A mulch of at least three inches shall be applied to all planting areas except turf.

## Certification

Upon completing the installation of the landscaping and the irrigation system, an irrigation audit shall be conducted by a certified landscape irrigation auditor prior to the final field observation. (See Landscape Irrigation Auditor Handbook as referenced in Section 492 (c)(9)(A)).

A licensed landscape architect or contractor, certified irrigation designer, or other licensed or certified professional in a related field shall conduct a final field observation and shall provide a certificate of substantial completion to the city or county. The certificate shall specifically indicate that plants were installed as specified, that the irrigation system was installed as designed, and that an irrigation audit has been performed, along with a list of any observed deficiencies.

Certification shall be accomplished by completing a Certificate of Substantial Completion and delivering it to the city or county, to the retail water supplier, and to the Owner of Record. A sample of such a form, which shall be provided by the city or county is:

### SAMPLE CERTIFICATE OF SUBSTANTIAL COMPLETION

Project Site: \_\_\_\_\_ Project Number: \_\_\_\_\_

Project Location: \_\_\_\_\_

Preliminary Project Documentation Submitted: (check indicating submittal)

\_\_\_ 1. Maximum Applied Water Allowance:

\_\_\_\_\_ (gallons or cubic feet per year)

\_\_\_ 2. Estimated Applied Water Use:

\_\_\_\_\_ (gallons or cubic feet/year)

\* \_\_\_ 2a. Estimated Amount of Water Expected from Effective Precipitation:

\_\_\_\_\_ (gallons or cubic feet/year)

\_\_\_\_ 3. Estimated Total Water Use:  
\_\_\_\_ (gallons or cubic feet/year)

Note: \* If the design assumes that a part of the Estimated Total Water Use will be provided by precipitation, the Effective Precipitation Disclosure Statement in Section 495 shall be completed and submitted. The Estimated Amount of Water Expected from Effective Precipitation shall not exceed 25 percent of the local annual mean precipitation (average rainfall.)

- \_\_\_\_ 4. Landscape Design Plan
- \_\_\_\_ 5. Irrigation Design Plan
- \_\_\_\_ 6. Irrigation Schedules
- \_\_\_\_ 7. Maintenance Schedule
- \_\_\_\_ 8. Landscape Irrigation Audit Schedule
- \_\_\_\_ 9. Grading Design Plan
- \_\_\_\_ 10. Soil Analysis

Post-Installation Inspection: (Check indicating substantial completion)

- \_\_\_\_ A. Plants installed as specified
- \_\_\_\_ B. Irrigation system installed as designed
- \_\_\_\_ dual distribution system for recycled water
- \_\_\_\_ minimal run off or overspray
- \_\_\_\_ C. Landscape Irrigation Audit performed

\_\_\_\_ Project submittal package and a copy of this certification has been provided to owner/manager and local water agency

Comments:

I/we certify that work has been installed in accordance with the contract documents.

\_\_\_\_\_  
Contractor Signature, Date, State License Number

I/we certify that based upon periodic site observations, the work has been substantially completed in accordance with the Water Efficient Landscape Ordinance and that the landscape planting and irrigation installation conform with the approved plans and specifications.

\_\_\_\_\_  
Landscape Architect Signature, Date, State License Number  
or Irrigation Designer/Consultant  
or Licensed or Certified Professional in a Related Field

I/we certify that I/we have received all of the contract documents and that it is our responsibility to see that the project is maintained in accordance with the contract documents.

\_\_\_\_\_  
Owner Signature, Date

Authority cited: Section 65594, Gov. Code. Reference: Section 65597, Gov. Code.

## **Public Education**

### **Publications.**

- Local agencies shall provide information to owners of all new, single family residential homes regarding the design, installation, and maintenance of water efficient landscapes.
- Information about the efficient use of landscape water shall be provided to water users throughout the community.

### **Model Homes.**

- At least one model home that is landscaped in each project consisting of eight or more homes shall demonstrate via signs and information the principles of water efficient landscapes described in this ordinance.
- Signs shall be used to identify the model as an example of a water efficient landscape and featuring elements such as hydrozones, irrigation equipment and others which contribute to the overall water efficient theme.
- Information shall be provided about designing, installing, and maintaining water efficient landscapes.

Authority cited: Section 65594, Gov. Code. Reference: Section 65597.

## **SECTION 493. PROVISIONS FOR EXISTING LANDSCAPES**

### **Water Management**

All existing landscaped areas to which the city or county provides water that are one acre or more, including golf courses, green belts, common areas, multi-family housing, schools, businesses, parks, cemeteries, and publicly owned landscapes shall have a landscape irrigation audit at least every five years. At a minimum, the audit shall be in accordance with the California Landscape Water Management Program as described in the Landscape Irrigation Auditor Handbook, the entire document which is hereby incorporated by reference. (See Landscape Irrigation Auditor Handbook, Dept. of Water Resources, Water Conservation Office (June 1990) version 5.5.)

If the project's water bills indicate that they are using less than or equal to the Maximum Applied Water Allowance for that project site, an audit shall not be required.

Recognition of projects that stay within the Maximum Applied Water Allowance is encouraged.

### **Water Waste Prevention**

Cities and counties shall prevent water waste resulting from inefficient landscape irrigation by prohibiting runoff, low head drainage, overspray, or other similar conditions where water flows onto adjacent property, non-irrigated areas, walks, roadways, or structures. Penalties for violation of these prohibitions shall be established locally.

Authority cited: Section 65594, Gov. Code. Reference: Section 65597, Gov. Code.

## **SECTION 494. EFFECTIVE PRECIPITATION**

If effective precipitation is included in the calculation of the Estimated Total Water Use, an Effective Precipitation Disclosure Statement (similar to the following Sample Effective Precipitation Disclosure Statement) shall be completed, signed, and submitted with the Landscape

Documentation Package. No more than 25 percent of the local annual mean precipitation shall be considered effective precipitation in the calculation of the Estimated Total Water Use.

**SAMPLE EFFECTIVE PRECIPITATION DISCLOSURE STATEMENT**

I certify that I have informed the project owner and developer that this project depends on \_\_\_\_\_ (gallons or cubic feet) of effective precipitation per year. This represents \_\_\_\_\_ percent of the local mean precipitation of \_\_\_\_\_ inches per year.

I have based my assumptions about the amount of precipitation that is effective upon: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_.

I certify that I have informed the project owner and developer that in times of drought, there may not be enough water available to keep the entire landscape alive.

\_\_\_\_\_  
Licensed or Certified Landscape Professional

I certify that I have been informed by the licensed or certified landscape professional that this project depends upon \_\_\_\_\_ (gallons or cubic feet) of effective precipitation per year. This represents \_\_\_\_\_ percent of the local mean precipitation of \_\_\_\_\_ inches per year.

I certify that I have been informed that in times of drought, there may not be enough water available to keep the entire landscape alive.

\_\_\_\_\_  
Owner Developer

**SECTION 495. REFERENCE EVAPOTRANSPIRATION**

in inches (Historical Data, extrapolated from 12-Month Normal Year ETo Maps and U.C. publication 21426)

[Reference Evapotranspiration Table](#)

# Appendix G: Sample Language for Water Conservation Ordinances

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Provided by the Minnesota Department of Natural Resources

## Emergency Authority

Subd. The Acting City Manager (and/or Mayor, Water Utility Superintendent) is hereby empowered to impose and enforce restrictions on the use of water for sprinkling, irrigation, vehicle washing, air conditioning, and other specified, non-essential uses.

Subd. The (City Council, Mayor, Water Utility Superintendent) may declare a critical water deficiency to prevail within the City whenever it finds and determines that the ordinary demands and requirements of water consumers cannot be satisfied without depleting the water supply of the City to the extent that there would be insufficient water for human consumption, sanitation, and fire protection.

Subd. When the (City Council, Mayor, Water Utility Superintendent) has so determined and declared the existence of a critical water deficiency within the City, (it, the Mayor, etc) shall thereupon enact such regulations and restrictions on the delivery of water and the consumption within the City of water supplied for public use as will in the sound discretion of (the Council, the Mayor, etc.) conserve the water supply for the greatest public benefit with particular regard to domestic use, sanitation, and fire protection.

Subd. When the Governor of the State of Minnesota declares a critical water deficiency, the (City Council, Mayor, Water Utility Superintendent) will enact and enforce water conservation restrictions in accordance with Minnesota Statute 103G.291.

Subd. Water use regulations and restrictions may include the right to deny applications for new or additional service connections, and provisions for their enforcement by discontinuing service to customers wilfully violating the regulations and restrictions.

## Lawn Watering, Sprinkling, and Irrigation

Subd. All lawn sprinkler systems and irrigation systems connected to the municipal water system, whether such systems are aboveground or underground, shall require a permit for connection and shall be installed in accordance with (reference state or local plumbing code)

Subd. To conserve water, all lawn sprinkler systems and irrigation systems which are automatic or are equipped to operate automatically, whether installed before or after (date of adoption of resolution), and which are connected to the municipal water system, shall be equipped with a rain-detection or soil moisture monitoring device so as to prevent the system from operating when it rains or there is already sufficient soil moisture.

Subd. With regard to sprinkler systems already connected to the municipal water system on (date of adoption of resolution), the deadline for compliance is (suitable date for deadline).

Subd. All lawn sprinkler systems and irrigation systems connected to the municipal water system shall be constructed and operated to prevent water waste resulting from inefficient landscape irrigation by prohibiting runoff, low head drainage, over spray, or other similar conditions where water flows onto adjacent property, non-irrigated areas, walks, roadways, or structures.

Subd. Property owners having even numbered addresses may water, sprinkle, or irrigate their lawns only on even numbered days, and property owners having odd numbered addresses may water, sprinkle, or irrigate their lawns only on odd numbered days.

Subd. All property owners are prohibited from watering, sprinkling, or irrigating their lawns between the hours of 10 a.m. and 6 p.m.

Subd. An exception shall be granted for recently established lawns, which may be watered daily for up to one month after installation, but only during hours listed in (subd. regarding restricted hours).

Subd. New sod or seeded lawns or other landscaping requiring watering, sprinkling, or irrigation, shall not be installed during a water shortage emergency.

## **Landscaping**

Subd. At least one tree no less than six feet in initial height and no less than one and one-half inch caliper (either existing or planted) shall be included and replaced as necessary as per the following ratios:

1. In street yards less than 10,000 square feet, one tree per 1,000 square feet, or fraction thereof, of street yard.
2. In street yards of between 10,000 and 110,000 square feet, one tree per 2,500 square feet, or fraction thereof, of street yard area over 10,000 square feet is added to the requirement of ten trees.
3. In street yards over 110,000 square feet, one tree per 5,000 square feet, or fraction thereof, of street yard over 110,000 square feet is added to the requirement of 50 trees. An existing or planted tree which is no less than eight inches in diameter, or no less than six inches in diameter and no less than 15 feet tall shall be considered as two trees for purposes of satisfying this subsection. All newly planted trees shall be planted in a landscaped area no less than eight feet wide.

## **Conservation**

Subd. No garbage disposal shall be installed in any new or remodeled residential structure in the City, and no garbage disposal shall be installed or replaced in any existing residential structure.

Subd. The serving of water in restaurants, clubs, or eating places, unless specifically requested by an individual, is prohibited.

## Water Wasting

Subd. Waste of water, as defined below, is prohibited.

- a. allowing water to run-off to a gutter, ditch, or drain
- b. failure to repair a controllable leak
- c. washing sidewalks, driveways, parking areas, tennis courts, patios, or other paved areas
- d. refilling a swimming pool with municipally supplied water after it has been drained
- e. non-commercial washing of privately owned vehicles, trailers, and boats, except from a bucket and except that a hose equipped with a positive shut-off nozzle may be used for a brief rinse
- f. failure to put water to a reasonable beneficial use

Subd. Residents shall be encouraged not to permit any water furnished by the City to run to waste in any gutter or other impervious surface.

## Penalties

Subd. Property owners in violation of water use restrictions are subject to a written warning for the first violation, a fine of \$\$\$ for the second violation, and disconnection of water service until the property owner agrees to comply with restrictions, for the third violation. A separate \$\$\$ fee will be assessed to reconnect service. Violation tickets will be issued immediately upon observation of violation by (law enforcement and/or city utility employees).

Subd. It shall be a misdemeanor for any person to use or apply water received from the City contrary to or in violation of the restrictions herein, and upon conviction thereof such person shall be punished by being imprisoned in the County Jail for not more than 30 days or by fine of not more than \$\$\$, or by both such fine and imprisonment.

Subd. Any person(s) may apply to the City for an exception to the terms of this Ordinance, which exception may be granted in the discretion of the Board of Supervisors, upon proof that some other device, system, or procedure will save as much or more water as those set forth herein, or that those set forth herein cannot be complied with, without undue hardship.



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