APPENDIX B

DEMAND MANAGEMENT PROGRAM DEVELOPMENT

PURPOSE AND BACKGROUND

The driving forces for establishing water demand management programs vary from community to community. The needs may be based on resource scarcity, distribution system limitations, and/or efforts to manage operating costs. Responses to such needs can range from a conservation strategy that preserves available supplies to a resource-management strategy that can reduce water demands placed on the water system. A comprehensive demand management program should be a balance between various strategies that meet the overall needs of the community.

Demand management has been one of the core components of Tucson Water's water-resource planning efforts since the early 1970s. The focus of demand management over the last 30 years has shifted from an initial strategy based on resource-management to one with a conservation-driven focus. For Tucson Water, management of available water resources is critical to the community's long-term sustainability. Conservation programs seek to promote efficiency in the use of available water resources. A conservation-based program does not produce additional water resources above and beyond what is physically available. Instead it preserves currently available water supplies by increasing water-use efficiencies and therefore reducing per capita consumption. Conservation programming is an important element in any comprehensive demand management program.

To be effective, the conservation components of a demand management program should provide an equitable distribution of benefits to all customer classes, employ a targeted mix of methods to achieve desired results, and be continuously evaluated to optimize program performance. A range of programs has been developed over the years to accomplish this.

- **General public information programs** are designed to promote awareness of conservation and to develop a low-water-use ethic through the use of pamphlets and brochures, public presentations, and public service announcements.

- **Education and training programs** are designed to increase knowledge and understanding of various issues, practices, and technologies that affect water-use efficiencies. These programs target specific uses or classes of water users and are presented in workshop or classroom settings. The reliability of water savings increases when education and training programs result in the application of more efficient technologies and practices.

- **Incentive programs** are designed to encourage changes in habits or the use of new technologies as a means of increasing efficiencies in water use. Water rates, rebates, and recognition programs are examples of such efforts.

- **Direct assistance programs** are designed to facilitate best-management practices to achieve reductions in water use. This can be accomplished by transfers of technology, such as retrofitting existing fixtures with more efficient ones, or providing direct technical assistance by conducting water audits to identify and prioritize measures for reducing water consumption.

- **Regulatory measures** are designed to ensure long-term efficient use of water through prescriptive requirements. Plumbing code requirements and local landscape ordinances based on Xeriscape™ design principles are examples. Regulatory measures are low-cost and reliable from the Utility's perspective.

CHRONOLOGY OF TUCSON WATER'S DEMAND MANAGEMENT PROGRAM

Prior to 1880, the primary water source for the Tucson basin was surface water, most of which came from the Santa Cruz River. In the 1880s, advances in pumping technology increased the accessibility to ground water as a source of supply. These technological advances brought changes in how ground water was used in the community. With access to the largely untapped ground water reservoir, agricultural development expanded as did outside urban water use. This increase in outside urban water use supported the increasing introduction of non-native water-loving plants in local landscapes (McPherson and Haip, 1989). During the first half of the 20th century, continued growth in the municipal and agricultural sectors in the Tucson area relied on ground water to meet increasing water demand. Over time, ground water utilization began to exceed the natural replenishment of local aquifers, and ground water mining became an increasing concern. Urban growth during the 1950s and 1960s spurred the expansion of municipal well fields; coupled with rapid growth in agriculture and industrial/commercial water usage, the regional aquifers were increasingly depleted and ground water levels declined at an increasing rate. In response, Tucson Water began developing demand-management programs in the early 1970s and many of those early practices are still being used today.

Demand Management in the 1970s

In 1973, annual potable per capita water use reached an all-time high, and the extremely hot summer of 1974 led to a near crisis for the Utility. Tucson Water's distribution system was overtaxed and the Utility could not guarantee domestic service or adequate fire-protection

flows to all customers in higher elevations. Tucson Water recognized that to meet peak demand and extend the timetable needed to make critical capital improvements, a demand management program had to be initiated.

In 1974, Tucson Water instituted an increasing block-rate structure for residential customers which established increasing charges within designated blocks of delivered water. In 1977, water rates were increased and seasonal surcharges were added. The higher charges during the months of greatest water use helped limit water use during peak summer demand periods and reduced overall demand on the water delivery system. The *Beat the Peak* program was initiated as a resource management tool to reduce demand on the water system during the peak daily usage period between 4 and 8 p.m. and delayed the need for expensive new production and distribution facilities. Customers responded favorably to *Beat the Peak* and peak daily usage was reduced. However, the popular *Beat the Peak* program also became a key component in establishing a strong water-conservation ethic in the community. The success of these early demand management efforts is reflected in the subsequent shift in the community's landscape preference from non-native, high water use plants in the 1970s to the increasing use of drought-tolerant desert plants and reduced turf usage by most residential and commercial users.

Demand Management in the 1980s

Decades of growth in the metropolitan areas resulted in aquifer overdraft in many parts of the State. In response to ground water depletion and federal requirements for funding the Central Arizona Project, the state legislature passed the 1980 Groundwater Management Act which established conservation requirements for municipal users. With this legislative mandate, Tucson Water's demand-management program became more focused on conservation to comply with regulatory water-usage requirements.

Throughout the 1980s, the Utility's demand management program continued to emphasize public information campaigns that promoted changes in water-use habits and encouraged the use of newer, more efficient technologies to conserve water. Tucson Water also partnered with other local agencies to provide funding and staff support for various public information campaigns including *Slow the Flow* and *Make Every Drop Count*. Tucson Water also collaborated with other organizations in projects such as the *Casa del Agua* (a conservation research and demonstration site), *A Sense of Water* (an in-school education program), and the *Xeriscape™ Demonstration Garden* at the Tucson Botanical Gardens.

In 1982, the City of Tucson and Pima County adopted the revised *Universal Plumbing Code* which required all new construction to install fixtures with reduced-flow requirements. The *Water Waste and Theft Ordinance* was approved in 1984 and authorizes City employees to issue citations for instances of waste resulting from water running off the property of origin. Also in 1984, Tucson Water began delivering reclaimed water to meet a portion of the community's non-potable demand. The reclaimed system continues to expand, providing non-potable water to irrigate parks, schools, golf courses, and other large turf properties. Residential, commercial, and industrial sites throughout the community use reclaimed water.

Revised Uniform Plumbing Code requirements were adopted in 1989. This code required all new construction to include fixtures with even higher water-use efficiency standards. With adoption of the new code, Mayor and Council authorized the *Ultra-Low-Flush (ULF) Toilet Rebate Program* designed to create a financial incentive for existing homeowners to replace older toilets with ULF fixtures.

Demand Management in the 1990s

The City of Tucson's *Landscape Ordinance* was approved in 1991 and requires adherence to Xeriscape™ design principles in new residential and commercial developments. Educational programs were expanded for residential and commercial customers. A Youth Education Program began providing formal classroom programming to elementary and middle school grades. The free *Water Smart Workshop* series was developed to provide homeowners with intensive two-hour sessions designed to teach proper landscape design, installation, and management techniques. Similarly, a *Smartscape Workshop* series was launched to provide landscape professionals and commercial property managers with the knowledge and skills needed to manage landscape for increased efficiency of water use. *Landscape Water Audit Training* was also introduced in 1992 to institute evapotranspiration-based irrigation scheduling and efficient use of irrigation systems.

Several programs providing direct assistance to commercial customers were also instituted during this time. The *LOW 4 Program*, a joint effort between the City of Tucson and Pima County's Cooperative Extension staff, resulted in contacts with over 400 multi-family and commercial water users and landscape water audits of multi-family and commercial properties. The *Business, Industry and Government Program (B/I/G)* conducted audits of some of the highest water-use nonresidential sites. Information developed through this program was used to identify the most water-intensive uses within the commercial sector - cooling and landscaping.

In 1993, residential assistance programs began with Tucson Water's participation in the *Southern Arizona Seniors Program* with Southwest Gas Corporation which provided water and energy conservation services to qualifying fixed-income senior citizens. In addition, while the original *ULF Toilet Rebate Program* was discontinued, a modified assistance program was developed to provide ULF toilets to low-income homeowners at no cost.

The *Zanjero Program*, a residential water-audit customer assistance program, was established in 1996. The *Zanjeros,* or water auditors, provide customers with a personalized indoor and outdoor water use profile along with suggestions to use water more efficiently. This program, in conjunction with all of the direct assistance programs, provided baseline data for assessing residential conservation potential.

In 1998, a *Teacher Internship Program* was introduced that provides high school teachers and students with opportunities to learn more about local water issues. This program includes a two-week internship for middle- and high-school faculty and provides opportunities for teachers to interact with Utility staff to discuss water-resource management issues facing the community. Teacher intern graduates are asked to develop water-related projects in their classrooms within the school year. More than 200 teachers have participated in the program.

Demand Management in the 2000s

Demand management must remain a strong component of an effective long-range water resource program. Seasonal resource-management needs and regulatory requirements continue to play a role in the structure and direction of Tucson Water's demand management program. The program's current focus is to reinforce the community's conservation ethic and to produce benefits for all levels and classes of water users.

Review and revision of educational outreach efforts will ensure that program content remains current and is integrated with other initiatives. Monitoring residential and commercial water-audit programs allows for the continuing reassessment of the audit process and the criteria used to estimate water savings. In 2003, Tucson Water helped fund research by the University of Arizona's Water Conservation Alliance of Southern Arizona (Water CASA) to study the effectiveness and cost benefit of various water conservation strategies. These assessments will provide a better understanding of the programs' effectiveness and will highlight areas in need of improvement.

A *Commercial Conservation Recognition Program* has been developed to target commercial-class customers. Elements of this program include identification and confirmation of best practices for various commercial users, identification of qualifying business locations, and establishment of an awards program to provide recognition to program participants. These incentives are balanced with efforts to enhance enforcement of the revised water-waste ordinance with stricter follow-up procedures to ensure resolution of problems.

ADWR established a new per capita potable system target for Tucson Water at 167 GPCD for calendar years 2000 to 2004. Public information, educational outreach, and maintaining compliance with this per capita target is the primary focus of the current conservation program. Tucson Water also is in the process of identifying other demand management efforts to reduce the per capita potable water use. The Utility is developing a program to reduce lost and unaccounted for water as part of the long range planning effort. Under this effort, a meter replacement program has been implemented, a leak detection program is being developed, and a water audit will need to be conducted.

PROGRAM EVALUATIONS AND PER CAPITA WATER USE TRENDS

Program Cost Versus Program Reliability

The Utility has adopted a broad-based approach to demand management that utilizes conservation and resource-management strategies. *Beat the Peak*, which started out as a resource-management tool in the late 1970s, has become a key element of the Utility's demand management conservation efforts. The reclaimed water system has become an increasingly important resource-management program because it replaces some previously potable ground water usage with recycled municipal wastewater which is appropriate for non-potable uses such as turf irrigation. These projects, like all the projects developed under the demand management program, range from low to high cost and from low to high reliability. A project's reliability refers to the expected water savings or effectiveness of the project in meeting its goals. The relationship between project cost and reliability is shown in

Table B-1 where General Public Information Programs and Incentives and Rebates are evaluated using cost and reliability for ranking purposes. The public information program has a relatively low implementation cost but is difficult to evaluate with respect to actual water savings while incentives and rebates have high cost but water savings can be quantified. Other programs such as Education and Training, Direct Assistance, and Regulatory Measures can also be evaluated on a cost versus reliability basis.

Level		Program Reliability		
		Low	**Medium**	**High**
Program Cost	**Low**	General Public Information Programs		Regulatory Measures
	Medium		Education and Training	
	High		Direct Assistance	Incentives and Rebates

Table B-1: Demand Management Program Cost Versus Reliability.

Reliability can be measured in terms of the volume of water saved or it may be inferred by measuring changes in attitudes or habits. Projects resulting in a change in technology, such as installing lower-volume fixtures, lend themselves more readily to actual measurement of water saved. Changes in attitudes or habits, the expected outcomes of information and educational outreach programs, can also be evaluated using survey techniques to compare differences between study and control populations. Conservation projects that are primarily informational or educational in nature are more easily evaluated in terms of public awareness and acceptance than actual water savings.

Per Capita Water Use

One of the primary variables employed to project total demand in future years is per capita water usage. The overall measure of water-use efficiency is total gallons per capita per day (Total GPCD) which represents the average total daily volume of water used over a given year divided by the total population served during the year (for both potable and non-potable reclaimed water usage). Total GPCD can be further broken down into component parts each of which provides information about per capita water use and about various water use classes. Over the years, the Total GPCD within Tucson Water's service area has remained relatively constant at around 177 GPCD as shown on Figure B-1.

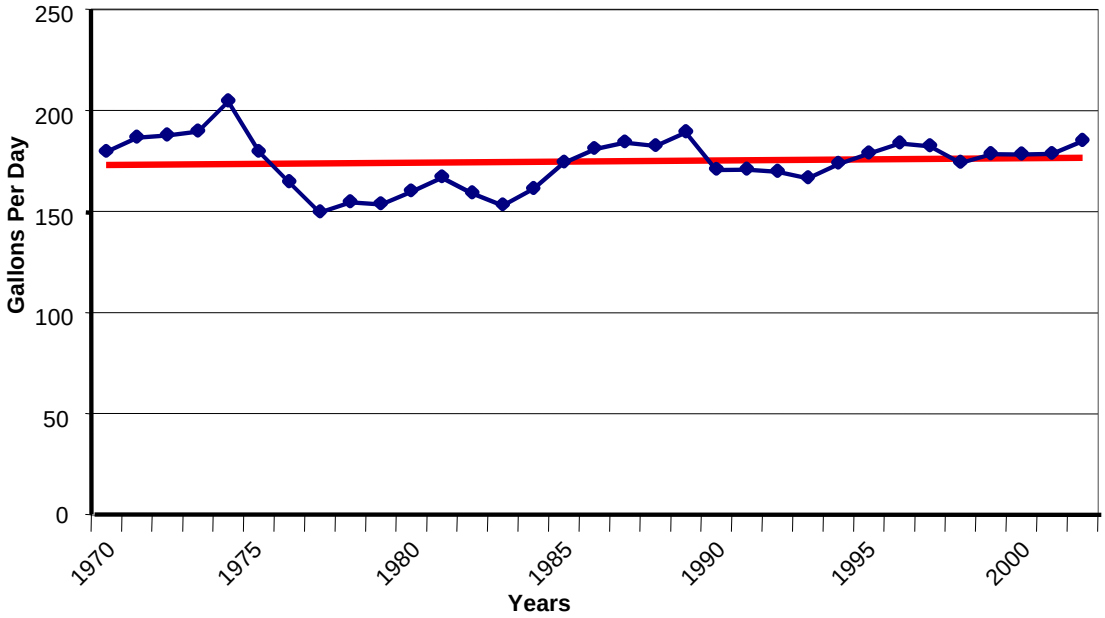

Figure B-1: Average Daily Per Capita Total System Demand 1970-2002.

Potable GPCD, a component of Total GPCD, represents the Tucson Water service area's per capita water-use for potable water only. The Potable GPCD has been used by ADWR to assess compliance with its per capita requirements since enforcement of its *Total GPCD Program* began in 1987. The Potable GPCD shows a slight downward trend from 1970 to 2000 as shown on Figure B-2.

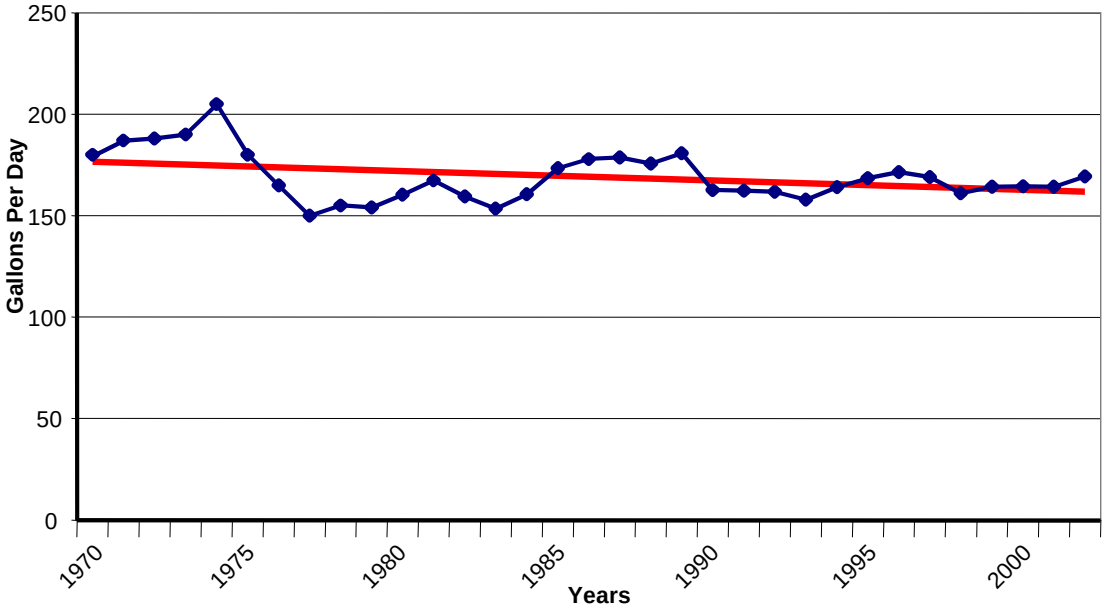

Figure B-2: Average Daily Per Capita Potable System Demand 1970-2002.

Since 1984, Total GPCD has included potable and non-potable reclaimed water usage. Figure B-3, which partitions potable and reclaimed system water use rates after 1984, suggests that increasing reclaimed water use has largely offset the decline in Potable GPCD.

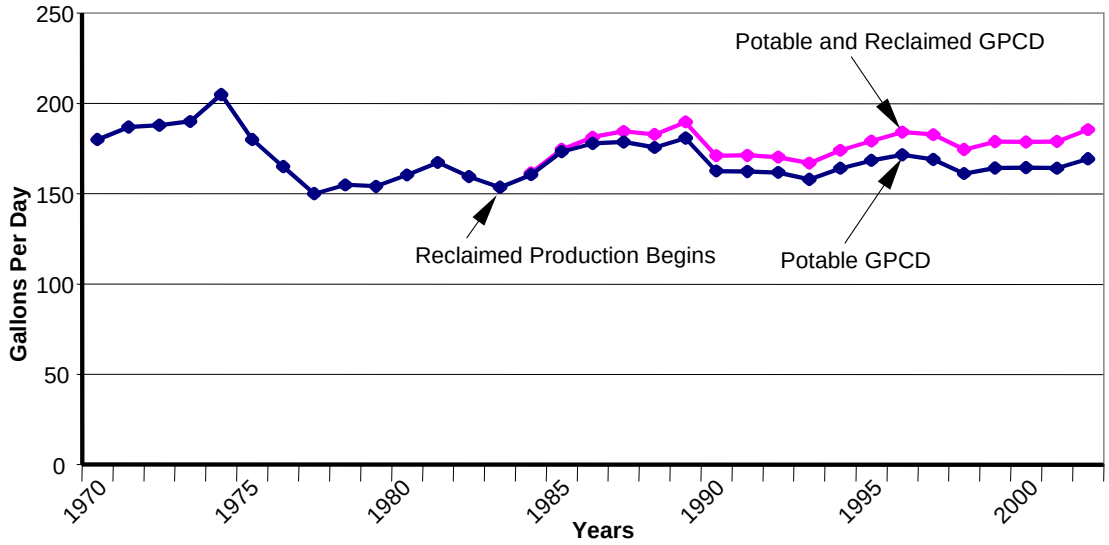

Figure B-3: Average Daily Per Capita Potable and Reclaimed System Demand 1970-2002.

Residential Potable Per Capita Water Use

Just over 50 percent of all potable system demand is delivered to the single-family residential class and about 25 percent is utilized by the multi-family residential class. Thus, total residential usage accounts for about 75 percent of total potable demand. The average single-family residential use is 120 GPCD while total residential demand accounts for 110 GPCD. Residential water use has historically been an important focus of Tucson Water's conservation program.

There has been a reduction in the average GPCD for the single-family residential class over the last 15 years, but the reasons for the reduction in water use are difficult to determine. It was anticipated that the plumbing ordinances requiring use of efficient plumbing fixtures would reduce interior demand and result in lower per-service usage. Interior water usage can be compared from year to year by looking at winter-month water use patterns which reflect interior water usage. However, most of the residential water use reduction has occurred almost entirely during the summer months. Possible explanations for this water use trend may be related to the positive impacts associated with the increasing block rate structure and the continuing emphasis on reducing summer demand through the *Beat the Peak* program. There may also be changes in residential cooling patterns (where more air conditioning systems and fewer evaporative coolers have been installed in the last 10 years) that might also contribute to the documented decline in single-family residential usage per service. Another significant contributing factor to the observed trend may also be related to the increasing use of drip irrigation systems as opposed to less-efficient hand/sprinkler watering.

Commercial and Industrial Potable Per Capita Water Use

The commercial and industrial customer classes account for about 25 percent of all potable system deliveries. These deliveries include all non-residential customers ranging from schools to manufacturing. The current non-residential potable GPCD is 35, which has been on a downward trend since 1980. This reduction in usage is mainly attributed to the conversion of customers from the potable system to the reclaimed system.

Conservation Potential by Customer Class

The future role of conservation in a demand management program should be assessed in terms of its potential for making improvements in the various customer classes. Program reliability needs to be considered in terms of cost. Conservation-based demand management has focused on the interior and exterior water use for the three primary customer classes:

- Single-family residential
- Multi-family residential
- Commercial.

Tucson Water's service area currently has a relatively low potable GPCD of 163 gallons and an overall single-family residential GPCD of about 120. This single-family usage rate is one of the lowest in the urban Southwest as shown on Table B-2 and is commonly used as an indicator to compare the relative effectiveness of conservation programming between similar communities. The overall potential for additional reduction in residential water usage is relatively low given current programming. Given the low to moderate conservation potential in this sector, cost to further reduce water consumption in this customer class would be high.

Single-Family Residential GPCD*	Selected Western Cities
114	El Paso, Texas
120	**Tucson, Arizona**
123	Mesa, Arizona
131	Glendale, Arizona
138	Albuquerque, New Mexico
140	Tempe, Arizona
165	Phoenix, Arizona
169	Scottsdale, Arizona
230	Las Vegas, Nevada
236	Oro Valley, Arizona
242	Sacramento, California
261	Fresno, California

*Source: Data provided by utility representatives except for Las Vegas and Albuquerque which were obtained from Western Resource Advocates (2003).

Table B-2: Comparison of Single-Family Residential Water Usage.

Conservation Potential in the Single-Family Residential Sector

Single-family residential customers have individual meters and include condominiums, single detached housing units, and mobile homes. They comprise roughly 80 percent of Tucson Water's service connections and about 50 percent of the service area's overall potable water use. The conservation potential in the single-family sector is relatively low for interior water use and moderate for exterior use.

An effective way to reach these customers is through continuous public information campaigns that stress the importance of reducing demand for the good of the community and the environment as well as for their own financial benefit. By continuously reminding single-family customers to conserve water, additional small reductions in per-household use could result in large cumulative savings. Such reminders are also needed to reduce risk that customers will become complacent with their water usage.

Interior conservation programming in the residential sector typically involves the replacement of inefficient fixtures with efficient ones. This is relatively straightforward and can result in permanent reductions since the program is technologically based and does not require a change in customer behavior. Important considerations for any mandatory or retrofit program are the state and national fixture-efficiency requirements and local plumbing codes requiring the use of efficient fixtures. As a result of these standards, water-efficient fixtures are installed in all new homes; over time the older housing stock will be retrofitted with the new efficient fixtures. Lastly, fixing leaks in residential plumbing, regardless of improvements in fixture efficiency, will remain one of the best demand management practices.

Exterior conservation programs are much more complicated than those for the interior because there are other variables that impact exterior demand. Where interior conservation is characterized as utilitarian, exterior water use is more commonly associated with quality of life issues and these are more difficult to address.

One of the most significant trends in the single-family exterior water use is the growing use of drip irrigation systems and the widespread adoption of low-water-use-landscapes. In a 1992 survey, Tucson Water noted that 27 percent of single-family customers had drip irrigation systems and approximately 50 percent of those were on timers. Ten years prior to this survey, relatively few homes had drip irrigation systems. A residential survey of homes that were constructed from 1992 to 1997 indicated that 83 percent had drip irrigation systems (Graft, 1997).

Another significant change in decreased exterior demand is that fewer evaporative coolers are being installed in new homes. In Tucson, nearly 96 percent of new homes have air conditioning and 85 percent have air conditioning only. In ADWR's 1992 survey, only 40 percent of the homes had air conditioning and only 19 percent had air conditioning only. New homes should annually use approximately 10,400 gallons of water less than the average home in 1992 based on this change alone.

Conservation Potential in the Multi-Family Residential Sector

Water use in the multi-family sector is a hybrid between the commercial/industrial and the residential sectors. Interior water use is essentially the same as in single-family residences while external water use patterns more closely resemble those observed in the commercial/industrial sector. However, there are some potential economies of scale in this sector not available in the single-family residential sector. Multi-family customers represent about 25 percent of all Tucson Water deliveries.

As a general rule, the interior conservation potential at most multi-family complexes is low. Interior use at multi-family sites is similar to those in single-family residences. The primary difference is the lack of clothes washing facilities in many units. Most large multi-family facilities do have on-site laundry facilities. These are potential sites where conversion to more efficient horizontal axis washers could be very cost-effective. Small complexes constructed prior to 1983 are expected to offer the greatest conservation potential due to aging laundry facilities.

The same issues discussed in the following commercial/industrial sector apply to the multi-family sector's exterior water-usage conservation potential. Landscape water-management education and training is considered the most effective method for improving overall efficiency of exterior water use in the multi-family sector.

Conservation Potential in the Commercial/Industrial Sector

Non-residential water use represents approximately 25 percent of total water deliveries in the Tucson Water service area. With the exception of a handful of large users, most commercial customers are low-volume water users. There is relatively little industrial process-water usage in the Tucson Water service area. Except for cooling towers, the types of water usage at most commercial facilities is similar to that observed in the residential sector but on a larger scale.

Targeting the commercial sector offers opportunities to make changes in water use with a relatively modest conservation program. A single commercial site can easily use as much water as 100 single-family homes. Rather than dealing with many individual homeowners, the non-residential and multiple-family residential sectors provide the possibility of working with property management companies who can make decisions that impact a large number of sites. Similarly, there are programmatic efficiencies when working with on-site managers or facility engineers who can influence all the water use at a single large site.

There has been a significant increase in the commercial use of reclaimed water throughout the service area. Fourteen of the eighteen golf courses located within the Tucson Water service area are using reclaimed water for outside watering. Of the four that still rely on ground water, one will convert to reclaimed water by the end of 2005, two rely on privately owned grandfathered water rights, and the fourth is located in an area where no alternative supplies are available. There are now 34 parks and 34 schools that have converted from ground water to reclaimed water for landscape irrigation. In 2003, nearly 13,000 acre-feet of reclaimed water was delivered throughout the Tucson Water service area.

Data collected in a local survey of 26 large cooling facilities in 1995 found that about 30 percent of the facilities' total water consumption was used for cooling (Black and Veatch, 1995). The institutional relationships between the chemical vendors/maintenance companies and the managers at commercial sites as well as aging systems tend to make change in this area difficult even though it can be demonstrated that significant water savings can occur. Commercial property owners do not need technical details of water chemistry and instrumentation to understand the cost-effectiveness of cooling tower management. However, for persons directly involved with day-to-day cooling tower operations, a series of seminars presented by knowledgeable professionals (such as water treatment vendors) could lead to improved efficiency. A financial incentive program may help promote water efficiency among cooling tower users.

Tucson Water's commercial conservation programming efforts have focused on education and training in an effort to raise the overall level of professionalism in the landscape industry and cooling tower managers. These efforts should lead to improvement in irrigation management and cooling tower operation. The summer surcharge that is part of the commercial/industrial rate structure also charges a premium for summertime exterior water use which should keep exterior demand from significantly increasing in the summer.

FUTURE DEMAND MANAGEMENT PLANNING

Total per capita water use in Tucson Water's service area has on average been predictable and stable for the last few decades. When local per capita residential water use is compared with other comparable southwestern urban communities, Tucson Water is at the lower end of the use spectrum. Tucson Water's average Total GPCD of 177 was used for projecting future demand in *Water Plan: 2000 – 2050*. With the present level of effort and expenditures, the Utility can reasonably assume the current trend in water usage will continue. If the current level of demand management programming is not maintained, water-use efficiency could decay and the per capita water usage demand could rise.

With a modest increase in effort and costs, there are opportunities for increased water-use efficiency and demand reduction. Some residential customers still have low-efficiency fixtures and would benefit from improved plumbing maintenance. The same can be said for multi-family customers. There also are opportunities for water savings in the commercial sector. Some commercial customers could benefit from converting cooling tower use to reclaimed water. Others have such high water usage that even a small improvement in efficiency might save significant amounts of water.

Many communities in the southwest have enacted ordinances for emergency water-use reduction. The City of Tucson has codified its own emergency response procedures in case of a water emergency. These measures are functional and necessary for emergency response but would not be effective in reducing water use in the longer term. Further water savings and increases in efficiency are matters for planning.

The present Total GPCD is the result of actions taken by both the Utility and its customers, through both mandatory and voluntary programs. The success of new or expanded demand management programs will also require the support of customers. The potential effectiveness

of more aggressive conservation programming as part of future demand management activities at Tucson Water will be evaluated to determine if GPCD can be further reduced in a cost-effective manner. The evaluation process will answer the following questions:

- Does the program address local demographics and historical water use?
- Will the program benefit all customer classes?
- What personnel resources will be needed for program implementation/maintenance?
- What are the rate consequences of the program?
- What processes are included for input/commitment from customers and stakeholders?
- Does the strategy strengthen and complement the Utility's water resource plan?

SUMMARY

For the past 30 years, Tucson Water's evolving water conservation program has proven to be an effective demand management tool for reducing overall water usage and creating a community conservation ethic. This ethic, along with an increasing use of reclaimed wastewater for irrigation and industrial purposes, has resulted in a steady reduction in per capita potable consumption and a consistent Total GPCD. Continued support for existing programming is necessary to maintain a stable Total GPCD in future years. Expansion of existing programs or implementation of new strategies may provide opportunities for further reduction to the Total GPCD figure, and should be evaluated as part of Tucson Water's long term water resource planning process.