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Conserving Our Finite Water Supplies in an Era of Chronic Drought: Practical Steps¹

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Despite America's abundant supplies of freshwater, a growing number of cities and towns face the challenge of providing an adequate and safe supply of drinking water. Increasing population, sprawl, chronic drought, pollution, and now the specters of terrorism are sharpening the nation's focus on how we can better preserve and protect our water for the future. While often ignored, many water systems in the United States and overseas waste significant quantities of water through excessive leakage and inefficient "end uses" in the home, yard, office, factory, and farm. This article explores the links between our growing demand for more water, population, the environment, and the myriad technologies and practices that can be utilized to blunt our increasing water demands through aggressive conservation actions.

America possesses abundant supplies of freshwater, yet a growing number of cities and towns face the challenge of providing an adequate and safe supply of drinking water. Increasing population, sprawl, chronic drought, pollution, and now the specters of terrorism are sharpening the nation's focus on how we can better preserve and protect our water for the future (Vickers, 2001, p. xv). We can ensure that we have enough water in the future, but we face significant hurdles to making that a reality. Conservation—more efficient use of water—can and must play a central role in the future if we are to survive and thrive within our existing resource limitations.

Consider these facts: America's population now stands at over 285 million. By 2050, it is projected to reach 413 million—a 45% increase in almost as many years. The world's population, now 6.1 billion, is projected to increase to over 9 billion by 2050, a 50% increase (Population Reference Bureau, 2001, pp. 2, 4). However, our water budget remains largely the same and fixed by nature, if not diminished by the contamination of sources that were not adequately protected. While desalination and wastewater reuse technologies are indeed additional supply options, they require massive capital investments. Such infrastructure translates into increased costs to consumers, many of whom are already seeing steep increases in their water and sewer bills. Further, such options are not without adverse environmental consequences (for example, excessive salt loading, increased

power and chemical use, and pollution combustion byproducts that contribute to global warming).

A New Era of Chronic Drought

Our experience and definition of drought may alter in the future as the primary symptom of drought-shortage of water-occurs on a more frequent and extended basis. While drought has historically been experienced as an inevitable but temporary climatological event in the natural world from which we eventually get relief, the human world may trump that cycle. Increasing demands (population) in effect further limit our water supplies, resulting in the creation of *chronic* and year-round drought conditions-water shortages-even when there is normal rainfall. For example, the 2002 drought across much of the United States affected not only the arid regions but also hit "water rich" New England in the winter. During the week before Christmas 2001, Gov. Angus King of Maine-a water rich state-declared a drought. A year later, some areas are still in drought conditions, despite increased rain.

Even without a formally declared drought, regions that share water resources-such as Georgia, Alabama, and Florida, as well as states that draw heavily from the Colorado River, Colorado, Arizona, New Mexico, and California-continue to place increasing demands on their sources of supply, despite obvious resource limitations and symptoms of ecosystem stress. Increasingly, such "water wars" are tangled in litigation, often without clear outcomes for the long term. We have more people wanting more water, but nature's water budget remains the same: fixed. Again, alternative supply options such as desalination and wastewater reuse are possible in some areas, but they are expensive, demand copious amounts of energy, and can only be delivered at a cost to the environment. The bottom line: we must learn to live, work, and farm within existing resource limitations by boosting the productivity of our water systems through application of water efficiency technologies and practices.

Water Waste

In many respects, today's water shortages are a manifestation of not only population but also mismanagement. Our culture and water management practices currently overlook and in some cases condone the waste of water in absurdly significant amounts. For example, typically half-and sometimes more-of residential water use in the Southwest and parts of the Southeast are for lawn watering. Cities such as Phoenix and Las Vegas use over 200 gallons per person per day, much of it for irrigating turf (about 69 gallons is used per person inside the home) (Vickers, 2001, p. 142). It is not uncommon to find industrial sites where 40-70% of water demand could be

averted simply by reusing clean cooling water, replacing rotting steam heating traps, and fixing leaks (Vickers, 2001, p. 239). American farmers use the majority of our freshwater supplies (Postel, 1999, p. 112), yet only 4% of crops are irrigated with efficient drip systems (*Irrigation and water use*, 2001).

There are consumers, businesses, and farmers who waste water-sometimes it is water systems themselves. Most U.S. water systems cannot account for between 10 and 25% (sometimes more) of their water supplies, with poorer countries typically having the highest water losses (over 50%) (Smith & Vickers, 1999). What is this water called, and what exactly is it? "Unaccounted-for water" or "lost water" is a combination of leakage and unmeasured flows. While it is virtually impossible to make any water system completely tight, the extent to which water is leaked and otherwise not accounted for (through meter errors, unmeasured use, and in some cases, theft) resides as a hidden and heretofore untapped water supply that could also be mined in the future. By investing in and implementing water efficiency measures in our homes, landscapes, schools, hospitals, offices, factories, farms, and water systems, our existing water supplies can be far better and more cost-effectively utilized.

Water Use and Conservation Measures

Major advances have been made in the science and art of water efficiency over the past decade. For example, the large-scale implementation of just a few conservation measures (system leakage reduction, low-volume 1.6 gal/flush toilets, recirculated cooling systems) have contributed to total water demand reductions of over 20% by several large U.S. water systems, including Boston, Seattle, and New York City (Vickers, 2001, p. xvi). There are now over 100 water conservation "hardware" (fixture, appliance, equipment, or device) measures and efficiency practices available for application among the major customer sectors that can result in permanent water savings when applied appropriately (Vickers, 2001, p.xvi). A number of these measures and practices are not known or commonly implemented by water managers. Such measures represent the potential for additional water savings from conservation that may be considered to help realize demand management goals (Vickers, 2001, p.xv). Below is a summary of the water use characteristics of homes, landscapes, businesses, and industry; the potential savings from conservation; and an overview of applicable conservation measures.

Homes: Water Use and Conservation Measures

Total residential water use in the United States for indoor and outdoor purposes averages about 26.1 billion gallons per day (bgd). Residential water use usually represents about 50 to 80% of billed urban water demand. For people living in single-family homes, the average combined indoor and outdoor use is about 101 gallons per capita per day (gpcd), according to the U.S. Geological Survey (Solley, Pierce & Perlman, 1998, p. 24). A study of metered residential water use in over 1,200 homes in North America found indoor use to average about 69 gpcd (Mayer & DeOreo, 1999, p. 86). Per capita water use in multifamily dwellings tends to be less, ranging from 45 to 70 gpcd (Vickers, 2001, pp. 14-16).

Several factors affect residential water use: climate, weather conditions, socioeconomic conditions, and other customer characteristics. As a result, the 101 gpcd average for single family users will not be found in every community or city. For example, people living in New England use about 70-80 gpcd (mostly indoor use), while people living in single family homes in hot and dry areas such as the southwestern United States often use hundreds of gallons a day per person due to high outdoor irrigation. Multi-family dwellers typically account for little or no water outdoors and have fewer fixtures and appliances and hence, tend to be the most efficient (Vickers, 2001, p. 16).

The potential water savings from conservation in the (indoor) residential sector ranges from about 10 to 50% when these measures are employed:

- Toilets: *low-volume, ultra-low volume, dual-flush toilets, waterless, composting, liquid and solid waste separation technology, toilet retrofit, and toilet leak repair*
- Urinals: *low-volume, waterless, composting, urinal retrofit devices, and urinal leak repair*
- Showerheads: *low-volume, showerhead retrofit*
- Faucets: *low-volume, faucet retrofit, point-of-use hot water heaters for faucets, faucet leak repair, food disposer retrofit*
- Clothes Washers: *high-efficiency, water-efficiency practices*
- Dishwashers: *high-efficiency, water-efficiency practices*

Landscapes: Water Use and Conservation Measures

About 8 bgd is used in the United States for outdoor purposes, primarily lawn irrigation (Solley, Pierce & Perlman, 1998, p. 27). (That figure may be low since some non-agricultural irrigation is not measured.) The typical suburban lawn in America is supplied with about 10,000 gallons of supplemental (nonrainwater) water a year. On average, an estimated 31 gpcd is used outdoors by people living in single family homes (Vickers, 2001,

pp. 16,141). Actual outdoor use varies significantly by region. For example, people living in New England use about 0-20 gpcd, while many single-family homes in hot and dry areas such as the southwestern United States use hundreds of gallons a day per person due to high outdoor irrigation (Vickers, 2001, pp. 141-143; Mayer & DeOreo, 1999, p. 114).

New single-family homes built in the United States now commonly have automatic irrigation systems for lawns, which may explain why landscape irrigation is increasing in many communities. In theory, automatic irrigation systems can be quite efficient; however, the reality is that they are not simple for the average homeowner or maintenance contractor to operate, and thus they can lead to high levels of water waste. Concomitant with the use of lawn irrigation systems is the use of landscape chemicals, with the use of one tending to increase the use and waste of the other. The typical American lawn receives 10,000 gallons of water per year-equivalent to 145 days of indoor use by one person-and 10 times more pesticides per acre than that used on farms to grow food. There is growing concern about "poisoned lawns" from the overuse of synthetic chemicals. For example, a recent study by the University of Wisconsin at Madison and the Universidad de Valparaiso in Chile has linked low levels of a common lawn and garden weed killer to lower fertility (Poisoned lawns, poisoned pregnancy, 2002).

The potential water savings from conservation in the landscape and irrigation sector can range from about 15 to 100% when these conservation measures are in place:

- Water-wise landscape planning and design
- Native, drought-tolerant, and low-water-use turf and plants
- Limited turf areas
- Efficient irrigation systems and devices: *no watering option, containers, appropriate spray heads, rainwater harvesting and cisterns, cisterns, manual hoses, drip irrigation*
- Efficient irrigation scheduling: *limited watering cycles and days per week, site-specific water budget controller adjustments based on hydrozones, ET-adjusted schedules*
- Soil improvements: *soil tests, topsoil preservation, reduced compaction, soil preparation, lawn chemical minimization and elimination, use of mulches*
- Maintenance: *irrigation system repairs, proper mowing, fertilizing, use of downspouts, weed control, IPM, leak repairs*
- Water decorations and fountains: *recirculating systems, hours of operations, leak repairs*
- Pools: *pool covers, temperature adjustments, splash control*

Businesses and Industry: Water Use and Conservation Measures

The total commercial and industrial (excluding mining and thermoelectric) water use in the United States is estimated by the U.S. Geological Survey to average 9.6 bgd and 27.1 bgd, respectively, or a total of 37 bgd. Customers in the ICI water-use sector usually represent about 20 to 40% of billed urban water demand.

The potential water savings from conservation measures in the ICI sector, depending on site-specific factors, can range from about 15 to 95% when these and other conservation measures are utilized:

- Leak repair
- Cooling Systems: *recirculated water, leak repair, optimized flow controls and water treatment, electric cooling systems*
- Heating Systems: *recirculated water, optimized flow controls and water treatment, steam trap repair or replacement*
- Process water reuse: *optimized process washing and rinsing, ozonation, "Living Systems" technology*
- Flow controls
- Maintenance: *minimization of water for cleaning, high-pressure hoses, reuse of graywater for nonpotable applications*

Farms: Water Use and Conservation Measures

Worldwide, irrigation water to grow crops takes about two-thirds of the water withdrawn from all rivers, lakes, and aquifers (Postel, 1997, p. 49). Irrigated crops have nearly three times the productivity of rain-fed land (Postel, 2001). Over 80% of the world's cropland is watered only by rain. Irrigated agriculture in the United States remains the dominant user of freshwater. Total freshwater withdrawals for irrigation for agricultural and horticultural purposes (including golf courses) are estimated to average 134 bgd according to the U.S. Geological Survey.

The potential water savings from conservation measures in the agricultural sector, depending on site-specific factors, range from about 10 to 40% when farmers use conservation measures such as these:

- Soil moisture monitoring
- Irrigation scheduling
- Laser leveling
- Furrow diking
- Low Energy Precision Application (LEPA)
- Surge valves

- Drip irrigation
- Tailwater reuse
- Conservation tillage
- Canal and conveyance system lining and management
- Community Supported Agriculture (CSA)

Conclusions

The world's growing population and diminishing drinking water supplies appear to pose ominous threats to future generations, but must that be our destiny? By understanding *where* and *how* water is used-and wasted-and then applying *effective efficiency technologies and practices*, we can achieve substantial water savings and other benefits in our homes, landscapes, offices, commercial enterprises, institutions, factories, and on farms. Indeed, water conservation can enable water-short cities and towns to not only survive but also thrive, using ingenuity instead of inefficiency to boost the productivity of water to meet our needs.²

Endnote

1. This article is based on a presentation, "How Cities and Individuals Can Help Preserve and Protect Our Water for the Future," given at the American Library Association Annual Conference in Atlanta, Georgia, on June 16, 2002. The session, "Promoting Public Health and Community Protection-Can Libraries Help?" was sponsored by the ALA/SRRT Task Force on the Environment.

2. To learn more about water conservation on the Web, here are some good portals to start from:

- National Water Efficiency Clearinghouse, www.waterwiser.org
- U.S. Geological Survey, Water Use in the United States, <http://water.usgs.gov/>
- National Drought Mitigation Center, <http://www.drought.unl.edu/index.htm>
- Wild Ones-Natural Landscapers, Ltd., www.for-wild.org

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