

# Chapter 3

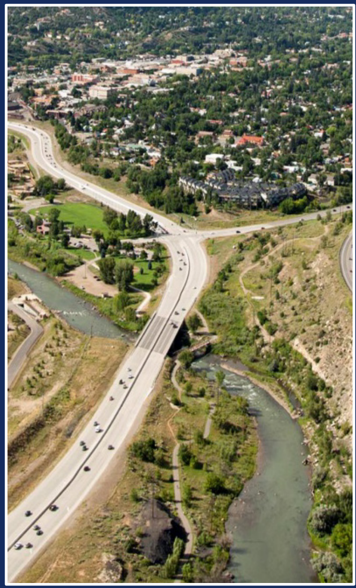
# Municipal and Industrial Water Conservation and Reuse

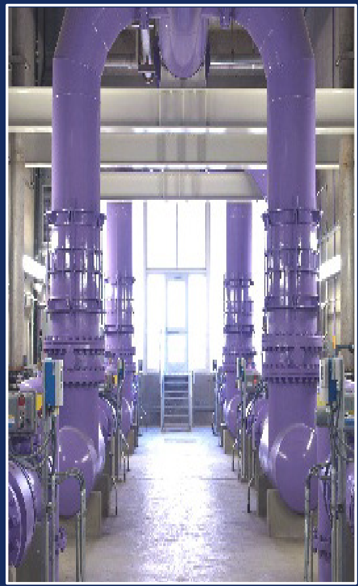
**This chapter is a product of the Municipal and Industrial Water Conservation and Reuse Workgroup**

**May 2015**

*Cover photo source: Central Arizona Project*

# 3 Municipal and Industrial Water Conservation and Reuse





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*3. Southern Nevada Water Authority*

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# Acronyms and Abbreviations

| | |
|---|---|
| °F | degree(s) Fahrenheit |
| ABCWUA | Albuquerque Bernalillo County Water Utility Authority |
| ADWR | Arizona Department of Water Resources |
| AF | acre-foot (feet) |
| AFY | acre-foot (feet) per year |
| AMA | Active Management Area |
| AMI | Advanced Metering Infrastructure |
| AWWA | American Water Works Association |
| Basin | Colorado River Basin |
| Basin States | Colorado River Basin States |
| Basin Study | Colorado River Basin Water Supply and Demand Study |
| BOPU | City of Cheyenne Board of Public Utilities |
| CAP | Central Arizona Project |
| CII | commercial, industrial, and institutional |
| CUP | Central Utah Project |
| CUPCA | Central Utah Project Completion Act |
| CUWCD | Central Utah Water Conservancy District |
| CVWD | Coachella Valley Water District |
| DOI | U.S. Department of the Interior |
| EPA | U.S. Environmental Protection Agency |
| GPCD | gallons per capita per day |
| GRUSP | Granite Reef Underground Storage Project |
| IID | Imperial Irrigation District |
| IRP | Integrated Water Resources Plan |
| JVWCD | Jordan Valley Water Conservancy District |
| KAF | thousand acre-feet |
| M&I | municipal and industrial |
| MAF | million acre-feet |
| MWD | The Metropolitan Water District of Southern California |
| MWDSLS | Metropolitan Water District of Salt Lake City and Sandy |
| NAUSP | New River-Agua Fria River Underground Storage Project |
| Reclamation | Bureau of Reclamation |
| SNWA | Southern Nevada Water Authority |
| SSI | self-supplied industrial |
| Workgroup | Municipal and Industrial Water Conservation and Reuse Workgroup |

**This chapter is a product of the Municipal and Industrial Water Conservation and Reuse Workgroup**

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# 3 Municipal and Industrial Water Conservation and Reuse

## 3.1 Introduction

Water conservation and reuse for municipal and industrial (M&I) purposes has long been recognized by Colorado River water managers and stakeholders as essential for adapting to and mitigating the impacts of current and future shortfalls between water supply and demand throughout the Colorado River Basin (Basin) and the adjacent areas that receive Colorado River water (Bureau of Reclamation [Reclamation], 2012a). Completed in 2012, the Colorado River Basin Water Supply and Demand Study (Basin Study) confirmed the importance of M&I conservation and reuse, but did so taking a broad-based Basin-wide approach. As a next step, the Basin Study recommended that a workgroup be established to identify current and potential future opportunities to improve water use efficiency and increase reuse in the M&I sector, but to do so by taking a more detailed and regional approach.

The M&I Water Conservation and Reuse Workgroup (Workgroup) was convened as part of the *Moving Forward* effort. This effort was initiated by Reclamation and the seven Colorado River Basin States[1] (Basin States) in collaboration with the Ten Tribes Partnership and conservation organizations.

The Workgroup is composed of leaders and experts in the M&I sector throughout the Basin and adjacent areas who represent a broad range of perspectives. The Workgroup strove to document trends in water conservation and reuse programs directed toward water use for M&I purposes, highlight innovative and successful programs and practices, identify opportunities to continue to build from such successes, and highlight and describe the important regional differences in M&I water conservation and reuse programs throughout the Basin and adjacent areas.

This chapter is a product of the Workgroup and documents their activities and findings during the approximately 18-month Phase 1 of the *Moving Forward* effort. The chapter provides information about the Workgroup's structure and specific Phase 1 objectives, background on M&I water use in the Basin and adjacent areas, past and planned future M&I water conservation and reuse programs and practices in metropolitan areas that receive Colorado River water, opportunities and challenges for expanding successful programs, and a suite of ideas that may be considered for potential future action.

## 3.2 Background on Municipal and Industrial Water Conservation and Reuse Considered in the Basin Study

The Basin Study evaluated several strategies to address future vulnerabilities associated with the projected water supply and demand imbalances. Common to all strategies was considerable M&I water conservation and reuse beyond current levels. The Basin Study assessed the potential for and costs of conservation and reuse at a Basin-wide level and found that, combined, M&I water conservation and reuse are cost-effective and have the potential to result in significant Colorado River water savings.[2]

Although this broad-based assessment was appropriate for the Basin Study, it did not reflect important local differences in water conservation potential or legal issues associated with the various state water rights policies. For example, in estimating the potential of M&I conservation to reduce Colorado River demand by 2060, M&I water conservation measures were considered for the entire Basin despite state and regional differences in current and potential levels of conservation. Likewise for water reuse, important regional distinctions were simplified. Further details regarding the analysis and assumptions related to M&I conservation and reuse are in the Basin Study, *Technical Report F* (Reclamation, 2012b).

[1] Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming

[2] The Basin Study estimated that beyond the M&I conservation and reuse included in the projections of future demand, these activities have the potential to result in approximately an additional 1.9 million acre-feet (MAF) of Colorado River water savings by 2060.

The Workgroup focused on highlighting local and regional efforts for M&I water conservation and reuse, describing past trends and future planned efforts, and identifying opportunities and challenges associated with expanding such efforts. While the Basin Study provided the impetus for the Workgroup formation, the objective of the Workgroup was not to confirm, verify, or revise the approach or assumptions used in the Basin Study.

## 3.3 Workgroup Objectives and Approach

The Workgroup's Phase 1 objectives were to document trends in M&I water conservation and reuse in areas that receive Colorado River water and to identify opportunities and challenges for expanding M&I water conservation and reuse programs to address projected future imbalances and to enhance the resiliency of the system.

The Workgroup identified six specific tasks for completing the Phase 1 objectives; these tasks are summarized in Table 3-1.

### 3.3.1 Workgroup Process and Approach

The Workgroup is composed of approximately 30 members representing a broad range of perspectives related to the M&I water sector. Workgroup members are representatives of water providers, conservation organizations, local municipalities, industries, state agencies, and federal agencies. Three Co-Chairs representing Denver Water, Arizona Municipal Water Users Association, and The Metropolitan Water District of Southern California (MWD) were selected to lead the Workgroup.

The Co-Chairs facilitated discussions and helped to define the Phase 1 tasks. The Workgroup was supported by resource personnel from Reclamation and the *Moving Forward* consulting team led by CH2M HILL. The Workgroup met periodically, either in person or by conference calls, between July 2013 and November 2014.

**TABLE 3-1**
Workgroup Task Summary

| Task Number | Task |
|---|---|
| 1 | Quantify water conservation and reuse savings to date |
| 2 | Compile information on successful water conservation and reuse programs |
| 3 | Provide information on projected future water conservation and reuse program savings |
| 4 | Investigate the impact of historical and future water savings on Colorado River use and demand |
| 5 | Identify opportunities and challenges for expanding successful M&I water conservation and reuse programs |
| 6 | Prepare Phase 1 Workgroup chapter |

A variety of methods to explore M&I water conservation and reuse was employed to maximize the Workgroup's input and obtain differing points of view. The following steps were included in the process:

1. Collect and analyze data
2. Select and develop case studies
3. Assess current and planned conservation and reuse programs
4. Identify opportunities and challenges

***Geographic Representation and Detail***

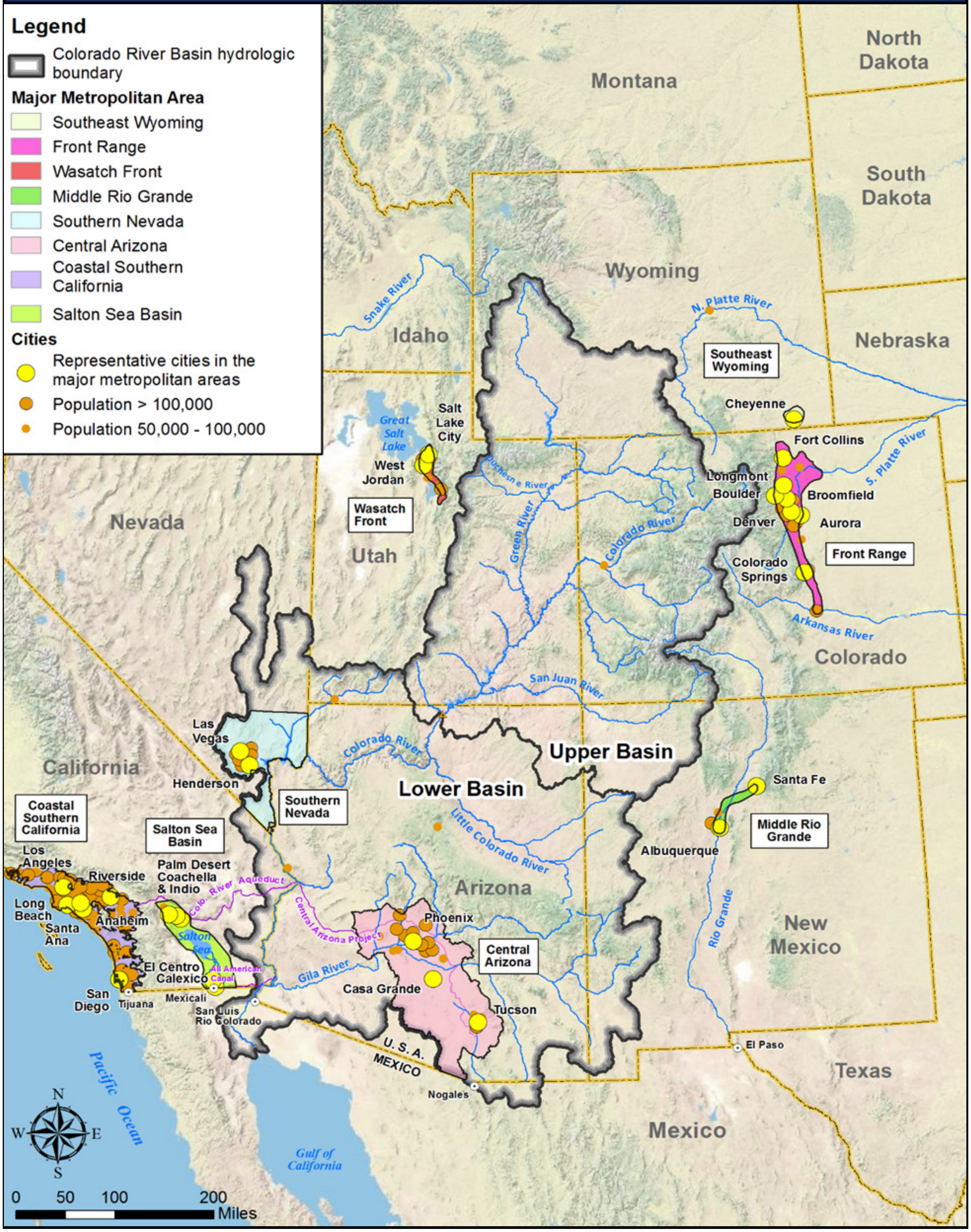
The Workgroup agreed to focus its efforts on major metropolitan areas in the U.S. with populations greater than 100,000 that receive Colorado River water. In addition, a metropolitan area was included for the state of Wyoming, even though the population was less than 100,000. The geographic areas included in this report refer to the major metropolitan areas within the hydrologic basin (such as Southern Nevada and Central Arizona) and also areas outside of the hydrologic basin where Colorado River water is used for M&I purposes (Front Range, Middle Rio Grande, Wasatch Front, Southeast Wyoming, Coastal Southern California, and Salton Sea Basin). The major metropolitan areas in the U.S. that receive Colorado River water and selected major cities within those areas are shown in Table 3-2; their locations are shown on Figure 3-1.

**TABLE 3-2**
Major Metropolitan Areas in the United States that Receive Colorado River Water

| Basin State | Major Metropolitan Area | Water Provider or Planning Area | Representative Major Cities | Population Served (2010) |
|---|---|---|---|---|
| Wyoming | Southeast Wyoming | City of Cheyenne Board of Public Utilities (BOPU) | Cheyenne | 72,000 |
| Colorado | Front Range | Denver Water | Denver | 1,310,000 |
| | | Colorado Springs Utilities | Colorado Springs | 445,700 |
| | | Aurora Water | Aurora | 325,100 |
| | | Fort Collins Utilities | Fort Collins | 129,000 |
| | | City of Boulder Public Works | Boulder | 109,600 |
| | | City of Longmont | Longmont | 87,500 |
| | | City and County of Broomfield Water Utility | Broomfield | 56,500 |
| Utah | Wasatch Front | Jordan Valley Water Conservancy District (JVWCD) | West Jordan | 585,400 |
| | | Metropolitan Water District of Salt Lake City and Sandy (MWDSLS) | Salt Lake City | 385,300 |
| New Mexico | Middle Rio Grande | Albuquerque Bernalillo County Water Utility Authority (ABCWUA) | Albuquerque | 606,800 |
| | | City of Santa Fe Water Division | Santa Fe | 79,200 |
| Nevada | Southern Nevada | Southern Nevada Water Authority (SNWA) | Las Vegas, Henderson | 1,956,900 |
| Arizona | Central Arizona | Phoenix Active Management Area (AMA) | Phoenix, Mesa, Chandler, Scottsdale, Gilbert, Glendale, Tempe, Peoria, Surprise | 3,701,600 |
| | | Tucson AMA | Tucson | 835,000 |
| | | Pinal AMA | Casa Grande | 100,600 |
| California | Coastal Southern California | The Metropolitan Water District of Southern California | Los Angeles, San Diego, Long Beach, Santa Ana, Anaheim, Riverside | 17,977,900 |
| | Salton Sea Basin | Coachella Valley Water District (CVWD) | Indio, Palm Desert, Coachella | 286,200 |
| | | Imperial Irrigation District (IID) | El Centro, Calexico | 177,600 |
| Total Population Served by Major Metropolitan Areas | | | | 29,228,600 |

Note:
Major metropolitan areas serve more than 85 percent of the population that receives Colorado River water.

**FIGURE 3-1**
Major Metropolitan Areas in the United States that Receive Colorado River Water




Note:
Similar to the Basin Study, the scope of the *Moving Forward* effort is limited to the portion of the Basin within the United States (U.S.).

Of the approximately 35 million[3] people in the U.S. that rely on Colorado River water for a portion of their water supply, more than 29 million, or more than 85 percent, are included in the major metropolitan areas represented in this report.

All of the major metropolitan areas are served by a mix of water sources that include Colorado River water, other surface water supplies, and groundwater supplies. Most major metropolitan areas (representing approximately 27 million people) that receive Colorado River water are located outside of the hydrologic basin or where water does not return directly to the mainstem Colorado River. Because multiple sources of supply are used to meet M&I demand in the major metropolitan areas, changes (growth or reductions) in this demand may not result in changes in the need for Colorado River water.

### *Data Collection and Analysis*

Historical M&I water use, conservation, and reuse information was solicited from the large water providers within the major metropolitan areas. For this report, information was collected from 18 water agencies and planning areas. This information was summarized into eight major metropolitan areas. The data sources and periods of data availability are summarized in Appendix 3A.

M&I water use, conservation, and reuse information was requested for the period from 1980 through 2010. However, it was acknowledged that most water providers do not have complete or accessible records of M&I water use, conservation and reuse programs throughout this period, and that data gaps exist. Also, because water supply and water use information is managed by different entities, which range from multiple local water providers to state planning agencies, the presentation of water use and program information at the appropriate geographic scale can be challenging. Additionally, water use data measurement, tracking, and accounting varies significantly between water providers, further complicating analysis. There are no consistent accounting categories or definitions for water use categories; therefore, the information provided in this report is appropriate for presenting general trends in M&I water conservation and reuse practices and provides a baseline for consideration of future programs and for evaluating water demand reductions and conservation achievements over time. These data are not appropriate for comparisons between water providers and regions, and regional reports may present information in a different manner.

The historical M&I water use data were organized into five M&I water use categories: (1) residential; (2) commercial, industrial, and institutional (CII), (3) irrigation only; (4) losses and other non-categorized use; and (5) self-supplied industrial (SSI). Descriptions of these categories are presented in Table 3-3. Other important terminology used in this report is shown in the following text box. Residential and CII uses were generally categorized consistently among the water providers. However, information related to irrigation only, losses and other non-categorized use, and SSI water use categories was not provided by all water providers. Many municipal water providers do not account separately for water supplied for irrigation only. SSI water use is independent of municipal water supply systems and represents a small but potentially locally significant water use. Most of the SSI water use in the areas that receive Colorado River water is associated with cooling water supply for power plants, but also includes other uses for industries such as mining, dairy, and cattle feedlot operations.

The gross per capita water use was computed for each major metropolitan area to examine trends in use over time. The per capita use was calculated as the sum of all M&I water use in a metropolitan area, excluding SSI use, divided by the total service area population. Trends in per capita use are described by using 5-year averaging periods around 1990 (1988-1992), 2000 (1998-2002), and 2010 (2008-2012) to account for single-year variability in weather, economy, and behavior that influences short-term water use but may not be reflective of longer-term trends. Additional data were compiled on population, climate, and demographics (characteristics of the population) to assess the principal drivers of M&I water demand. This information was used to present an overview of M&I water use and trends in major metropolitan areas that receive Colorado River water.

[3] Estimate based on the 2010 Census population data from cities within planning areas, as defined in the Basin Study, that receive Colorado River water. See Basin Study, *Technical Report C* for more information on the planning areas (Reclamation, 2012c).

**TABLE 3-3**
Water Use Categories

| Category | Description |
|---|---|
| Residential | Includes residential indoor and outdoor water uses by single-family, multi-family, and other dwelling units. |
| CII | Includes all CII uses such as industry, manufacturing, universities, hospitals, military facilities, fire protection, and other public institutions. |
| Irrigation Only | Includes designated uses for agriculture, parks, golf courses, or other landscaping irrigation. Residential and CII irrigation are captured in Residential and CII categories. |
| Losses and Other Non-Categorized Use | Includes water lost in the transmission and distribution portions of municipal water systems or due to inaccurate metering. Also includes water use that does not fit into the other categories, such as water used in exchanges. |
| SSI | Includes SSI water uses that are independent of the supply provided by municipal water systems. May include water use for cooling, mining, snow making, oil and gas extraction, or other industries. |

## *M&I Water Conservation and Reuse Terminology*

The terminology associated with M&I water use, water conservation, and water reuse varies considerably in the literature and throughout the M&I water providers that receive Colorado River water. In this report, the following definitions are used:

**Water use:** Uses for all M&I purposes including residential, commercial, institutional, industrial, municipal system irrigation, municipal system losses, and other non-categorized uses.

**Per capita use:** A measure of the per capita water use to evaluate trends over time. Calculated as the sum of all M&I water uses in the metropolitan area, except SSI uses, divided by the total area population. Reported as gallons per capita per day (GPCD).

**Water conservation:** Programs and practices that provide for sustained reductions in water use, loss, or waste.

**Reclaimed water:** Municipal wastewater that has been treated to meet specific water quality criteria with the intent of being used for beneficial purposes. The term "recycled water" is synonymous with reclaimed water.

**Water reuse:** The use of treated wastewater (reclaimed water) for a beneficial purpose. Synonymous with the term "wastewater reuse".

**Potable reuse:** Augmentation of drinking water supply with reclaimed water through indirect or direct methods.

**Non-potable reuse:** Reuse of reclaimed water for non-potable uses such as industrial, irrigation, or agricultural uses.

The Workgroup members also provided information on current and future water reuse programs. Water reuse is the use of treated wastewater or reclaimed water for beneficial purposes such as for M&I water supply, agricultural water supply, or for environmental uses. Reuse programs were organized into two groups, depending on the intended end use: non-potable reuse or potable reuse. The amounts and types of reuse occurring in the major metropolitan areas were estimated based on this information.

### *Selection and Development of Innovative Water Saving Case Studies*

Information on innovative or particularly successful M&I water conservation and reuse programs and practices was compiled based on responses to a Workgroup questionnaire. Based on the questionnaire responses, individual programs were selected as examples of innovative or successful water conservation and reuse programs and also to reflect the breadth of programs implemented across the major metropolitan areas that receive Colorado River water. The intent was not to collect information on all conservation and reuse activities, but rather to solicit information about efforts that providers deemed innovative or particularly effective for their service area. In addition to questionnaire responses, information was also solicited from Workgroup members related to water conservation and reuse programs through a data collection template. Combined with the cases studies, more than 400 programs were identified from the data collection process.

***Assessment of Current and Planned Conservation and Reuse Programs***

Water resources plans from the water providers that receive Colorado River water were reviewed to identify current and planned water conservation and reuse practices being considered as part of their water management strategies. Based on this review, the Workgroup estimated the potential future water savings from these practices.

***Identification of Opportunities and Challenges***

The Workgroup identified and documented opportunities and challenges associated with the expansion or implementation of new water conservation efforts throughout the major metropolitan areas that receive Colorado River water. For each opportunity, the Workgroup identified ideas for potential future action.

## 3.4 Municipal and Industrial Water Use in Areas that Receive Colorado River Water

### 3.4.1 Overview

Between 35 and 40 million people[4] in the U.S. currently rely on the Colorado River and its tributaries to provide some, if not all, of their M&I water needs. The cities and communities in the major metropolitan areas are some of the nation's most vibrant communities and robust economies. The combined gross state product (consistent with gross domestic product) of the Basin States represents approximately 20 percent of the total U.S. gross domestic product (U.S. Bureau of Economic Analysis, 2014)[5]. Much of the economic output and employment (more than 20 million employees) is spurred by the M&I sectors (U.S. Department of Labor, 2014).

Residential water use, which includes outdoor water use, accounts for the largest percentage of the overall M&I water use, ranging from 55 percent to almost 80 percent across the major metropolitan areas reviewed. Outdoor water use varies greatly depending upon geographic location. In dry climates such as the Southwest, average household outdoor water use can be as high as 60 percent (U.S. Environmental Protection Agency [EPA], 2014). In some areas with large institutional and industrial users, the CII sector can account for up to 30 to 40 percent of the total M&I water use. Educational complexes (such as schools and universities) and government complexes (such as research and data management centers) represent a significant portion of the CII use in the Basin. Cities such as Las Vegas and Phoenix feature a large number of resorts, golf courses, and transient populations, which influence M&I water use.

Many factors affect M&I water use, including population, climate, demographics, and the extent of the provider's water conservation programs. The sections below describe these key factors and their trends.

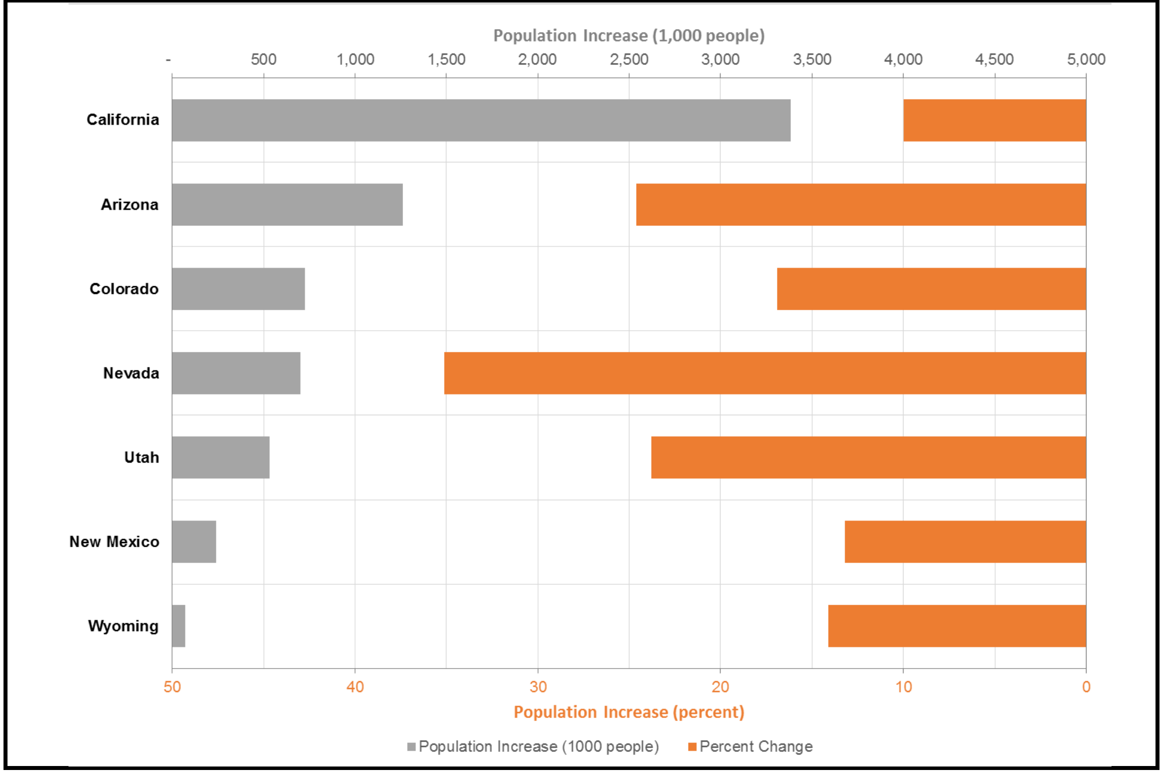
Population is one of the principal drivers influencing M&I water use. The Basin States include some of the nation's fastest-growing urban and industrial areas, and communities and economies of cities such as Albuquerque, Denver, Las Vegas, Los Angeles, Phoenix, Salt Lake City, and San Diego are in part dependent on Colorado River water. Changes in population for each of the Basin States from 2000 to 2010 (U.S. Census Bureau, 2011) are shown on Figure 3-2. California ranks second among all states in the country for populations increases, while Arizona, Nevada, Utah, and Colorado are among the top 10 states for population growth rates (U.S. Census Bureau, 2011).The Basin Study projected the total population in areas that receive Colorado River water could range from 49 to 77 million corresponding to a 23 and 91 percent increase by 2060 (Reclamation, 2012b).

Climate varies significantly across the major metropolitan areas and has a strong influence on water demand. A summary of climate in representative cities that receive Colorado River water is shown on Figure 3-3. The figure shows monthly temperature, precipitation, and potential evapotranspiration for selected climate stations near representative cities for each major metropolitan area.

[4] The Basin Study estimated 40 million people by 2015 in the portion of the Basin and the adjacent areas that receive Colorado River water in the U.S. See Basin Study, *Technical Report C* for additional detail (Reclamation, 2012c). Estimate of 35 million people is based on the 2010 population data from the U.S. Census Bureau for cities within planning areas, as defined in the Basin Study, that receive Colorado River water.

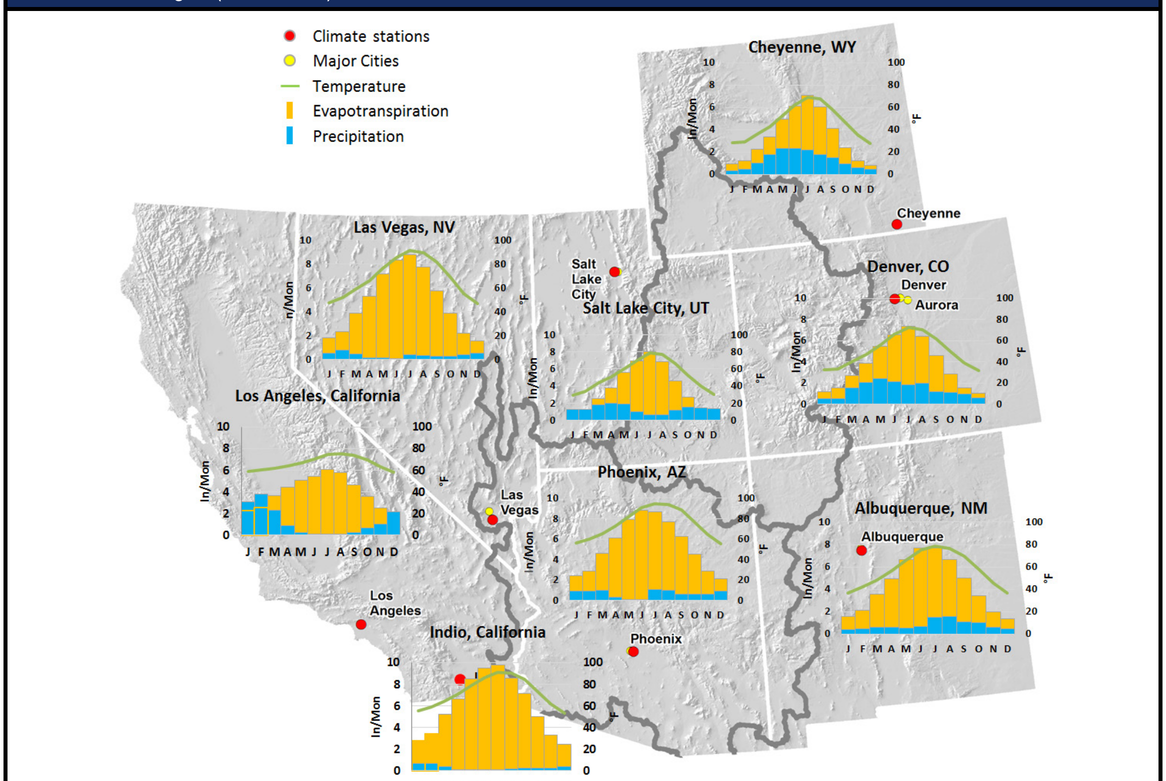
[5] Estimates of gross state product are for entire state and not separately evaluated for the specific areas within each state that receive Colorado River water.

**FIGURE 3-2**
Population Change in the Basin States between 2000 and 2010




*Source: U.S. Census Bureau, 2011*

**FIGURE 3-3**
Climate Averages (1981-2010) for Selected Cities in Areas that Receive Colorado River Water



The mean annual climate for stations in selected representative cities is shown in Table 3-4. Mean annual precipitation ranges from approximately 17 inches in Denver to approximately 4 inches in Las Vegas. Summer temperatures can regularly exceed 100 degrees Fahrenheit (°F) in Phoenix, Las Vegas, and Indio. Potential evapotranspiration, the main driver influencing outdoor water demand, ranges from less than 45 inches in Cheyenne and Salt Lake City to over 70 inches in Phoenix and Las Vegas. As a result of climate conditions, landscape watering needs can be relatively high in many municipal areas, but particularly so in the desert areas. Even landscaping designed for arid and semiarid climates may require supplemental irrigation. The Basin Study reported that outdoor irrigation demands were projected to increase by approximately 3 to 4 percent per degree Celsius of climate warming (Reclamation, 2012b).

**TABLE 3-4**
1981-2010 Average Annual Precipitation, Temperature, and Potential Evapotranspiration for Selected Stations in the Proximity of Selected Cities

| Basin State | Representative City | Average Annual Precipitation (inches) | Average Annual Temperature and Range (Jan., July) (°F) | Average Annual Potential Evapotranspiration (inches) | Potential Evapotranspiration Minus Precipitation (inches) |
|---|---|---|---|---|---|
| WY | Cheyenne | 16 | 46 (29, 69) | 40 | 25 |
| CO | Denver | 17 | 50 (33, 73) | 45 | 28 |
| UT | Salt Lake City/West Jordan | 16 | 53 (30, 79) | 45 | 29 |
| NM | Albuquerque | 9 | 57 (37, 79) | 53 | 43 |
| NV | Las Vegas | 4 | 68 (48, 92) | 90 | 86 |
| AZ | Phoenix | 8 | 75 (57, 95) | 77 | 69 |
| CA | Los Angeles | 15 | 67 (59, 74) | 48 | 34 |
| CA | Indio | 3 | 72 (55, 91) | 68 | 65 |

*Source: Annual values estimated from monthly observations of precipitation, mean average temperature, and reference evapotranspiration downloaded from Utah Climate Center at the Utah State University (2014). These data are from the National Weather Service cooperative network of weather observation stations and Global Historical Climatology Network. The selected stations are Wyoming (USW00024018), Colorado (USC00054762), Utah (USW00024127), New Mexico (USW00023050), Nevada (USW00023169), Arizona (USC00024829), and California (USW00093134). Reference evapotranspiration is from the Utah Climate Center except for Las Vegas, which is from International Water Management Institute World Water and Climate Atlas database, and Arizona, which is from the Arizona Meteorological Network.*

Demographic characteristics that influence M&I demand are socioeconomic factors such as housing densities, types and age of housing, and economic characteristics (such as income, employment, and main industries). In the major metropolitan areas, these factors vary considerably, and even within individual communities important differences can be found. The following are some important socioeconomic factors and differences that can be identified from U.S. Census Bureau information[6].

- Housing units in the Basin States represent approximately 17 percent of the total in the entire U.S (U.S. Census Bureau, 2013a).
- High population and housing unit densities exist in the Coastal Southern California, Front Range, and Southern Nevada metropolitan areas, with the lowest densities in Wyoming (U.S. Census Bureau, 2013a).
- Single-family homes are the dominant housing stock in the metropolitan areas and exceed 70 percent of the total housing units in Utah, Wyoming, and Colorado (U.S. Census Bureau, 2014).
- The percentage of multi-family units is higher than the national average in California and Nevada (more than 30 percent of the total housing stock) and relatively low in New Mexico (only 15 percent of the total housing stock and lower than the percent of mobile homes) (U.S. Census Bureau, 2014).

[6] Information is for an entire state and not separately evaluated for the specific areas within each state that receive Colorado River water unless otherwise specified.

- The percentage of renter-occupied housing units varies throughout the metropolitan areas. In California and Nevada, more than 40 percent of the occupied houses are being rented, while in other metropolitan areas the number of renter-occupied units is about 30 percent, below the national average of 35 percent (U.S. Census Bureau, 2014).
- Household economic characteristics also vary across the Basin States; median household income ranges from $44,900 in New Mexico to $61,400 in California. In addition, within each state are significant income distribution variations (U.S. Census Bureau, 2014). For example, in New Mexico an estimated 16 percent of households had annual incomes below $15,000 and 6 percent had annual income above $150,000 (U.S. Census Bureau, 2014).
- The average single-family home size in Denver is approximately 2,100 square feet (U.S. Census Bureau, 2013b), while the average single-family home size in San Diego is approximately 1,700 square feet, just below the national average (U.S. Census Bureau, 2013c).

Research shows that these types of factors influence M&I water use, primarily in the residential sector. For example, higher housing densities and multi-family housing units tend to correspond with lower per capita residential water demands due to the relatively small amount of outdoor landscaping as compared to single-family units. Conversely, older homes and renter-occupied houses tend to have a higher per capita water demand than newer, homeowner-occupied homes. Larger residential properties with horses or other livestock also have a higher per capita use. Higher-income homes tend to have more updated indoor water-efficient fixtures than lower-income homes, but also tend to have higher outdoor water uses due to greater application of automated irrigation controllers and larger landscaped areas.

### 3.4.2 Municipal and Industrial Water Use and Trends for Major Metropolitan Areas

The M&I water use for each major metropolitan area is described in the following sections to provide an understanding of the unique regional characteristics related to water management, water use, and historical water use trends. The general characteristics of each major metropolitan area are described, and summaries of the water management and water infrastructure in the region are provided. Factors such as climate and demographics that influence water demand in these areas are also described. The categories of water use in the major metropolitan area and their relative contribution to total water use are identified, and historical and ongoing efforts related to water conservation and reuse are summarized. Finally, historical trends in population and per capita water use are presented to examine gross trends over time.

#### *3.4.2.1 Southeast Wyoming*

The Southeast Wyoming major metropolitan area is represented by the service area of the City of Cheyenne Board of Public Utilities (BOPU). The BOPU supplies water to approximately 72,000 customers and is located in Laramie County, which includes the City of Cheyenne and extends to the Colorado border.

The principal water source for the City of Cheyenne has historically been surface water from multiple watersheds, which has provided on average 70 percent of total demand. The surface water comes from mountain streams in the Medicine Bow and Laramie Mountain Ranges through a trans-basin trade system, known as Stage I/II, which moves water from one side of a mountain to another, trades water across a valley, and then pipes water across two mountain ranges to Cheyenne. The City of Cheyenne diverts, on average, 10,664 acre-feet (AF) of water annually from the Little Snake River Basin to replace out-of-priority diversions of North Platte River Basin water used within Cheyenne. Groundwater has been used as a supplemental source for water quality blending and as an important way to meet peak summer demands. As the water demands increase, groundwater will become an even more important source of supply.

Hog Park Reservoir Outlet, web camera image from October 29, 2014
*Source: City of Cheyenne Board of Public Utilities*

The climate in this metropolitan area is relatively cool because of Wyoming's northerly latitude and the state's high average elevation. Winters are cold and moderately long, with January average temperature below 30°F. Summers are generally warm, with a July average temperature of 69°F and a high diurnal temperature range. Average annual precipitation in Cheyenne is about 16 inches.

BOPU has the authority for implementation and enforcement of specific water conservation programs based on the BOPU Resolution No. 2004-03, City of Cheyenne Resolution No. 4564, water supply status and conservation level declaration, and annual fine and fee ordinances approved by the Board and City Council (BOPU, 2011). Wasting water is prohibited and can result in a warning or fine. Conservation programs include restrictions on watering, water budgets for watering large community areas, increasing tiered rate structures, rebate programs and incentives, and commercial and industrial best management practices among others. An annual conservation goal is identified based on a forecast impact on reservoir levels during May. During normal years, the conservation goal ranges from 5 to 10 percent and during severe and extreme conditions can range from 30 to 60 percent.

In 2007, the BOPU began producing Class "A" reuse water or "recycled water" as it is called in Cheyenne. The reuse water replaces drinking water resources to irrigate parks, athletic fields and green spaces in Cheyenne. The system produces approximately 550 acre-feet per year (AFY), saving an equivalent amount of drinking water resources (BOPU, 2013).

Water use data availability for Southeast Wyoming for this report was limited. However, based on information included in Cheyenne BOPU's 2013 Master Plan (BOPU, 2013), annual potable water use for the 2010 period (2008-2012 average) was approximately 14,200 AF and served nearly 72,000 customers within the service area. The estimated per capita water use for this period is approximately 207 GPCD.

#### *3.4.2.2 Front Range*

The Front Range metropolitan area includes the following Colorado cities: Denver, Colorado Springs, Aurora, Fort Collins, and Boulder, and the smaller cities of Longmont and Broomfield. Several other cities in the Front Range metropolitan area use Colorado River water, but they did not provide water use information so were not included in the analyses for this report. The population served by participating cities in this area is approximately 2.4 million. The two largest water service providers are Denver Water and Colorado Springs Utilities. Denver Water serves more than 1.3 million people in Denver and its surrounding suburbs. The majority of Denver's water comes from rivers and streams fed by mountain snowmelt. The South Platte River, Blue River, Williams Fork River, and Fraser River watersheds are Denver Water's primary water sources, but Denver Water also uses water from the South Boulder Creek, Ralston Creek, and Bear Creek watersheds. The Blue, Williams Fork, and Fraser Rivers are tributaries to the Colorado River. Approximately half of Denver's supply comes from the Basin imports. Colorado Springs Utilities serves nearly 450,000 people with water from local and non-local surface water systems. The local system includes the south and north slopes of Pikes Peak, the Northfield System, the South Suburban System, and the Monument Creek diversions. The non-local systems are complex projects that include mountain water collection systems, pump stations, and terminal storage infrastructure. These systems include projects such as the Homestake Project, Twin Lakes, The Continental-Hoosier system, and the Fry-Ark project, all of which bring water from the other side of the Continental Divide, and the Colorado Canal, Lake Henry, and Lake Meredith Systems which provide native Arkansas River water.

The Front Range climate has four distinct seasons. The weather is subject to sudden changes due to its location along the Front Range of the Colorado Rockies. Average annual precipitation is about 17 inches in Denver, but can range from about 14 inches in Longmont to about 21 inches in Boulder. Precipitation occurs throughout the year, but is higher from March through June. Summers range from mild to hot with occasional afternoon thunderstorms and high temperatures regularly exceeding 90°F in July in Denver. Winters range from mild to occasionally bitter cold, with periods of snow and low temperatures alternating with periods of mild weather, the result of Chinook winds.

There are a variety of water uses in the Front Range metropolitan area. In the Denver Water service area, residential water use accounts for nearly 80 percent of the total use, while CII water use accounts for less than 15 percent. Conversely, in the Colorado Springs Utilities service area, CII water use accounts for almost

40 percent of total deliveries due to the classification of multi-family customers as CII, the presence of five military bases with more than 40,000 military personnel and their families, and the delivery of water to high-tech manufacturing.

In the Front Range area, emphasis on water conservation education programs has contributed to reductions in residential per capita use. A culture of conservation in Denver dates back to 1936 when Denver Water advertised on street trolleys asking customers to help save water. Each summer, Denver Water hires temporary workers known as Water Savers to educate thousands of customers about water waste and enforce summer watering rules. From 2007 to 2010, Denver Water invested $5.13 million in conservation outreach (Denver Water, 2011). During this same period, Denver Water reported issuing nearly 58,000 washing machine and toilet rebates for residential customers, which represented an investment of $7.8 million (Denver Water, 2011). From 2005 to 2007, Colorado Springs Utilities went through the rigorous process of identifying and selecting water conservation programs for implementation as part of its 2008-2012 Water Conservation Plan. Final programs were selected based on water savings, cost-effectiveness, social acceptance, likelihood of success, and business and system impacts. The five higher ranked programs were associated with residential block rates, commercial seasonal rates, commercial landscape codes and policy, conservation education, and water waste ordinances (Colorado Springs Utilities, 2008). The City of Fort Collins Utilities includes as part of its conservation program reduction of indoor demand through improved technology, leak reduction, and behavior change and reduction of outdoor demand through improved irrigation efficiency and landscape transformation (City of Fort Collins Utilities, 2009).

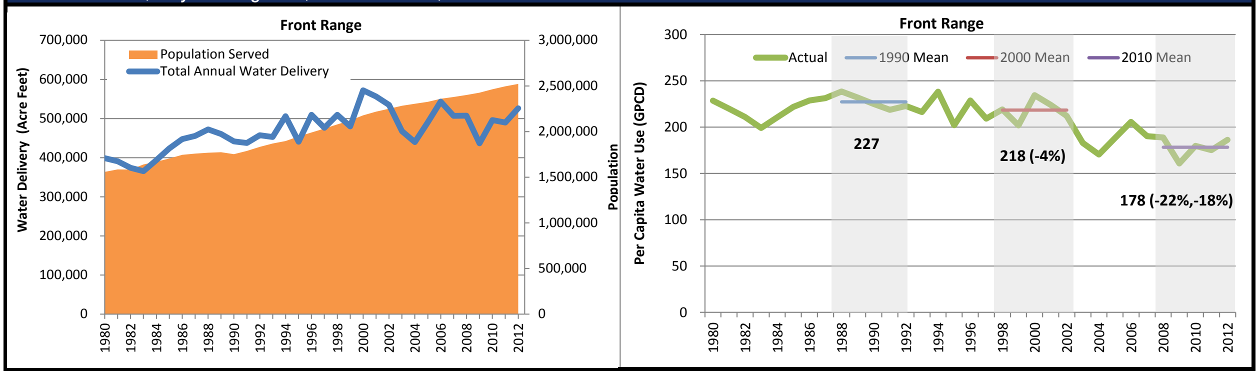
Dillon Reservoir
*Source: Denver Water*

Water reuse has been practiced for decades in the Front Range metropolitan area. In 1961, Colorado Springs built a reuse system and began delivering treated wastewater to parks, cemeteries, golf courses, and commercial properties for turf grass irrigation (Colorado Springs Utilities, 2008). Front Range providers also reuse their reusable effluent indirectly through exchanges or re-diversion, utilizing projects such as Colorado Springs Southern Delivery System project and Aurora's Prairie Waters Project. Denver Water also implements wastewater reuse through exchanges with downstream agricultural users for surface water rights.

The Front Range uses a complex network of water systems to help maximize the use and reuse of available supplies. Depending on the situation, municipalities reuse water through river exchanges and through non-potable and potable recycling systems. Except during periods of high river flows, most of the municipal wastewater from Front Range cities is used as water supplies for the large farming areas located downstream on the eastern plains of Colorado. Water rights decrees and various operating requirements determine whether a city can reuse its wastewater or whether the wastewater belongs to downstream users. For instance, water rights decrees prevent Denver Water from reusing most of its local South Platte supplies, and a water rights settlement agreement limits the reuse of a portion of Denver's Colorado River supplies. The cities that receive Colorado River water from the Colorado-Big Thompson project, including Fort Collins and Boulder, cannot reuse water from the project, thereby making it available for downstream agricultural users. Reuse of lawn irrigation return flows is also controlled by water rights decrees.

The historical population, total M&I water use, and gross per capita water use for the Front Range metropolitan area are shown on Figure 3-4. This metropolitan area has added nearly 1 million people to the municipal water service population since 1980, an increase of approximately 60 percent. Over the same period, total annual water use increased by about 26 percent. Per capita water use rates have decreased by approximately 22 percent since 1990 (1988-1992 average) and by approximately 18 percent since 2000 (2008-2012 average). The most recent annual average (2008-2012 average) per capita use was estimated at 178 GPCD.

**FIGURE 3-4**
Water Delivery, Population, and Per Capita Water Use Trends in the Front Range Metropolitan Area
*Includes aggregated service areas of Colorado Spring Utilities, Aurora Water, City and County of Broomfield Water Utility, City of Boulder Public Works, City of Longmont, Denver Water, and Fort Collins Utilities*




### *3.4.2.3 Wasatch Front*

The Wasatch Front metropolitan area includes the service areas of the Jordan Valley Water Conservancy District (JVWCD) and the Metropolitan Water District of Salt Lake City and Sandy (MWDSLS) near the Great Salt Lake, Utah.

The JVWCD, created in 1951 under the Water Conservancy Act, is a political subdivision of the State of Utah and one of the largest water districts in the state. It is primarily a wholesaler of water to cities and improvement districts within Salt Lake County. JVWCD has a retail service area primarily in unincorporated areas of the county, making up about 10 percent of its deliveries; approximately 90 percent of its municipal water is delivered on a wholesale basis to cities and water improvement districts in the Wasatch Front area such as the city of West Jordan and Granger-Hunter Improvement District in West Valley City.

In addition, JVWCD treats and delivers water to the MWDSLS on a contractual basis for delivery to Salt Lake City and Sandy City, even though neither city is within JVWCD's service boundaries. JVWCD also delivers untreated water to irrigators in Salt Lake and Utah Counties to meet commitments under irrigation exchanges.

Water sources for JVWCD are mainly derived from the Provo River through the Central Utah Project (CUP), Provo River Project, and irrigation exchanges. Other surface water sources are direct flow supply from mountain streams. Approximately 20 percent of JVWCD's supply is groundwater from wells scattered throughout the Salt Lake Valley. Low-quality groundwater, which is approximately 7 percent of the total supply, is treated with reverse osmosis as part of a groundwater cleanup project. In addition to potable water deliveries by JVWCD, many of the member agencies have their own water sources, which represent about 44 percent of the total water deliveries in the district service area, including secondary (untreated) water.

The CUP currently provides more than one half of JVWCD's annual water supply. While this water is physically diverted from the Provo River System, it is the CUP and its facilities that make this diversion possible. Under the CUP, water is captured and stored by CUP facilities on the eastern slopes of the Uinta Mountains, within the Colorado River Basin. The water is then stored and conveyed through a series of reservoirs, tunnels, and pipelines to the Wasatch Front. This is water that would have naturally reached the Colorado River, but through the CUP, provides a significant source of supply through exchanges on the Provo River System. JVWCD's current CUP supply is 50,000 AFY, but will grow to more than 70,000 AFY in the future.

Jordanelle Reservoir
*Source: Jordan Valley Water Conservancy District*

The Salt Lake Valley receives approximately 16 inches of precipitation annually, mostly during late fall/early winter and in spring, while early summer is the driest season. During winter, temperature inversions are a common problem. The inversion traps pollutants, moisture, and cold temperatures in the valley while the surrounding mountains experience warm temperatures and sunshine. Average summer temperatures in West Jordan range from 67°F to 90°F (average low and high during July), and average winter temperatures range from 22°F to 37°F (average low and high during January).

The average household size is high in this area, while population and housing unit densities are low. Also in this area, the number of homes built after 2000 is significant, and represents almost 30 percent of the total housing stock.

Based on water use data in 2010, residential water use accounted for 71 percent of the total water delivered by JVWCD. The combined total of CII (12 percent) and Irrigation Only (12 percent) use categories account for 24 percent of the total annual water use.

Several of JVWCD's member agencies own and operate their own secondary irrigation water systems. Water used in secondary systems is derived through agricultural conversions and is of low quality and high hardness and total dissolved solids concentrations. These systems are used to deliver non-treated secondary water for residential and CII irrigation use. Currently, most secondary water delivered in JVWCD's service area is unmetered, which significantly increases per capita water use.

Since 1999, JVWCD has aggressively implemented water conservation programs and has updated its Water Conservation Plan every 5 years. Since 2001, the JVWCD has spent nearly $19 million in conservation programs including conservation personnel and demonstration garden maintenance (JVWCD, 2014).

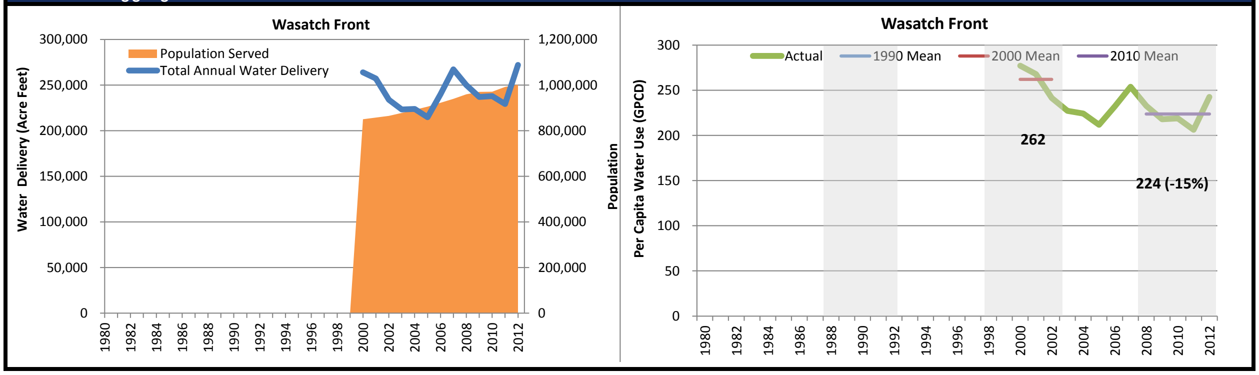
A Member Agency Assistance Program allows JVWCD's member agencies to apply for funding in the form of grants for conservation-related projects.

Examples of JVWCD conservation programs include a public education and media campaign named Slow the Flow, Save H2O, a 7.5-acre conservation garden and education center, free water audit program, and a high-flush toilet replacement program. JVWCD is currently investing in advanced metering infrastructure for its retail service area. In addition to specific programs, JVWCD has implemented a wholesale water conservation rate structure and developed model water efficiency landscape ordinances to encourage and promote proper design, installation, and maintenance of water-wise landscapes.

Under CUP repayment and water sales contracts, the Central Utah Water Conservancy District (CUWCD) has significant future water reuse requirements. As such, plans are now underway to begin building projects involving reuse of the CUP supply in JVWCD's service area. In addition, plans are underway to begin metering secondary irrigation deliveries over the next 5 years.

The historical population, total M&I water use, and the gross per capita water use for the Wasatch Front are shown on Figure 3-5. The metropolitan area has increased population significantly since 1999, adding more than 150,000 to the municipal water service area population. Drought in 2003 and above normal precipitation in 2010 clearly had an effect on water use patterns, showing a drop in water delivered during those years. The unusually hot, dry summers of 2007 and 2012 also contributed to increased per capita water use. On average, per capita water use rates have decreased by approximately 15 percent since 2000 (1999-2002 average), and the current annual average (2008-2012 average) per capita use was estimated at 224 GPCD.

**FIGURE 3-5**
Water Delivery, Population, and Per Capita Water Use Trends in the Wasatch Front Metropolitan Area
*Includes aggregated service areas of JVWCD and MWDSLS*




Note:
The 2000 mean represents the average period from 2000 to 2002.

### 3.4.2.4 Middle Rio Grande

The Middle Rio Grande metropolitan area includes the service areas of two major utilities that receive Colorado River water: the Albuquerque Bernalillo County Water Utility Authority (ABCWUA) and the City of Santa Fe Water Division. Both receive Colorado River water through the San Juan-Chama Project, which conveys water diverted in Colorado from tributaries of the San Juan River to the Chama River, a tributary of the Rio Grande. The ABCWUA, the largest water utility in New Mexico, provides water to the greater Albuquerque metropolitan area, while the City of Santa Fe Water Division serves the greater Santa Fe area. The total population served by these utilities is about 700,000.

The ABCWUA currently (2012) supplies about 106,000 AFY from surface water (the San Juan-Chama project), local groundwater, and reuse. In the mid-1990s, the ABCWUA embarked on development and implementation of a comprehensive water resource management strategy. This strategy resulted in an extensive conservation program and a gradual transition from groundwater as their sole source of supply to today's more diverse portfolio. The ABCWUA began diverting non-potable surface water for irrigation and industrial supply in the early 2000s and began direct diversion and treatment of San Juan-Chama water in 2008. Non-potable reuse was recently added, and an aquifer storage and recovery program is being piloted.

The City of Santa Fe Water Division produces about 10,000 AFY from the Santa Fe River, the City wellfield, the Buckman wellfield, and the Rio Grande (San Juan-Chama project). The City of Santa Fe Water Division also uses reclaimed wastewater and water conservation to reduce the total demand for potable water (City of Santa Fe, 2013). The percentage of water from any one source changes from month to month and year to year depending on a number of factors including availability, status of infrastructure, water rights, turbidity in the Rio Grande, customer use, and engineering improvements.

The Middle Rio Grande metropolitanrea has a semiarid climate; average annual temperature is 57°F, ranging from an average of 36°F in January to 79°F in July. Peak water use on a hot summer day is about twice the use of an average winter day. Annual precipitation in Albuquerque is approximately 9 inches per year and tends to fall mostly in the late summer and early fall during the monsoon season. Precipitation events vary widely across the service area, with the foothills generally receiving twice as much as areas on the west side of the river. Santa Fe receives an average of 14 inches of rainfall annually. Droughts lasting several years are not unusual.

The major water use in the Middle Rio Grande metropolitan area is for residential customers. The recent 5-year annual average (2008-2012) period indicates that the residential water use accounts for about 70 percent of the total water delivered by the Rio Grande area's water suppliers. About two thirds of the population live in single-family residences and one third live in multi-family homes (ABCWUA, 2013). The CII water use category represents 22 percent of the total water use, while use for irrigation only represents about 9 percent. Approximately 1,300 irrigation-only accounts are in the service area for golf courses, parks, and athletic fields. The federal government (such as national laboratories) and tourism are important industries that contribute to local water use rates. With ongoing conservation efforts, there has generally been a steady downward trend in total water use while sustaining a significant population increase. The success of outdoor conservation efforts has led to an increase in the proportion of indoor use to outdoor use, from about a 50-50 mix to approximately 60 percent indoor use.

The ABCWUA and its predecessor, the City of Albuquerque, have made significant progress in the first 17 years of the water conservation program, moving from among the highest municipal water users in the Southwest to among the lowest. The ABCWUA provides a number of services (including free water audits and a rebate program) to help customers conserve water. Since the water conservation program was initiated in 1995 and enhanced due to the 2002 drought, the area has experienced a significant transition to xeriscaping in both residential and commercial landscapes. More than 3 million square feet of turf has been converted to xeriscape since 1995. As customers transition to xeriscape for private use, public use space that provides turf has become increasingly important.

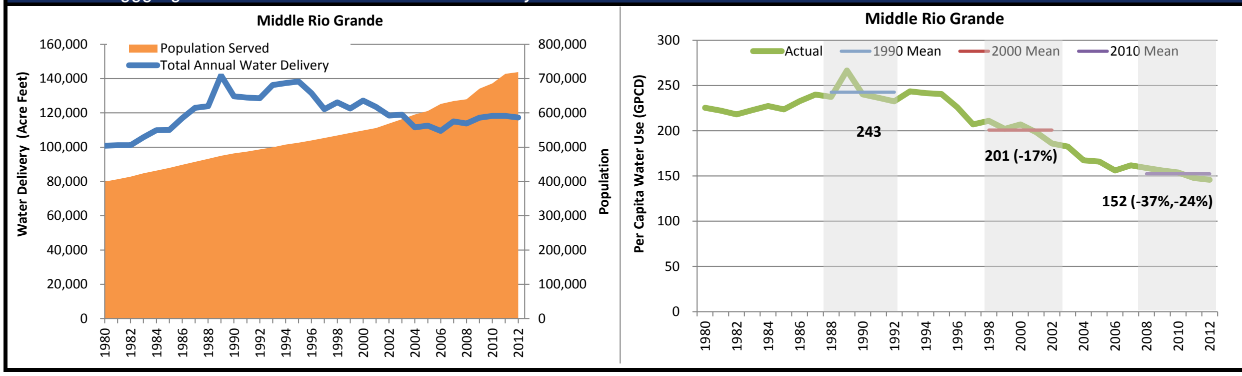
Rio Grande River
*Source: Bureau of Reclamation*

The City of Santa Fe has built a comprehensive and effective water conservation program from incremental steps that began in 1997. Currently, the Water Conservation Office provides educational activities for all ages, administers rebate and incentive programs, enforces the water conservation requirements of various city ordinances, provides public outreach through the media and participation in community events, and leads by example with low-water-use demonstration gardens. Tiered water rates have also played a key role in reducing consumption. This rate structure adjusts seasonally to allow for additional water usage during the months when irrigation systems are typically in use. Also, the City of Santa Fe has addressed some aspects of the tourism industry through ordinances limiting hotel linen changes, mandating requests for water at restaurants, and implementing requirements for public signage. Other examples of conservation efforts are the rebates in conjunction with the City's Water Bank, and the Qualified Water Efficient Landscaper training (EPA certification).

Reclaimed wastewater is a vital and valuable water resource that helps the City of Santa Fe meet its current water supply needs; it can also play a critical role in meeting future potable water supply demand. In 2013 the City of Santa Fe created the Reclaimed Wastewater Reuse Plan, which replaces the 1998 Treated Effluent Management Plan. The Reclaimed Wastewater Reuse Plan allocates the reclaimed wastewater among the current needs and reserves 2,200 AF to meet future potable water demand.

The historical population, total M&I water use, and the gross per capita water use for the Middle Rio Grande metropolitan rea are shown on Figure 3-6. The etropolitan area population has increased significantly since 1980, adding more than 320,000 users to the municipal water service area. However, total water deliveries have declined by about 12 percent since 1990, while per capita water use rates have decreased by approximately 38 percent since 1990 (1988-1992 average) and by 24 percent since 2000 (1998-2002). The most recent annual average (2008-2012 average) per capita use was estimated at 153 GPCD.

**FIGURE 3-6**
Water Delivery, Population, and Per Capita Water Use Trends in the Middle Rio Grande Metropolitan Area
*Includes agggregated service areas of ABCWUA and City of Santa Fe Water Division*




### 3.4.2.5 Southern Nevada

The Southern Nevada metropolitan area includes the service areas of the member agencies of the Southern Nevada Water Authority (SNWA): Big Bend Water District, City of Boulder City, City of Henderson, City of Las Vegas, City of North Las Vegas, Clark County Water Reclamation District, and Las Vegas Valley Water District. SNWA was formed by coorperative agreement in 1991 and charged with managing the region's water resources and providing the Las Vegas Valley with present and future water supplies. Together, the seven member agencies provide water and wastewater service to more than 2 million residents in Boulder City, Henderson, Las Vegas, Laughlin, and North Las Vegas, and areas of unincorporated Clark County. The majority of the SNWA service areas lies within the Las Vegas area, with a population density that is among the highest in the interior west. The SNWA service area represents approximately 70 percent of the population of Nevada, the driest state in the nation.

About 90 percent of the water delivered by SNWA to its member agencies is from Nevada's basic Colorado River consumptive use apportionment of 300,000 AFY, while the remaining 10 percent comes from SNWA member agency Las Vegas Valley Water District groundwater rights. SNWA supplements these resources with extensive water reuse. Nearly all of the wastewater flows in Southern Nevada are reused through direct non-potable reuse and indirect potable reuse (through Colorado River return flow credits). SNWA's plan for meeting future water demands relies on the use of a portfolio of water resources that includes current and future permanent and interim Colorado River and in-state water resources, water conservation, direct non-potable reuse, and indirect potable reuse. SNWA maintains a water resource plan to assess the role of water resources and conservation in meeting long-term regional water demands.

Southern Nevada has a hot and dry climate, typical of the Mojave Desert in which it lies. The summer months of June through September are very hot and mostly dry, with a July average daily maximum temperature of 104°F, while average daily minimum temperatures remain above 80°F. Winters are short and the season is generally mild. December, the coolest month, consists of average daily maximum temperatures of 57°F and average daily minimum of 39°F. Annual precipitation is about 4 inches in Las Vegas Valley. Most of the precipitation falls in the winter, but even the wettest month (February) averages only 0.76 inch of precipitation with only 4 days of precipitation. The water use patterns in Southern Nevada show that approximately 40 percent of overall use is returned to wastewater treatment plants, while the remaining 60 percent is consumed with a majority being used for outdoor irrigation.

The recent 5-year annual average (2008-2012) period indicates that the residential water use accounts for about 56 percent of the total water delivered by SNWA. Within residential water use, the use by single-family housing represented about 45 percent in 2012. The CII water use category represents about 26 percent of the total water use, of which 7 percent corresponds to water use by the resort industry. Gaming and tourism are the major Las Vegas sources of employment and the historical drivers for the economy with annual visitor volume in Las Vegas of nearly 40 million. The use for irrigation represents 12 percent of total water delivered for use by common areas and golf courses. Golf course use represents 6 percent of water deliveries.

The average age of infrastructure in the water distribution system in Southern Nevada is less than 25 years, and 60 percent of the regional transmission system is less than 20 years; as a result, the systems operate efficiently.

Since its creation in 1991, SNWA has implemented an array of conservation programs focused on reducing water use throughout the community. SNWA service area residences include nearly 70 percent with plumbing fixtures meeting or exceeding the national plumbing standards adopted in early 1990s, and significant natural replacement in the housing stock with plumbing fixtures predating these standards.

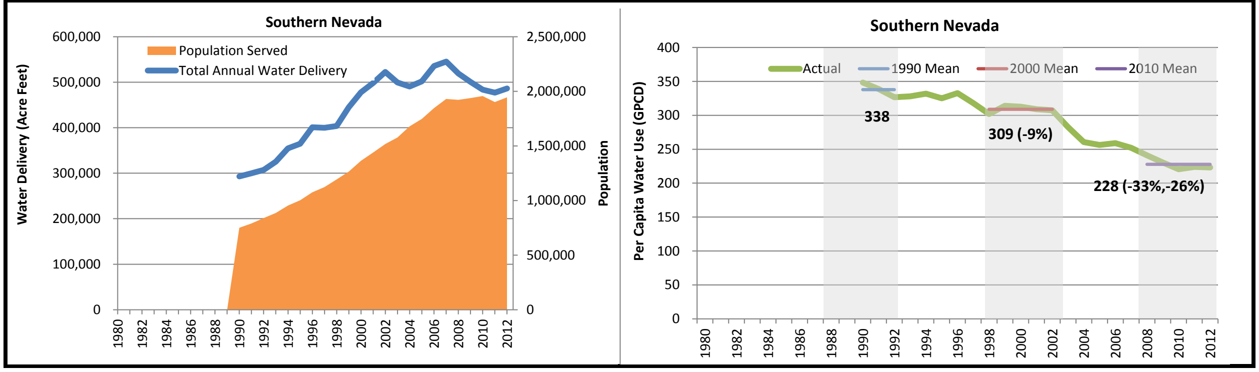
While SNWA actively promotes indoor conservation, in Southern Nevada the greatest opportunity for water conservation lies in curbing outdoor water use (SNWA, 2009). SNWA has embarked on an aggressive long-term water conservation program that has contributed to extraordinary conservation gains. In recent years, participation in SNWA's rebate programs realized peak participation levels in almost every area. SNWA and its member agencies use a variety of tools to promote conservation and reduce overall water use. These tools include a combination of regulation, water pricing, incentives, and education to elicit the necessary community response to reduce demands (SNWA, 2009).

To date, SNWA has invested roughly $200 million in various water conservation efforts. Between 2002 and 2013, Southern Nevada's consumption of Colorado River water decreased by approximately 100 thousand acre-feet (KAF), despite the addition of 480,000 residents during that decade. While some of the reductions in water use can be attributed to the economic downturn in recent years, there is no question that the community's conservation efforts played a critical role (SNWA, 2014). Over the past six years, the community has lowered its GPCD well ahead of the projected GPCD expected in order to meet the 2035 goal of 199 GPCD. SNWA's Water Smart Landscape Rebate Program has helped the community to upgrade more than 168 million square feet of lawn to water-efficient landscaping, saving the community thousands of acre-feet of water each year. More than 33,000 coupons have been distributed to participants in the Pool Cover Instant Rebate Coupon Program, contributing to a total of more than 1,200 AF of water saved annually. The Irrigation Clock Rebate Program, which provided financial assistance for customers to upgrade landscape irrigation controllers to models that can increase water efficiency, facilitated replacement of nearly 2,000 controllers for residential and commercial properties, saving the community more than 400 AF annually.

Lake Mead and intakes
*Source: CH2M HILL*

The historical population, total M&I water use, and the gross per capita water use for the Southern Nevada metropolitan area are shown on Figure 3-7. The population of the SNWA service area has increased by approximately 2.6 times between 1990 and 2013. During the same period, SNWA's annual water use increased by approximately 1.7 times. The recent Great Recession resulted in measured unemployment peaking above 14 percent, and nearly no change in population between 2007 and 2011 for Southern Nevada. Annual water use has declined in the SNWA service area over the past decade as a result of many factors including SNWA's aggressive water conservation efforts and the recent economic downturn. On average, per capita water use rates have decreased by approximately 33 percent since 1990 (1988-1992 average) and 26 percent since 2000 (1998-2002). The most recent (2008-2012 average) annual average per capita use was estimated at 228 GPCD. The SNWA service area is continuing to recover economically and this recovery may place upward pressure on water demand.

**FIGURE 3-7**
Water Delivery, Population, and Per Capita Water Use Trends in the Southern Nevada Metropolitan Area
*Includes aggregated service areas of SNWA member agencies*




Note:
1990 mean represents the average period from 1990 to 1992.

### *3.4.2.6 Central Arizona*

Located approximately 200 miles from the Colorado River, the Central Arizona metropolitan area consists of the vast majority of Maricopa, Pinal, and Pima Counties and covers more than 13,000 square miles. Major cities within Central Arizona include Phoenix, Mesa, Chandler, Scottsdale, Gilbert, Glendale, Tempe, Peoria, Surprise, Tucson, and Casa Grande. The population of the Central Arizona area in 2012 was approximately 4.7 million. Forty-one municipal water providers in this area have allocations to use Colorado River water delivered through the Central Arizona Project (CAP), totaling 548,762 AF. Nine of the largest municipal water providers in Maricopa County serving approximately 83 percent of the county's population, receive about 50 percent of their total supplies from the Salt River Project, which operates reservoirs on the Salt and Verde Rivers. These municipal providers also use reclaimed water and a small percentage of groundwater. Municipal water providers in Pinal and Pima Counties rely on CAP water, reclaimed water, and groundwater.

Situated in the Sonoran Desert, Central Arizona has one of the nation's most arid climates. Rainfall is highly variable, averaging between 7 and 11 inches annually, with more precipitation at higher elevations. Average daily maximum summer temperatures are between 100°F and 110°F, and average annual evapotranspiration across the metropolitan area is between 77 and 79 inches.

The Central Arizona metropolitan areas has the highest percentage of CII use of any of the metropolitan areas analyzed. The recent 5-year annual average (2008-2012) period indicates that the residential water use accounts for about 60 percent of the total water delivered in this area, while the CII water use represents about 30 percent of the total water use. The residential and CII water uses have actually decreased by more than 2 percent compared to 1990 (5-year annual average, 1988-1992), while the CII sector has decreased by more than 5 percent (as a percentage of overall use) over the same period.

In the early 1900s, modern municipal water conservation measures began to emerge in Tucson and Phoenix, including fines for wasting water, irrigation restrictions, elimination of flat rate water fees, and requirements for metering of all connections.

For nearly 35 years, the 1980 Groundwater Management Act has shaped Arizona's approach to water management. Enacted in response to decades of depletion of the state's limited groundwater supplies, the Act aims to halt groundwater mining in the state's most heavily populated areas, known as AMAs. The Act encourages the use of renewable supplies (surface water and wastewater) before groundwater is pumped. All of the Central Arizona metropolitan area is included within the AMAs.

The Act established the Arizona Department of Water Resources (ADWR) and gave it extensive authority to regulate water uses and consumption. Within AMAs, the Act prohibits new residential growth without a proven 100-year assured water supply. Significantly, ADWR has broad inspection and enforcement authority.

To achieve the Act's goal of safe-yield in the Phoenix and Tucson AMAs by 2025 (a balance between the amount of groundwater withdrawn and the amount replenished), ADWR is required to adopt five management plans for each of five management periods between 1980 and 2025. The plans must include mandatory conservation requirements for all water uses. For municipal uses, the conservation requirements are based on reductions in per capita use and other appropriate measures. Large municipal providers are required to meter all connections and limit system losses to no more than 10 percent, and many municipal providers in the Phoenix area have reduced their losses to 4 to 7 percent. Landscaping in public medians and rights-of-way is restricted to low-water-use plants identified in Regulatory Plant Lists. Many jurisdictions within the AMAs have officially adopted the local regulatory list and incorporated it into ordinances and design guidelines for development. More than 90 percent of the population in this metropolitan areas is served by municipal providers implementing a wide range of best management practices in the categories of public awareness, education and training, outreach service, system evaluation and improvement, ordinances and conditions of service and tariffs, rebates and incentives, and research and innovation. Most large providers have conservation rate structures.

Central Arizona Project aqueduct delivers Colorado River water to Pima, Pina, and Maricopa Counties
*Source: Central Arizona Project*

A primary focus of Central Arizona municipal conservation programs has been exterior water use, driving the acceptance and adoption of desert-adapted landscaping and water-efficient practices. Preliminary results of research into residential landscaping in Phoenix indicate that only 10 percent of single-family residences continue to maintain large areas of turf.

Efforts to encourage low-impact design and passive and active residential and commercial water harvesting have gained ground. Tucson recently adopted the nation's first commercial rainwater harvesting ordinance.

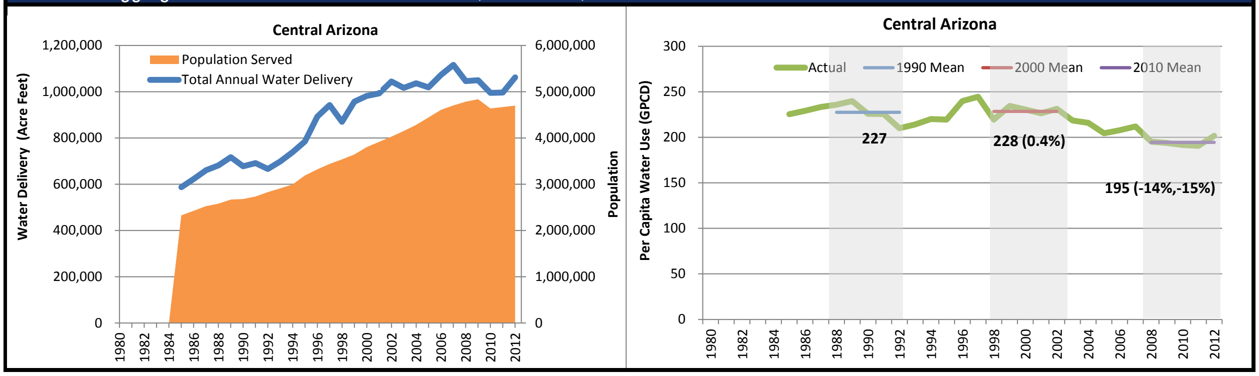
Conservation requirements have also been established for persons or entities receiving water from a municipal provider for a non-agricultural uses. These uses include turf-related facilities, large-scale cooling facilities, and publicly owned rights-of-way.

Arizona established itself as a leader in reuse in 1926 with the construction of the first operational water reclamation plant in the U.S., providing reclaimed water for non-potable needs at the Grand Canyon Village. As early as 1932, the City of Phoenix supplied treated wastewater for agricultural purposes. Today, 95 percent of the wastewater generated in the Phoenix, Pinal, and Tucson AMAs is reclaimed to serve beneficial uses, including agriculture, underground storage, power generation, industrial uses, turf irrigation, and aquatic and riparian habitat (Thomure et al., 2013). Arizona law allows cities to contract for the disposition of their treated wastewater, and most uses of reclaimed water are allowed and practiced in the state. The one purpose that is not permitted is reuse for human consumption. A steering committee, formed by WateReuse Arizona in 2012 as a result of the Governor's Blue Ribbon Panel on Water Sustainability, is working to identify opportunities to enhance the State's regulatory framework for potable reuse and develop a roadmap for communities to use in developing future water reuse projects.

The population, total M&I water use, and the gross per capita water use for the Central Arizona metropolitan area between 1985 and 2012, based on annual report data collected by ADWR, are shown on Figure 3-8. As noted, the Central Arizona metropolitan area had the highest percentage of CII use of any of the major metropolitan areas that receive Colorado River water. CII uses may have a disproportionate impact on per capita water use, but industry provides an important economic value to the metropolitan area. Several large municipal providers in the Central Arizona metropolitan area have seen significantly greater GPCD declines than the average shown on Figure 3-8. For example, between 1991 and 2013, Phoenix, the sixth largest city in the country, increased in population by 47 percent, yet the city's per capita use rate decreased by 29 percent while water deliveries rose by only 4.5

percent. On average, per capita water use rates in the Central Arizona metropolitan area have decreased by approximately 14 percent since 1990 (1988-2002 average) and by 15 percent since 2000 (1998-2002 average). The most recent current annual average (2008-2012 average) per capita use was estimated at 195 GPCD.

**FIGURE 3-8**
Water Delivery, Population, and Per Capita Water Use Trends in the Central Arizona Metropolitan Area
*Includes aggregated service areas of Phoenix AMA, Pinal AMA, and Tucson AMA*




### 3.4.2.7 *Coastal Southern California*

The MWD, established in 1928 under an act of the State Legislature, is a public agency and a regional water wholesaler that provides supplemental water supplies to 26 member agencies and serves about 18 million people across six counties (Los Angeles, Orange, San Diego, Riverside, San Bernardino, and Ventura) in coastal Southern California. For this report, the Coastal Southern California metropolitan area is the same as MWD's service area.

MWD draws supplies from the Colorado River through the Colorado River Aqueduct, which it owns and operates; from Northern California via the State Water Project and from local programs and transfer arrangements. In fiscal year 1990, Colorado River water represented 26 percent of the total water supply, Northern California supply 33 percent, 34 percent from local supply, which included groundwater recovery, and 7 percent from conservation, and water recycling. In fiscal year 2014, the Colorado River water supply represented 23 percent of the total water supply, Northern California supply 17 percent, 33 percent from local supply, which included groundwater, surface water, Los Angeles Aqueduct, and groundwater recovery, and 28 percent from conservation and water recycling.

The Coastal Southern California metropolitan area has a Mediterranean climate with average summer temperatures ranging from 64°F to 85°F during August, the warmest month, and average winter temperatures ranging from 46°F to 70°F during December, the coolest month. In the more inland areas, the climate is semiarid, with colder winters and markedly hotter summers. Precipitation in the metropolitan area occurs primarily during the winter months and ranges from 10 to 17 inches per year.

The average household size and population and housing unit densities are high in this area. Higher housing unit density often translates into smaller lot sizes and potential lower irrigated acreage per housing unit. In Los Angeles, which represents more than 20 percent of the total MWD-served population, the population density is 12.6 persons per acre, housing unit density is approximately 4.7 units per acre, and the median home size is 1,600 square feet, all below the national average. The median household income and median home value are relatively high compared to other areas served with Colorado River water. In 2011, the median home value was $400,000 in Los Angeles (U.S. Census Bureau, 2013d), and the median household income for 2010 ranged from $35,600 in the Central Basin to $95,300 in San Marino (MWD, 2010).

The recent 5-year annual average (2008-2012) period indicates that residential water use accounts for about 70 percent of the total water delivered by MWD. Within the residential water use, the use by single-family housing represented about 60 percent in 2010. The use by multi-family housing has been increasing as growth of urban in-fill development has increased. The CII water use category represents 26 percent of the total water use, while use for irrigation only represents about 4 percent. The residential and CII water uses have increased by almost 7 percent compared to the 1990 period (5-year annual average, 1988-1992),while the irrigation only use has dropped by more than 60 percent (from 10 percent to 4 percent) over the same period.

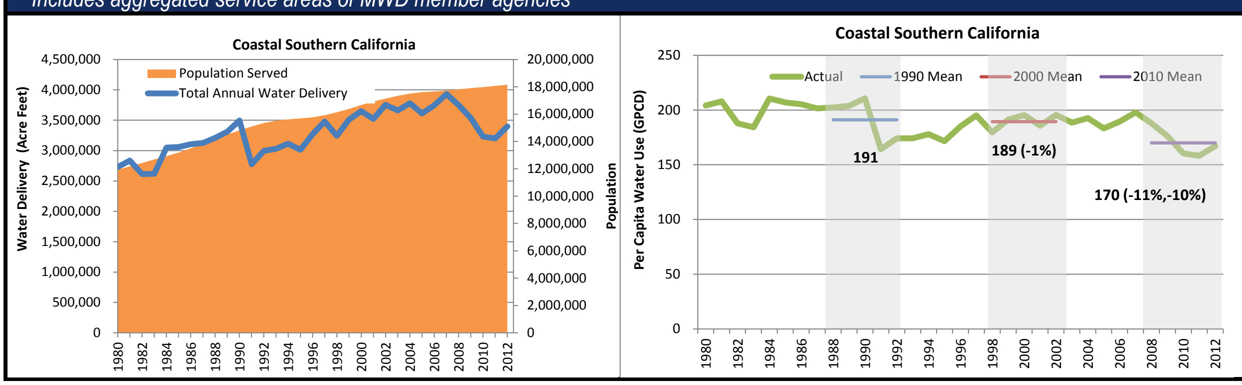
Colorado River Aqueduct
*Courtesy Metropolitan Water District of Southern California*

A growing element of MWD's water supply reliability is water conservation and reuse. Water conservation and reuse represented 7 percent of the 1990 water supply mix and is planned to grow to 33 percent by 2015. Over the past two decades, MWD has invested more than $352 million for incentive programs to reduce residential and commercial water use, resulting in about 2.05 million AF of cumulative savings.

Currently, MWD's region-wide residential conservation program is operated under the umbrella of SoCal Water$mart. This program provided 51,000 rebates for water-efficient products, and the estimated water savings is about 3,350 AF for fiscal year 2013-14. The regional commercial program is also administered through SoCal Water$mart and saved an additional 4,020 AF in fiscal year 2013-14. Popular rebates in the two programs are for turf removal, high-efficiency clothes washers and toilets, multi-stream rotating nozzles for sprinklers, and weather-based irrigation controllers. For the commercial sector, incentives are also available through a customized program called the Water Savings Incentive Program and through member agency administered-programs. Combined with "code-based" conservation achieved through building and plumbing codes, and water use restriction ordinances, and from reduced consumption resulting from changes in water pricing, the area saved about 923,000 AF in fiscal year 2013-14.

The historical population, total produced water (treated water delivered through M&I water systems), and the gross per capita water use for the Coastal Southern California metropolitan area are shown on Figure 3-9. The metropolitan area population has increased by about 50 percent since 1980, adding more than 6 million to the municipal water service area population, while total annual water use increased by approximately 20 percent. On average, per capita water use rates have decreased by approximately 12 percent since 1990 (1988-1992 average) and by 10 percent since 2000 (1998-2002 average). The most recent annual average (2008-2012 average) per capita use was estimated at 170 GPCD.

**FIGURE 3-9**
Water Delivery, Population, and Per Capita Water Use Trends in the Coastal Southern California Metropolitan Area
*Includes aggregated service areas of MWD member agencies*




### 3.4.2.8 Salton Sea Basin

The Salton Sea Basin metropolitan area is represented in this report as the M&I service areas in the Imperial and Coachella Valleys of California. This area includes cities such as Indio, Palm Desert, El Centro, and Calexico. Water is served to these cities by the Coachella Valley Water District (CVWD) and Desert

Water Agency in Coachella Valley and the Imperial Irrigation District (IID) in the Imperial Valley.

The CVWD began operation in 1918 providing service to approximately 1,000 square miles from the San Gorgonio Pass to the Salton Sea, mostly within the Coachella Valley in Riverside County, California. The boundaries also extend into small portions of Imperial and San Diego counties and provides water-related service to over 303,000 people living in the nine cities of CVWD's service area. The CVWD relies on three sources of water (groundwater, recycled water, and imported water) to provide service to its customers, either through the State Water Project (via exchange) or from the Colorado River via the Coachella Canal, a branch of the All-American Canal.

All-American Canal
*Source: Bureau of Reclamation*

IID, the largest irrigation district in the nation, was formed in 1911 to import and distribute raw Colorado River water mainly to agricultural irrigation customers. However, IID also supplies water to approximately 178,000 people across seven municipalities. The largest cities included in the IID M&I service area are El Centro and Calexico. The IID diverts water at Imperial Dam on the Colorado River through the 80-mile-long All-American Canal.

The Salton Sea Basin is located in the northernmost part of the Sonoran Desert and characterized by hot, dry summers and mild winters. Summer temperatures typically exceed 100°F and the winter low temperatures rarely drop below 32°F. Annual rainfall in the Imperial Valley averages less than 3 inches, with most rainfall associated with brief but intense summer monsoon storms.

The IID delivers an average of 2.8 million AF of water each year and 97 percent is used for the irrigation of over 400,000 acres. The remaining 3 percent of water delivered is distributed among M&I customers in seven municipalities, one private water company, and two community water systems as well as a variety of industrial uses and rural homes or businesses. The majority of the M&I use is associated with residential water users with about 85 percent of the customers represented as single-family residential (City of El Centro, 2011).

In the CVWD service area, approximately 300,000 AFY of water delivered from the Coachella Canal was initially used exclusively by agriculture. As residential growth moved into the eastern valley, other water users, primarily golf courses and homeowner associations, began using Colorado River water for large landscape irrigation. Based on the 2010 Urban Water Management Plan (CVWD, 2011), single-family residential water use represents about 57 percent of the total M&I use and landscape irrigation represents about 28 percent of the total M&I use. During the 2008-2012 period, more than 40 percent of the total CVWD deliveries was distributed to M&I water users.

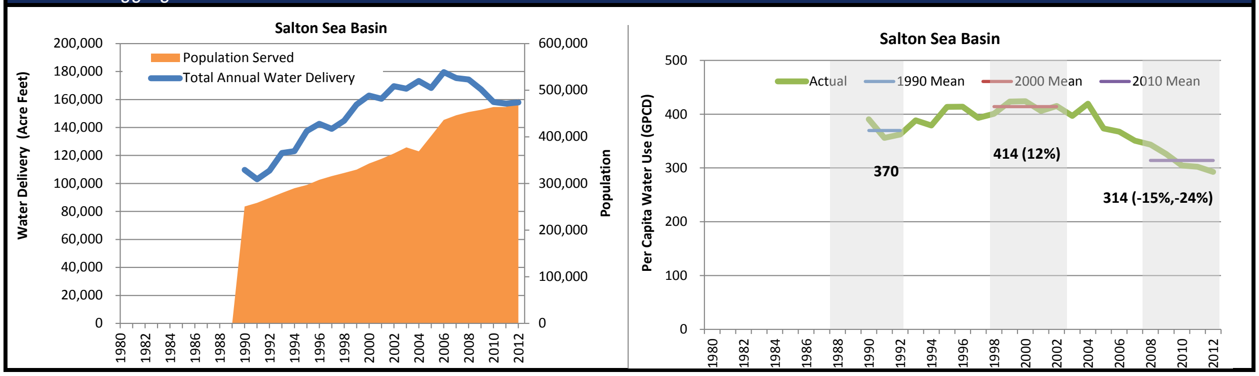
The water conservation efforts in this area are mainly driven by the California state reduction target requirements to follow demand management measures and California Urban Water Conservation Council (CUWCC) Best Management Practices (CUWCC, 2011). In El Centro, conservation programs such as school education, public information, and landscape design and water use standards are being implemented.

CVWD implemented a water conservation program in the 1960s. However, as a desert resort community having a large transient population, per capita water use tends to be much higher than other portions of California. Special emphasis has been placed on landscape irrigation demand reductions. New and rehabilitated landscape sites are required to submit water conserving landscape plans to CVWD's Water Management Department for a plan check prior to construction. The cost to CVWD to implement this program is approximately $81,000 per year, and annual water savings generated by this program is approximately 1,644 AFY (CVWD, 2011).

In terms of water reuse, the City of El Centro provides sewer service and has a wastewater treatment plant but it is not currently being recycled. It is not currently financially feasible for the City to provide the facilities for recycling wastewater but some recycled water projects have been proposed in the Imperial Valley for use in solar and geothermal plants (City of El Centro, 2011). Recycled wastewater has been used for irrigation of golf courses and municipal landscaping in the Coachella Valley since 1968.

The historical population, total M&I water deliveries, and the gross per capita water use for the Salton Sea Basin metropolitan area are shown on Figure 3-10. The metropolitan area population has almost doubled since 1990, adding more than 230,000 to the municipal water service area population. Total annual water use increased by approximately 143 percent over the same period. However, average per capita water use rates have decreased by approximately 15 percent since 1990 (1988-1992 average) and by approximately 24 percent since 2000 (1998-2002 average). The most recent annual average (2008-2012 average) per capita use was estimated at 314 GPCD. The high per capita use rates for this metropolitan area are generally associated with large-scale turf irrigation in resort areas of the Coachella Valley and reflect much higher rates than the M&I areas in the Imperial Valley.

**FIGURE 3-10**
Water Delivery, Population, and Per Capita Water Use Trends in the Salton Sea Basin Metropolitan Area
*Includes aggregated service areas of CVWD and IID*




Note:
The 1990 mean represents the average period from 1990 to 1992.

## 3.4.3 Summary of Trends in Municipal and Industrial Water Use

Trends in M&I water use and water reuse are summarized in the following sections.

### *3.4.3.1 Municipal and Industrial Water Use Trends*

As discussed in the preceding sections, each major metropolitan area that receives Colorado River water is unique in its climate, population and demographics, industries, water conservation efforts, and available water supplies. These characteristics influence M&I water use, water management, and historical and future approaches for M&I water conservation and reuse. For example, areas with high potential evapotranspiration and low rainfall often provide a larger share of their overall water use for outdoor irrigation. Rapidly growing cities with new residential development have had success in improving the efficiency of residential use through a variety of codes and programs encouraging, for example, more efficient indoor fixtures and outdoor landscaping.

For most major metropolitan areas, M&I water use has increased over the past two decades as a result of continued population growth. The populations in the major metropolitan areas have increased significantly since 1990, adding nearly 8 million to the municipal water service area population. While population has increased over the recent decades, the per capita water use has decreased over the same period, partially attenuating the effect of population growth on M&I water use. The changes in per capita water use, represented as GPCD, are used to examine gross trends over time in each major metropolitan area. It is important to understand that differences in GPCD rates are not a measure of the success of conservation efforts from one area to another. On average, per capita water use rates have decreased by 12 percent to 38 percent since 1990 (1988-1992 average), and the most recent annual average (2008-2012) per capita uses ranges from 152 GPCD to 314 GPCD (Table 3-5).

**TABLE 3-5**
5-Year Annual Average, 2008-2012: Water Use and Trend for Major Metropolitan Areas

| Major Metropolitan Area | Population Served | Annual Water Delivery (AF) | Percent Colorado River Water (%) | Climate Index: Potential Evapo-transpiration minus Precipitation (inches) | GPCD (% reduction from 1990, 2000) | Residential[1] (%) | CII[1] (%) |
|---|---|---|---|---|---|---|---|
| Front Range | 2,461,600 | 491,300 | 46 | 28 | 178 (22%, 18%) | 79.4 | 14.6 |
| Wasatch Front | 978,600 | 245,200 | 27 | 29 | 224 (NA, 15%)[2] | 70.6[3] | 21.3[3] |
| Middle Rio Grande | 685,800 | 117,000 | 36[4] | 43 | 152 (38%, 24%) | 68.8 | 22.2 |
| Southern Nevada | 1,932,900 | 493,400 | 91 | 86 | 228 (33%, 26%) | 55.7 | 25.5 |
| Central Arizona | 4,725,100 | 1,029,800 | 46 | 68 | 195 (14%, 15%) | 60.0 | 30.4 |
| Coastal Southern California | 17,983,400 | 3,422,200 | 34 | 34 | 170 (11%, 10%) | 70.2 | 26.0 |
| Salton Sea Basin | 464,000 | 166,300 | NA | 65 | 314 (15%, 24%) | NA | NA |

*Not available (NA)*

[1] Residential and CII use may not sum to 100 percent due to other uses.
[2] GPCD values and percent reductions developed from 5-year averages centered around 1990, 2000, and 2010. Percentage reductions from 1990 represent the change over 20 years, while percentage reductions from 2000 represent the change over 10 years.
[3] 2010 values, data not available for the 5-year period.
[4] 2009-2012 average, data not available for 2008.

Since 2000, M&I water use has either remained stable or decreased for many of the major metropolitan areas that receive Colorado River water, despite increases in population. Per capita water use rates for the these areas decreased by 10 percent to 26 percent since 2000 (1998-2002 average). During this period, the U.S. experienced a steep economic downturn (known as the Great Recession), the Basin experienced its most severe drought in the past 100 years, and some water providers increased water conservation efforts to reduce water use in response to reduced water availability. These factors have each contributed to recent decreases in per capita water use.

Over the longer term, reductions in per capita water use are due to a variety of factors including water conservation programs, more efficient water use in new developments, replacement of appliances and fixtures with more efficient models, changes in urban development, water supply reliability concerns,

*While population has increased over the recent decades, the per capita water use has decreased, partially attenuating the effect of population growth on M&I water use. Since 2000, M&I water use has either remained stable or decreased for many major metropolitan areas that receive Colorado River water, despite increases in population. Per capita water use rates for the major metropolitan areas receiving Colorado River water decreased by 10 percent to 26 percent since 2000 (1998-2002 average). During this period, the U.S. experienced a steep economic downturn and the Colorado River Basin experienced its most severe drought in the past 100 years, influencing water use.*

behavioral shifts toward increasing efficiencies, and the increase in the price of water. The "landscapeable areas" of single-family homes have decreased as home sizes, garages, and other impervious spaces increase, and lot sizes have become smaller. There is also a significant increase in the percentage of new homes with high-efficiency indoor fixtures (such as low-flow toilets and showerheads and high-efficiency appliances). The median construction date of homes in California and Colorado is about 1975 (1960 for Los Angeles), while Arizona has newer homes with a median construction date of 1987. About one third of Utah housing units were built after 2000. Moreover, many cities are seeing an ongoing transition away from water-intensive landscaping toward more native or low-water-use landscaping, partially in response to ongoing drought and rebate programs, landscape development codes, and also in response to long-running educational efforts that have greatly influenced acceptance.

Numerous water conservation and reuse programs have been put in place over the past several decades in the major metropolitan areas that receive Colorado River water. Although it is often difficult to determine the effectiveness of individual water conservation measures, M&I water conservation and water reuse have played a significant role in reducing water demand in these areas.

*The available data demonstrate that municipal providers in the major metropolitan areas that receive Colorado River water have implemented a wide range of conservation measures that have increased water use efficiency and reduced per capita demand. Comprehensive data on conservation and reuse programs implemented to date in the major metropolitan areas that receive Colorado River water are not available. It is often difficult or impossible to attribute quantifiable savings to specific programs or measures.*

Using the information collected during Phase 1, and assuming 1990 per capita water use rates and 2010 population, the M&I water demand would have been 1.7 million AFY higher in 2010. Water conservation has played an important role in these savings; however, other factors such as economic, social, and behavioral changes also influence changes over time. While this is a relatively simple measure of the volumetric savings due to historical per capita use reductions, it does provide a sense of the magnitude of these historical trends.

Each state and metropolitan area has taken different approaches to M&I conservation and water reuse; and many are at different stages of implementation. In some of these metropolitan areas, specific water conservation measures have been widely adopted and implementing additional measures may be increasingly costly and yield less incremental benefit. However, in many metropolitan areas, certain categories of conservation measures, such as outdoor landscaping and system water loss reduction, may offer greater potential for continued reductions in M&I water demand.

Residential water use accounts for approximately 55 to 80 percent of total M&I water use in the major metropolitan areas that receive Colorado River water (Table 3-5). The residential use commonly includes both indoor and outdoor uses in single- and multi-family dwellings. While not typically metered independently, agencies estimate that on average about 50 to 60 percent of the total residential use is for outdoor landscape irrigation. However, the proportion of indoor versus outdoor use depends on household demographics, lot size, amount of irrigated landscape, type of landscape, household income, and efficiency improvements already in place.

CII water use represents approximately 25 percent of the total use in the major metropolitan areas that receive Colorado River water. In some areas with large institutional and industrial users, the CII sector can account for more than 30 percent of the total M&I water use.

In most major metropolitan areas, the M&I deliveries for irrigation only use represents only a small percentage of the total use. Overall, this use represents less than 2 percent of the total M&I use because most water is delivered to urban and industrial uses. However, in the Wasatch Front metropolitan area this irrigation only use represents about 10 percent of the total use, because unmetered water systems deliver raw water (secondary water) to large landscapes through older distribution systems. In other major metropolitan areas, delivery for golf courses, parks, nurseries, or turf-related water uses is significant, but is typically reported under CII use.

#### 3.4.3.2 Municipal and Industrial Water Reuse Trends

Reuse of wastewater occurs through a variety of methods in the major metropolitan areas that receive Colorado River water. The type of reuse practiced in any particular area depends on the hydrologic conditions, regulatory environment, and water management objectives.

> *Municipal water providers in the major metropolitan areas that receive Colorado River water have implemented water reuse to varying degrees depending on geographic, legal, regulatory, and other considerations.*

Reuse has been categorized in this report based on the method in which reclaimed water is developed and used. Based on a review of the reuse practices in each of the major metropolitan areas, the following categories of reuse were identified:

- **Direct Non-Potable Reuse**
  - *Reuse through direct delivery for non-potable uses*

  This type of reuse occurs largely in Coastal Southern California and Central Arizona as reclaimed water is delivered directly for non-potable uses such as landscaping irrigation (for example, purple pipe systems), delivered directly to industrial uses (for example, power plant cooling), or delivered directly to agricultural uses (for example, generally non-food crops).

  - *Reuse through exchange with non-potable uses*

  This type of reuse is most prominent in Colorado's Front Range. Treated wastewater that comes from the importation of Colorado River water is used as an exchange supply for downstream agricultural water users. Through exchange, the upstream M&I user can increase the quantity of diverted surface supply for non-potable uses, while the downstream agricultural users make use of the treated wastewater supply.

- **Indirect Potable Reuse**
  - *Reuse through recharge to groundwater or surface storage*

  This type of reuse occurs in most of the Basin States. Treated wastewater is stored underground or added to surface storage and subsequently (sometimes years after storage) used as source water for M&I purposes. This is the case in Central Arizona (underground storage), Southern Nevada (returns to the Colorado River at Lake Mead), and many areas of Coastal Southern California (groundwater and local surface storage).

  - *Reuse through exchange for subsequent potable use*

Treated wastewater that comes from the importation of Colorado River water is used as an exchange supply for downstream agricultural water users. Through exchange, the upstream M&I user can increase the quantity of diverted surface supply for potable uses, while the downstream agricultural users make use of the treated wastewater supply.

The trends in M&I water deliveries of untreated water, potable water, and reuse water supply are shown on Figures 3-11A through 3-11C. As the figures show, M&I water providers have increased the amount of wastewater reuse included in the water distributed to customers. Wastewater reuse is practiced in nearly every major metropolitan area that receives Colorado River supply and the quantity is growing in its percentage of the total water supply.

The reported water reuse that is used as a water supply for the M&I sector for the major metropolitan areas that receive Colorado River water is summarized in Table 3-6. Water reuse was found to be practiced in nearly all of the Basin States. A total of 709,000 AFY of reuse supply was identified as M&I supply in 2012. In many of the metropolitan areas, a significant portion of the treated wastewater flows are put toward non-M&I beneficial uses such as delivery to groundwater recharge, agricultural uses, or wetland habitats.

In some of the major metropolitan areas, more than 90 percent of the reusable supply is currently being reused.

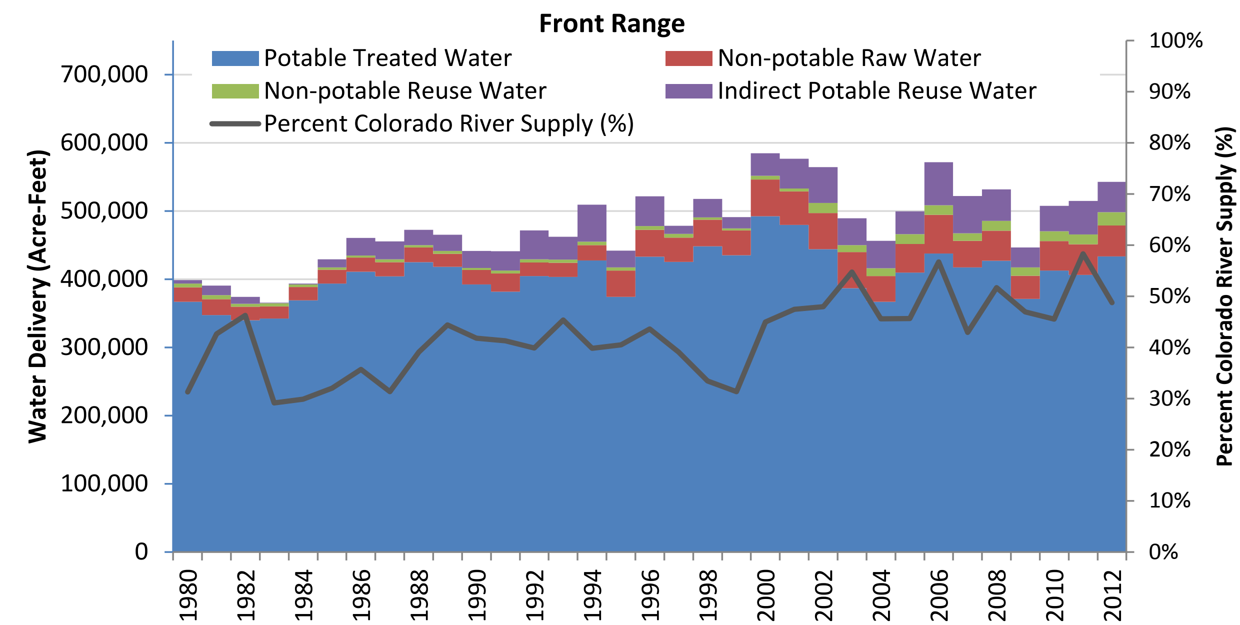
Water reuse represents an important source of supply in many metropolitan areas, but varies significantly across geographic regions. The percentage of total M&I water delivered that is derived from reuse ranges from about 1 percent in the Wasatch Front and Middle Rio Grande metropolitan areas to approximately 40 percent in the Southern Nevada metropolitan area. Water reuse represents between 9 and 12 percent of the total water delivered to M&I users in the Coastal Southern California, Central Arizona, and Front Range metropolitan areas. Reuse for non-potable end uses represents the most common method employed, with the exception of those metropolitan areas where reclaimed water can be used for return flow credits or for exchanges.

Along the Wasatch Front, heavy use of secondary water has helped to defer expensive reuse projects. However, reuse project plans are now underway to meet CUPCA reuse goals and requirements under CUPCA repayment and water sales agreements.

In Coastal Southern California, it is estimated that nearly 315,000 AFY of M&I supply is generated from wastewater reuse, with the majority being used for direct non-potable uses. MWD has invested $356 million for incentive programs for water recycling (MWD, 2014). It is estimated that about one quarter of all wastewater flows in this metropolitan area are currently being reclaimed, and many reuse projects are currently being planned. .

In Central Arizona, it is estimated that 95 percent of wastewater is reclaimed to serve beneficial purposes (Thomure, 2013). Of that, about 95,000 AFY of reclaimed wastewater is delivered by municipal providers for M&I uses. In addition, about 70,000 AFY of reclaimed wastewater is contractually supplied by Phoenix metropolitan areas cities to the Palo Verde Nuclear Generating Station, providing the plant's entire cooling water supply.

**FIGURE 3-11A**
Trends in Water Deliveries by Type and Percentage of Colorado River Water
*Selected aggregated service areas*



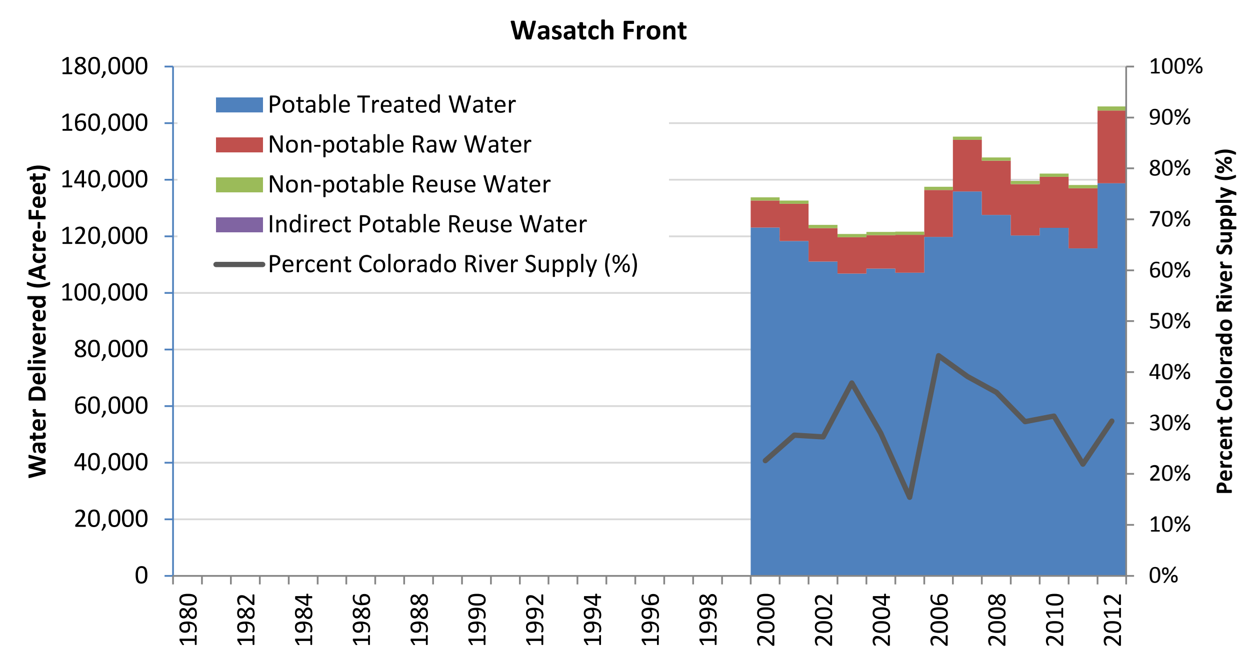
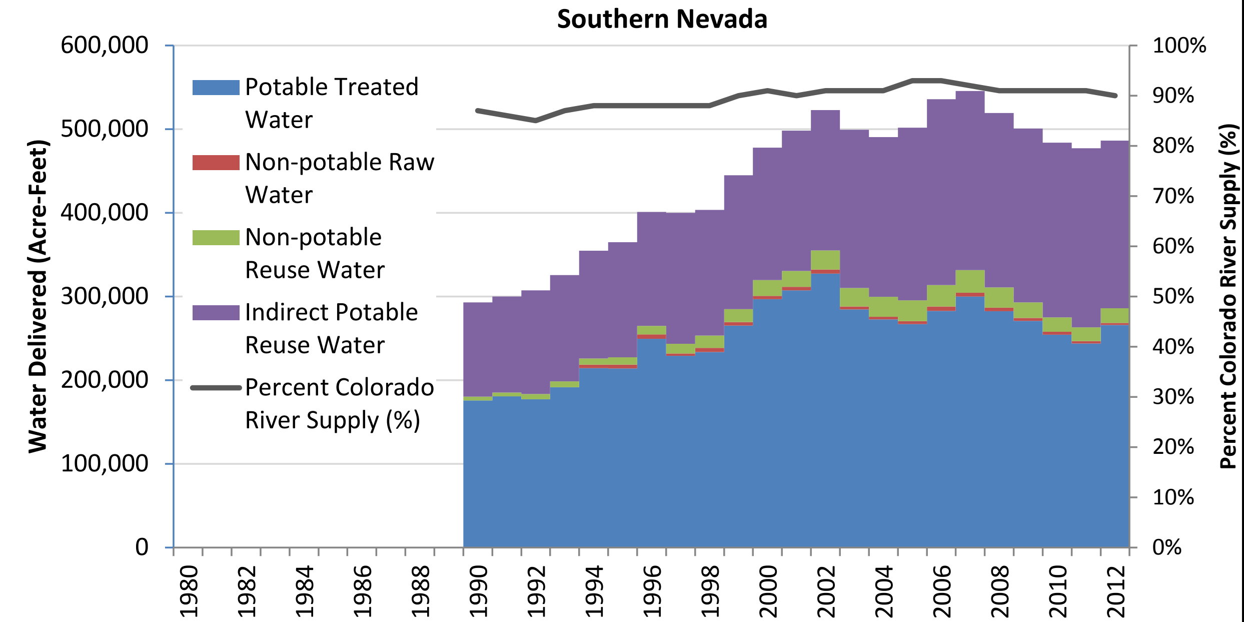



**FIGURE 3-11B**
Trends in Water Deliveries by Type and Percentage of Colorado River Water
*Selected aggregated service areas*



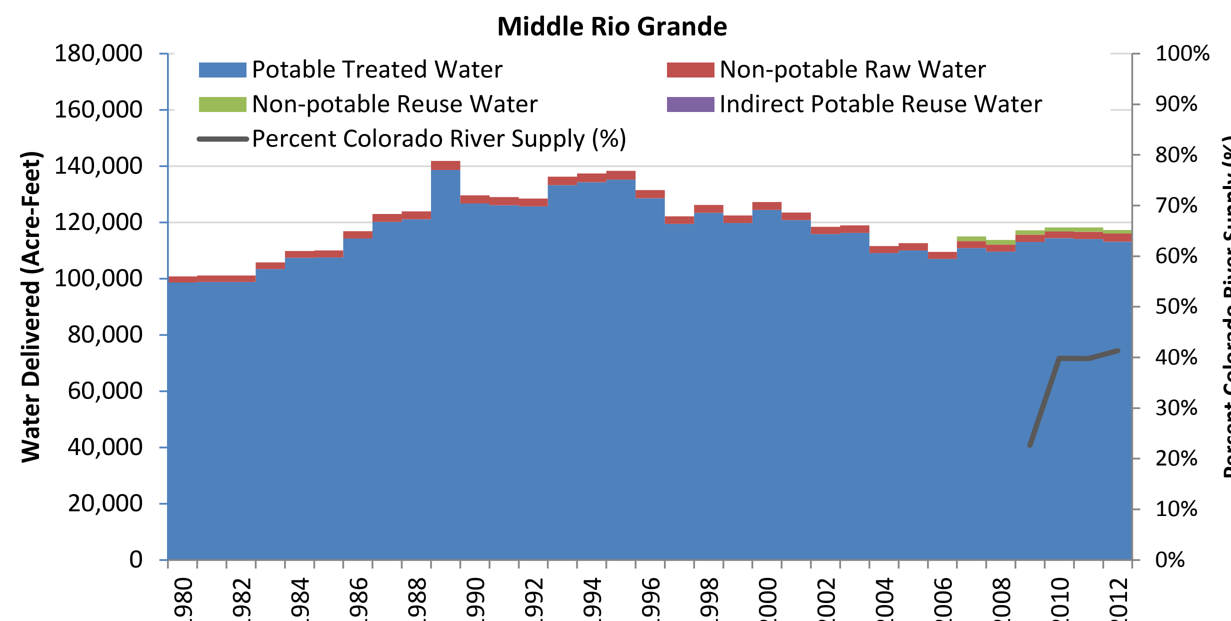
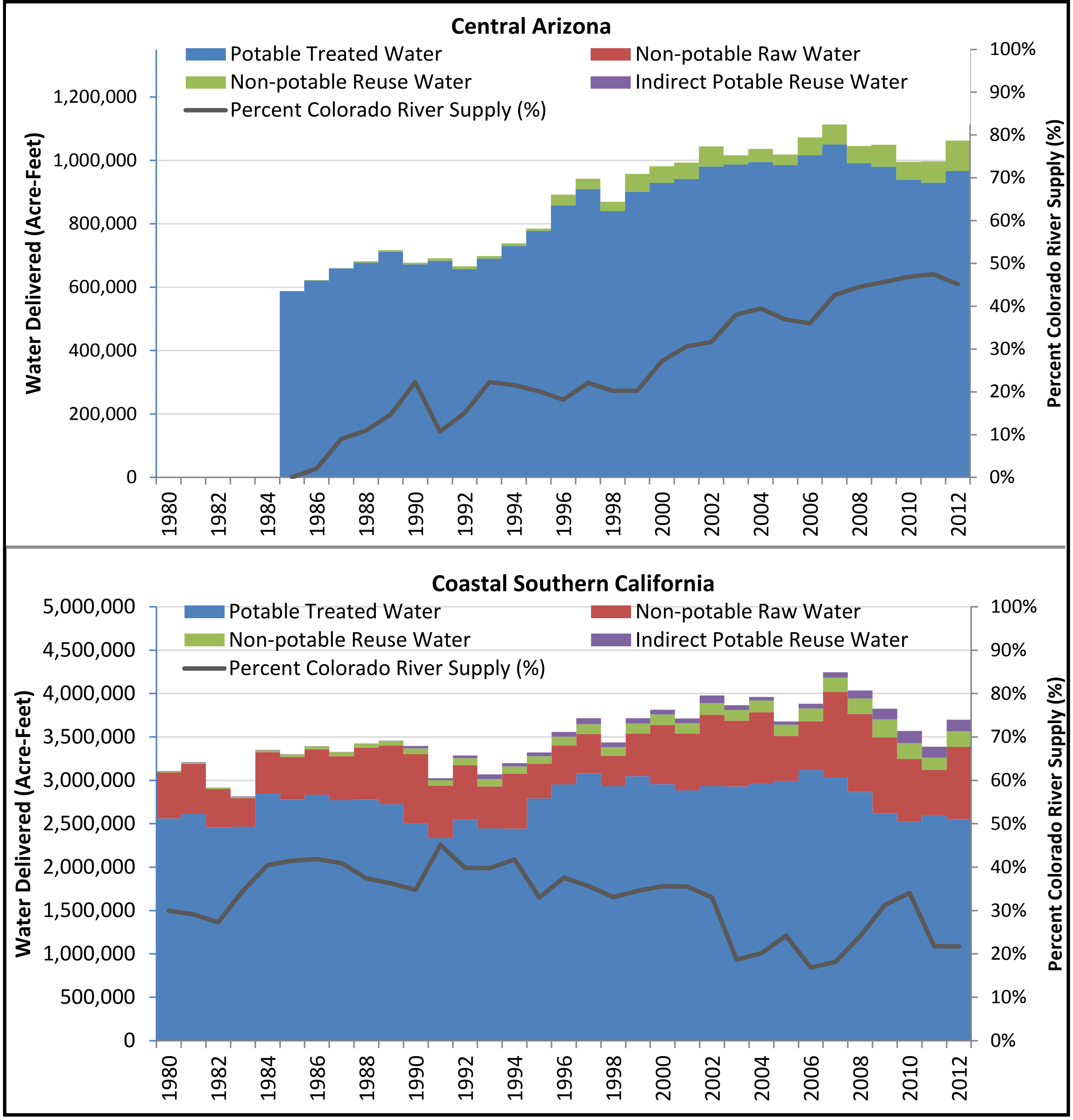



**FIGURE 3-11C**
Trends in Water Deliveries by Type and Percentage of Colorado River Water
*Selected aggregated service areas*




Note:
Coastal Southern California percentage Colorado River water includes water delivered through MWD's Colorado River Aqueduct for exchange with Desert Water Agency and CVWD.

**TABLE 3-6**
M&I Water Reuse in the Major Metropolitan Areas: Volume (AF) and Percentage (%) of Total M&I Water Supply Derived from Reclaimed Water (2012)

| State | Major Metropolitan Areas | M&I Reuse | | | | Total Reuse for All Uses as % of Reusable Supply |
|---|---|---|---|---|---|---|
| | | Non-potable Reuse Water | Indirect Potable Reuse Water | Total M&I Reuse | | |
| | | AF | AF | AF | % | |
| WY | Cheyenne | 600 | 0 | 600 | 4 | 9 |
| CO | Front Range | 19,300 | 44,300 | 63,600 | 12 | 80 |
| UT | Wasatch Front | 1,500 | 0 | 1,500 | 0.6 | 1 |
| NM | Middle Rio Grande | 1,300 | 0 | 1,300 | 1 | 100 |
| NV | Southern Nevada | 17,500 | 200,400 | 217,900 | 45 | 99 |
| AZ | Central Arizona | 95,000 | 0 | 95,000 | 9 | 95 |
| CA | Coastal Southern California | 179,200 | 134,900 | 314,100 | 9 | 24 |
| CA | Salton Sea Basin | 8,700 | 0 | 8,700 | 6 | 65 |
| | Total | 328,400 | 379,600 | 708,800 | | |

Note:
Table presents reclaimed water that is delivered by municipal providers for M&I purposes only. Values do not represent the full amount of reclaimed water that may be used by industrial users, agricultural users or put to other beneficial purposes.

Southern Nevada currently reclaims nearly all of its wastewater, with return-flow credits and direct reuse (SNWA, 2009) totaling approximately 217,900 AFY in 2012. The return flow credits mechanism represents a particular case where indirect reuse is possible.

In the Front Range metropolitan area, approximately 64,000 AFY of reuse was reported in 2012. A significant portion of the reuse is developed through exchanges in which municipal return flows are provided to downstream agricultural users and exchanged for native river supply. It is estimated that about 80 percent of the reusable portion of the Front Range cities' wastewater is reused. Approximately 60 percent is reused for non-potable and potable M&I uses, while approximately 20 percent of the reusable portion of wastewater is used by downstream agricultural users.

Indirect potable reuse accounts for approximately 52 percent of all M&I reuse in the major metropolitan areas that receive Colorado River water, while direct non-potable reuse accounts for the remaining 48 percent. There are currently no known direct potable reuse facilities in operation in the major metropolitan areas that receive Colorado River water.

Accounting for both changes in per capita use and water reuse, M&I water demand could have been nearly 2.4 million AFY higher in 2010. This finding points to the considerable efforts that municipal water providers have made to reduce overall water demand.

While many of the M&I users receiving Colorado River water have diversified water supplies, implemented increasing water reuse, and aggressively implemented water conservation, dependence on Colorado River water appears to be growing. All major major metropolitan areas except Southern California reported the same or greater percentage of the total supply from the Colorado River in 2010 than in 1990. In many areas, the reliance on Colorado River water is due to the limited alternative water supplies. However, in California and Arizona, users have come to use their full apportionment of Colorado River water, so new growth in demand is being supplied by other water supplies or through conservation and reuse efforts.

## 3.5 Municipal and Industrial Water Conservation and Reuse Programs and Practices

The sections below describe M&I water conservation and reuse programs and practices.

### 3.5.1 Overview of Programs and Practices

Water conservation and reuse is practiced in all of the major metropolitan areas that receive Colorado River water. However, the types of water conservation and reuse practices and the extent to which they have been implemented vary among water providers and depend on many regionally specific factors such as climate, demographics, funding availability, water supply portfolios, and reliability.

*The types of water conservation measures and the extent to which they have been implemented vary extensively among municipal providers and among major metropolitan areas that receive Colorado River water based on water supply portfolios and reliability, climate, demographics, and available funding.*

Information about innovative or successful M&I water conservation and reuse programs and practices was provided by the Workgroup members. This effort did not intend to collect information on all of the programs and practices implemented in the Basin, but to solicit information on efforts that water providers felt were innovative or particularly effective for their service areas. From the information received, 33 programs were selected as case studies to represent the breadth of innovative water conservation and reuse efforts throughout the major metropolitan areas. The geographic locations and types of conservation or reuse practices represented in the case studies are shown on Figure 3-12 and detailed descriptions can be found in Appendix 3B.

This section begins with a summary of federal programs and activities that support or drive local-level implementation of water conservation and reuse activities. Then, based on information provided by the Workgroup, an overview of the types of M&I water conservation and reuse activites along with examples of programs and practices implemented throughout the Basin, including those selected as case studies, is provided. The programs and practices were organized into six categories of conservation: metering and billing, public education and outreach, water loss characterization and reduction practices, residential indoor practices, CII practices, outdoor landscaping practices, and one category for reuse.

### 3.5.2 Federal and State Assistance Programs

Federal and state governments provide leadership for water conservation and reuse programs and are an important source of technical and financial assistance for many water providers. Some agencies address regulatory mandates while others are voluntary programs, and the funding mainly comes in the form of loans or grant opportunities. According to the Workgroup, the federal programs providing the most support for M&I conservation and reuse in the major metropolitan areas that receive Colorado River water are the EPA’s WaterSense Program and the U.S. Department of Interior (DOI)’s WaterSMART (Sustain and Manage America’s Resources for Tomorrow) Program.

WaterSense, an EPA partnership program, seeks to help consumers make smart water choices that save money and maintain high environmental standards without compromising performance. Products and services that have earned the WaterSense label have been independently certified to be at least 20 percent more efficient without sacrificing performance. Products currently certified by the WaterSense program are toilets, bathroom sink faucets, urinals, new homes, showerheads, weather-based irrigation controllers, and commercial pre-rinse spray valves. New products soon to be certified include water softeners, sprinkler heads, soil moisture-based control technologies, and flushometer-valve toilets. Professional services such as certification programs for landscape irrigation professionals are also provided.

WaterSMART allows DOI agencies to work with States, tribes, water users, local governments, and nongovernmental organizations to pursue a sustainable water supply for the U.S. by establishing a framework to provide federal leadership and assistance on the efficient use of water, integrating water and energy policies to support the sustainable use of all natural resources, and coordinating the water conservation activities of the various DOI agencies. Reclamation plays a key role in the WaterSMART program as DOI's main water management agency. Focused on improving water conservation and helping water and resource managers make wise decisions about water use, Reclamation's portion of the WaterSMART program is achieved through the administration of grants, scientific studies, technical assistance, and scientific expertise.

Additional information on relevant federal and state programs related to water conservation is included in Appendix 3C.

### 3.5.3 Water Conservation Programs

M&I water conservation programs address areas of water use and delineate specific measures to help reduce water use. The following sections describe each of the program categories and include associated examples and case studies. While only a few examples are included for each program category, they serve as a good representation of the efforts many,water providers have implemented.

#### *3.5.3.1 Metering and Billing*

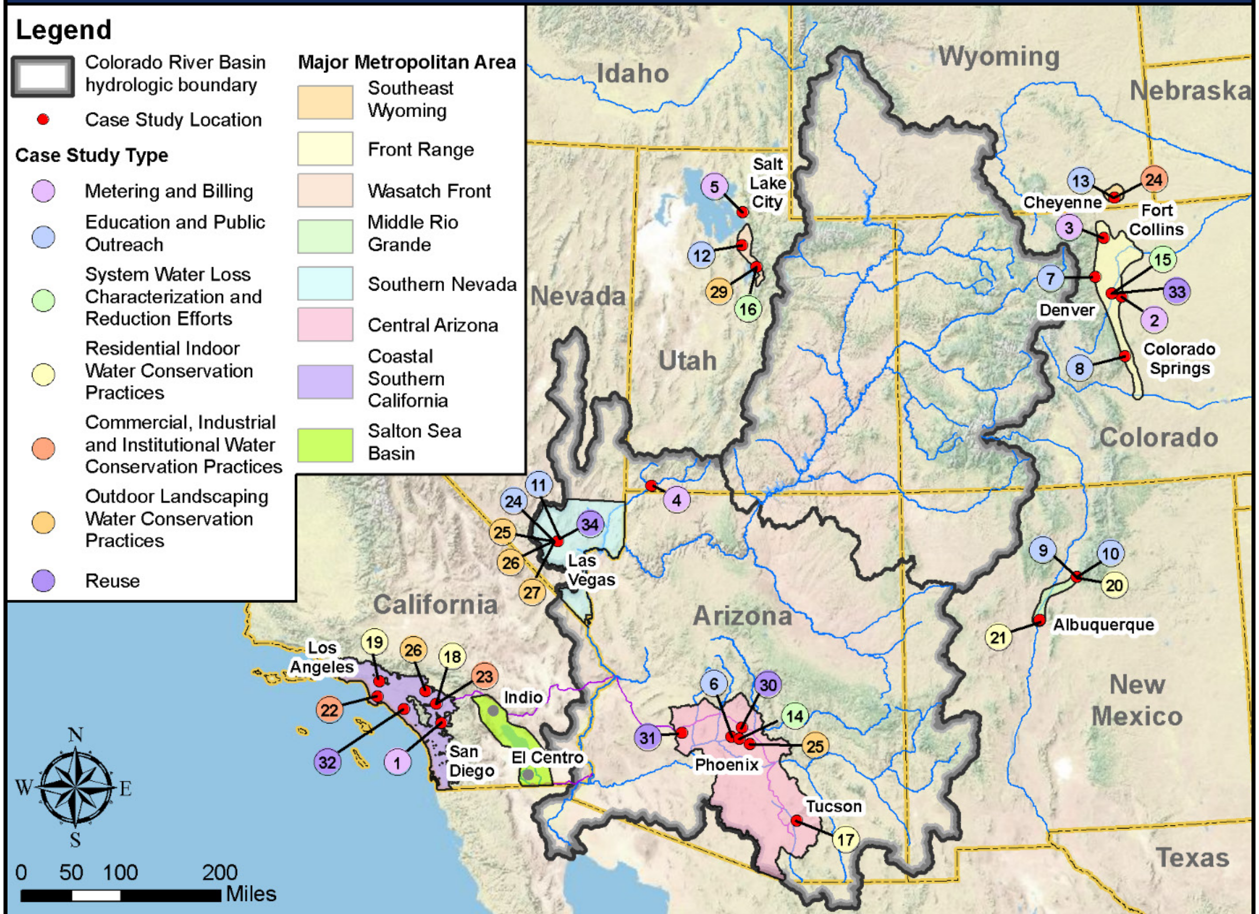
The conservation programs in this category use meters, billing structures, and consumer water use information to promote reductions in water use. Water metering is an essential element for water conservation because it improves understanding of water use, can support leak detection, informs billing structures, and can serve as a platform for communicating water use and conservation messages with consumers. The American Water Works Association's (AWWA) Water Conservation Program Operation and Management Standard (AWWA, 2013) recommends universal metering to best manage water resources.

Approximately, 95 percent of the users in the major metropolitan areas are metered. The City of Tempe in Arizona started metering water use in the 1930s, Colorado Springs was fully metered in the 1940s, and others such as Denver Water completed metering all customer water use in the 1980s. Similarly, SNWA and MWD members meter all customer water use. However, some water delivery service areas that receive Colorado River water are not fully metered. Current efforts focus on adding new meters to the system and upgrading existing metering infrastructure.

New metering systems are especially relevant in Utah's Weber Basin Water Conservancy District where a secondary system delivers untreated river water for residential irrigation. Historically, this secondary system has not been metered and water allocation and use was estimated based on parcel size. In 2010, the District began a program to install meters. To date, approximately 10 percent of Weber Basin's secondary connections are metered and the District anticipates 100 percent of the retail secondary water users to be metered within the next 10 years (Case Study 5).


Secondary Water Meter with Radio Transmitter
*Source: Weber Basin Water Conservancy District.*

**FIGURE 3-12**
Selected Water Conservation and Reuse Program Case Studies




| | | | |
|---|---|---|---|
| 1 | Water Budget-Based Tiered Rates | 18 | High Efficiency Clothes Washers |
| 2 | Water Use Efficiency Mapping and Identification Integrated with the System Incentive Program Project | 19 | Innovative Conservation Program |
| 3 | Home Water Reports | 20 | Albuquerque Bernalillo Water Conservation Program[2] |
| 4 | Water Conservation Easement | 21 | City Rebate and Water Bank Program |
| 5 | Secondary Water Metering (untreated residential irrigation) | 22 | Cash for Kitchens |
| 6 | Water—Use It Wisely® | 23 | Public School Retrofit Program |
| 7 | Commercial, Industrial, Institutional Water Audit Tool | 24 | National Center for Atmospheric Research – Wyoming Supercomputing Center Conservation Program |
| 8 | WaterSense® New Homes Builder Incentive Program | 25 | Parkway Improvement Districts Water Conservation Program |
| 9 | Water Conservation Planning Guide for Public Water Suppliers | 26 | Free Sprinkler Nozzles |
| 10 | Southwest Plant Selector Application | 27 | Water Smart Landscape |
| 11 | WaterSmart Innovations Conference and Exposition | 28 | Water Use Restrictions and Land Development Code |
| 12 | Slow the Flow, Save $H_2O$ | 29 | Central Utah Gardens[3] |
| 13 | Recycled Water Public Information and Outreach Campaign[1] | 30 | Reclaimed Water Distribution System |
| 14 | Distribution System Replacement and Repair | 31 | Zero Discharge: Palo Verde Nuclear Generating Station and Redhawk Power Plant |
| 15 | Denver Water Pipe Replacement Program | 32 | Crean Lutheran High School |
| 16 | Provo Reservoir Canal Enclosure Project | 33 | Denver Zoo Recycled Water |
| 17 | Conserve2Enhance™ [2] | 34 | Southern Nevada Water Reuse |

[1] Also relevant as a water reuse program case study.
[2] Also implemented in the CII and outdoor landscaping water use sectors.
[3] Also relevant as a public education and outreach program case study.

Most of the existing water meters in the metropolitan areas that receive Colorado River water are mechanical devices that lose accuracy with time and have a replacement cycle of 15 to 20 years. The AWWA Manual M6 (AWWA, 2012) recommends a planned meter replacement program to be implemented over a specified number of years to upgrade meters and incorporate new technology. For example, 10 percent of the meters could be replaced each year over a 10-year period.

- The cities of Buckeye and Peoria, and the town of Gilbert, in Arizona, are among those implementing such replacement programs. During the replacement process, some water utilities are opting to upgrade the meters to advanced or automated meter infrastructure.
- In the Colorado Springs Utility, starting in 2005, virtually all electric, gas, and water meters used for billing were converted from a manual meter reading system to an automated system.
- In New Mexico, the City of Santa Fe operates metering technology that stores usage profile data to pinpoint where water is being wasted to improve conservation efforts and save customers money.
- JVWCD, a Wasatch Front water supplier, is installing Advanced Metering Infrastructure in its retail service area.

Many municipal water providers that receive Colorado River water implement conservation-oriented rate structures, including tiered billing or budget-based rate structures, seasonal billing rates, and additional fees. In addition, some water providers have implemented billing information mapping and management systems to incentivize consumers' behavior to use less water because they save money and avoid being identified as a high water user.

Across Southern California, several agencies (such as Eastern Municipal Water District, Rancho California Water District, Irvine Ranch Water District, and Western Municipal Water District) have implemented budget-based tiered rates (Case Study 1). The billing systems use customer-specific information related to the number of persons per household and the size of the irrigated area to establish a water budget and develop tiered rates based on water use in relation to the water budget. Some places even integrate the condition of service-based water waste penalties into their water billing such as purveyors in SNWA's service area. This enhances conservation signaling through billing and in this particular area the penalties multiply if a customer fails to address the infraction.

In places where the metering infrastructure has been automated and billing information is being managed, successful programs have been identified. For example, the Home Water Report program in Fort Collins, Colorado (Case Study 3), is proving to be an effective way to help the city reach its water reduction goals. This program is based on research on social norms marketing; the idea is that much behavior is influenced by people's perceptions of what is "normal" or "typical."

In Colorado, Aurora Water's billing information management program is a good example of a sophisticated program. This program maps water efficiency to identify inefficient water consumers who are then offered incentives to reduce their water consumption (Case Study 2). Similarly, since 2009 the City of Goodyear in Arizona has sent letters to the top 1 percent of water users (based on use) to offer resources that may help them reduce their use; these resources include classes and home irrigation audits.

#### *3.5.3.2 Public Education and Community Outreach*

Conservation programs under the public education and outreach category often represent low-cost efforts to develop a conservation ethic among water consumers. Conservation programming and messaging work best when they are locally relevant and promote conservation behaviors as a community norm or way of life. These programs can support water conservation across all customer types such as residential or commercial users and have been implemented in all of the major metropolitan areas.

As expected, the intensity of public awareness campaigns increases during drought periods. The Drought Response Information Project was initiated by the City of Grand Junction, Colorado, in 2003 in response to a 2002 drought and has expanded to cover a broad spectrum of water conservation outreach. The City of Boulder, Colorado, partnered with a local non-profit to augment water conservation staff during drought, enhancing public outreach efforts when water restrictions were in effect.

Conservation education and training courses for professionals have been widely implemented in the major metropolitan areas that receive Colorado River water. Programs range from those targeting education for school children to irrigation workshops for property managers and landscape maintenance supervisors. For example, since 2006, the Water Watcher Youth Education Program has provided interactive classroom demonstrations for more than 120 classrooms and 3,560 elementary school students in Glendale, Arizona. Also, SNWA's Water Smart Contractor program provides partnering professional landscapers with training in best practices for installing water-conscious landscaping and features required proficiency examinations and ongoing monitoring of adherence to program expectations. In turn, SNWA provides brand labeling and promotional assistance and places the contractor in a list on its website which local residential and commercial property owners then may use.

The development and distribution of water conservation information has been important since at least the late 1970s. The method of disseminating water conservation information has changed with the use of social media, Web-based platforms, and software applications for hand-held devices, making it easier for customers to obtain relevant and timely material. Several examples of modern programs include:

- The Water–Use It Wisely® program (Case Study 6) developed by coalition partners in Arizona,
- The New Mexico Office of State Engineer's Water Conservation Planning Guide for Public Water Suppliers (Case Study 9) that provides tools and step-by-step water conservation planning directions and the Southwest Plant Selector application for identifying native plants for landscapes (Case Study 10),
- San Diego County Water Authority's eGuide to a WaterSmart Lifestyle for single-family homeowners is a resource for water use efficiency,
- The Slow the Flow, Save H2O campaign in Utah (Case Study 12).

Another tool used for public education and community outreach is the implementation of pilot-scale projects and public demonstration gardens to inform customers and the public about landscaping with low-water-use plants. Some new initiatives such as the Linen Exchange program in Southern Nevada that aim to reduce the linen washing water use at hotels, and the use of rainwater harvesting water for toilet flushing in Arizona, are being implemented as pilot projects to assess program effectiveness and to explore implementation at a larger scale.

The implementation of audits, certifications, and awards oriented to specific water use sectors has been used as an opportunity to perform strategic outreach and water use education. Examples of this type of program are the CII Water Audit Tool developed by the City of Boulder (Case Study 7).

There have been efforts in the Basin to link municipal water conservation with environmental benefits, creating opportunities for individuals to invest in watershed health and water resources. For example, the Water Resources Research Center's Conserve2Enhance program in partnership with Tucson Water allows residential and commercial participants to save water and then donate the value of their saved water to a program fund that provides funding for local and regional environmental enhancement projects (Case Study 17). Another example is the City of Santa Fe's Water Bank Program in which water saving credits derived from this program are deposited in the City's Water Bank and may be allocated for programs including affordable housing and the "living river" (Case Study 21).

#### 3.5.3.3 Water Loss Characterization and Reduction Efforts

Water losses occur in water distribution systems and are unavoidable. Obvious major breaks are addressed quickly, but smaller leaks can go undetected, resulting in significant water loss if not corrected. Various measures and actions are being taken throughout areas that receive Colorado River water to quantify and characterize these yet undetected losses and when economically feasible, eliminate these losses.

The AWWA has developed an industry standard best practices process for completing a water distribution system water audit (AWWA, 2009). Water losses are defined as the difference between (1) water supplied to the distribution system and (2) authorized consumption. Losses are further disaggregated into real losses and apparent losses. Real losses may include leakage from pipes and storage overflow. Apparent losses may include inaccurate metering, data handling errors, and theft. The AWWA audit process provides a systematic approach for identifying real and apparent losses and suggests ways of improving water loss characterization and reduction efforts.

The AWWA M36 manual (AWWA, 2009) outlines four pillars to reduce these water losses: pressure reduction, leak detection, pipe replacement, and speed and quality of repairs. A fundamental component of any water loss control program is an understanding of the existing levels of leakage and losses. The AWWA Free Water Audit Software© is considered an industry best practice for loss assessments, and the software is recommended by Colorado, New Mexico, and California. Arizona sets requirements for maximum allowable loss and unaccounted for water. In the other Basin States, water purveyors are conducting audits ahead of state recommendations.


Water distribution system leak detection
*Source: M.E. Simpson Co., Inc.*

Many municipal water providers in the major metropolitan areas that receive Colorado River water are substantially reducing their water losses. For example, the City of Tempe, Arizona, is conducting leak detection on approximately 200 miles of their distribution system annually, or approximately 20 percent of the total system. The program pays for itself through the reduction of water leakage (Case Study 14).

To reduce leakage, an active control program must be in place continuously, and methods such as acoustic leak detection must be applied. Denver Water is working to reduce real losses by proactively replacing pipe with the highest risk of failure. Denver has allocated approximately 10 percent of its total funds in capital programs toward pipe replacement to help reduce real losses. This program increases the reliability of its system by reducing failure of existing pipes and reducing leakage in the distribution system (Case Study 15).

Meter replacement reduces apparent losses by increasing the accuracy of new meters, which actually may increase revenue. Meter replacement also has a water conservation effect because appropriate water rates are applied and customers are charged for what they consume. The City of Tempe has a regular meter testing and replacement program that is focused on reducing water loss.

#### *3.5.3.4 Residential Indoor Water Conservation Practices*

Conservation practices for reducing residential indoor water use often include ordinances, and incentives for plumbing and fixture retrofits and the encouragement of the purchase of water/energy-efficient appliances.

Some cities receive Colorado River water began revising ordinances and initiating incentive programs to install low-flow toilets and fixtures in the 1980s. In 1986, the City of Glendale, Arizona, was the nation's first city to offer a toilet rebate program. Today most rebate programs are oriented toward homes constructed before 1994 when current federal plumbing standards for low-flow showerheads, faucets, and toilets were passed.

Most Basin states have adopted more restrictive standards (Appendix 3C) and have ordinances in place for new construction or home remodels to include changes to the existing plumbing system.

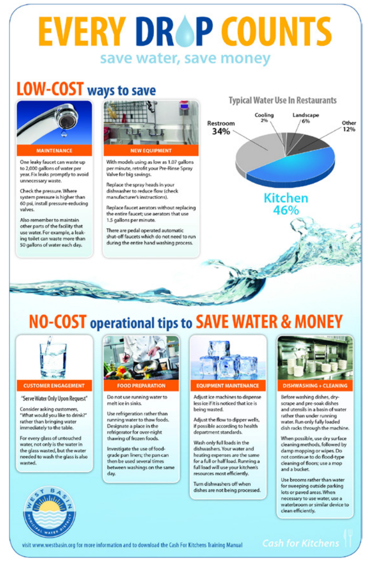
The changes in federal, state, and local construction standards or ordinances over the last decades helped to drive the rapid rate of installation of water-conserving devices and appliances. For example, in California the current standard for high-efficiency toilets (1.28 gallons or less per flush) is 20 percent lower than the national plumbing standard. These high-efficiency fixtures are the only toilets allowed to be purchased or installed in California. In response to statewide drought, the MWD increased its annual conservation and outreach budget from $20 million in fiscal year 2013-14 to $100 million in fiscal year 2014-15, providing additional rebate incentives for Southern Californians to purchase water-saving devices and to help meet the state's goal of a per capita water use reduction of 20 percent by 2020.

Most water providers receiving Colorado River water are partners in EPA's WaterSense Program, which encourages consumers to purchase water-efficient products and ensures consumer confidence in those products with a label backed by independent certification. Products carrying the WaterSense label are 20 percent more efficient than average products by reducing water and energy use, as well as meeting performance criteria.

For metropolitan areas that also support EPA's ENERGY STAR program, which promotes energy-efficient products and buildings, water-energy efficiency synergies can be realized. For example, Colorado Springs Utilities has implemented the WaterSense New Home Builder incentive program (Case Study 8) that builds on and complements the existing EPA ENERGY STAR New Home Builder Incentive Program. Through SNWA's successful Water Smart Homes program, partnering builders have constructed over 10,000 new highly water efficient residences. Another example is the Eastern Municipal Water District's program to help fund the installation of high-efficiency clothes washers through the Southern California Gas Company's energy savings assistance program (Case Study 18).

### 3.5.3.5 Commercial, Industrial, and Institutional Water Conservation Practices

Similar to residential indoor water conservation programs, retrofits and incentive programs to replace CII fixtures are also main components of water conservation programs. Many of the programs in this category are targeted to specific industries, commercial activities, or institutional users. For example, Arizona's Pre-Rinse Spray Valve Program (installing high efficiency pre-rinse spray values in the food industry) has been successfully implemented, saving both water and energy. Similarly, the West Basin Municipal Water District in California has implemented the Cash for Kitchens audit program (Case Study 22) that seeks to increase water efficiency with the introduction of water-saving devices, such as a pre-rinse sprayer and water broom, in more than 600 commercial kitchens.




*Source: West Basin Municipal Water District*

These types of programs have also been implemented in hotels, hospitals, corrections facilities, and schools. For example, the Public School Retrofit Program in California (Case Study 23), partially funded through the CALFED Water Use Efficiency Grant Program, was launched by the Eastern Municipal Water District to save water in public schools through the installation of water-efficient devices.

In industrial and commercial buildings with cooling towers, standards to reduce the volume of water used in the cooling process have been introduced. The National Center for Atmospheric Research Wyoming Supercomputing Center has reduced cooling energy used by up to 89 percent over typical data center configurations and reduced water use from evaporative cooling towers by 40 percent (Case Study 24). Similarly, the City of Tempe, Arizona, runs the Industrial Grants Program to offer incentives to businesses to make sustainable reductions in their water use. As part of this program, businesses must reduce their water use by at least 15 percent and sustain these levels of savings to qualify for the grants.

Another effort in the Basin has been the development of CII audit tools to support water agency efforts to reduce water use. The City of Boulder has developed a CII auditing tool that references EPA and U.S. Department of Energy standards for water and energy and seeks to produce simple reports to show savings and implement efficiencies (Case Study 7).

#### 3.5.3.6 Outdoor Landscaping Water Conservation Practices

Outdoor landscape irrigation is the single largest consumptive water use in the M&I sector. Outdoor water use can be as high as 60 percent of the total residential customer use and as much as 50 percent of the total M&I water use (EPA, 2014; California Department of Water Resources, 2010). Water conservation practices include water conservation demonstration gardens, landscape consultations and audits, landscape irrigation budgets, rebates, and incentives to use smart irrigation technology and/or convert landscaping and restrictions on irrigation amount and timing.

Outdoor landscaping irrigation efficiency measures have been the focus of many water providers. These measures seek to reduce excess irrigation and allow for improved irrigation efficiencies through best practices and new technologies. For example, the California Sprinkler Adjustment Notification System allows urban irrigators to voluntarily register to receive regular emails containing updated irrigation index factors specific to their sites. The factor is used to make global scheduling adjustments on irrigation timers that have a percentage adjustment feature. In Las Vegas, rebates have been implemented to increase the use of smart irrigation infrastructure such as pressure-reduction valves, backflow preventers, rain sensors, multi-setting sprinkler timers, and multi-stream rotor sprinkler heads. The town of Gilbert, Arizona, has reported about a 30 percent reduction in outdoor landscape water use resulting from a program in which water conservation staff worked directly with local parks and recreation staff, street right-of-way contractors, and Parkway Improvement Districts maintenance staff on water budgeting and irrigation maintenance best practices (Case Study 25). Onsite landscape consultation and development of water budgets for homeowners associations have also been implemented in multi-family buildings as a requirement to qualify for rebates.

Conversion of landscapes to low-water-use plants is an effective method for reducing water use. These programs seek to encourage conversion to attractive, low-water-use landscapes. For example, in Southern Nevada, an aggressive outdoor landscaping water use efficiency program has been implemented. SNWA has invested over $200 million in its Water Smart Landscapes program that offers up to $1.50 for every square foot of grass that is removed and replaced with low-water use landscaping (Case Study 27). A legally recorded covenant and grant of conservation easement and annual monitoring helps assure the long-term retention of the landscape. Similar programs encouraging landscape conversions have been implemented in MWD's service areas.

Finally, ordinances and regulations have been enacted in many of the major metropolitan areas to reduce outdoor water use. Ordinances and new development codes have been enacted to limit the amount of irrigated turf that can be included in new developments. Typically, they have been applied only to new developments for which the regulatory authority exists to adopt such limits. However, under drought conditions some states and water providers, through drought management plans, have implemented water use restrictions for the broader community.

Facing a 2003 drought, agencies in Southern Nevada enacted more stringent policies including limitations on installation of turf at new properties (Case Study 28). These include prohibiting installation of turf in most new developments. In multi-family units, turf was limited to private parks and at single-family homes, front yard-turf was prohibited with it limited to 50 percent of the backyard landscapeable area. Additional restrictions included seasonal watering restrictions, limitations on surface and vehicle washing, operation of water features and misters, and golf course water budgets. These limitations have now been placed into permanence in the interest of long-term sustainability goals.

No lawn in front yards of new homes
*Source: Southern Nevada Water Authority*

Similarly, local water agencies across California took action in the face of dry conditions in 2014, the state's third consecutive dry year. Many water providers called on customers to step up conservation efforts, while some have implemented mandatory restrictions on water use such as prohibiting watering lawns on consecutive days, refilling swimming pools, or using a hose to clean. An drought-related emergency regulation to increase conservation practices for all Californians was adopted by the California State Water Resources Control Board (CSWRCB, 2014). In 2014, the Governor of California's goal was to reduce overall statewide water use by 205 (State of California, 2014) percent during these drought conditions.

While these drought management measures are distinct from the long-term water conservation programs, some carryover impacts are often realized in years following droughts as landscapes are modified or technologies are adopted. The persistence of these drought-induced changes is an area of active study.

### 3.5.4 Reuse Programs

Municipal providers have implemented a range of reuse programs in the Basin. As water demands have increased in the past decades, water supplies available to water providers have not substantially increased. The potential for imbalances has led to increasing focus on reuse to meet existing or future demands. Three general categories of reuse describe the method in which reclaimed water is developed and used: direct non-potable reuse, indirect potable reuse, and direct potable reuse. The reuse categories are described in the following sections. Direct Non-Potable Reuse Programs

Direct non-potable reuse is the most widely applied type of reuse in the metropolitan areas that receive Colorado River water. In direct non-potable reuse, treated municipal wastewater is reused for non-potable purposes such as landscape irrigation, dust control, and power production and cooling. When agriculture is near municipal areas, treated wastewater can sometimes be used for irrigation of non-food crops. The reuse supply can also be used for some non-potable CII and residential uses, but dual plumbing is required, which substantially increases construction costs, so its current use is limited. Regardless of final end use, direct non-potable reuse water is distributed through a separate piping system from the municipal treated drinking water, requiring substantial investment. Direct non-potable reuse reduces the demand for treated water and helps avoid or defer the need to develop additional water supplies.

A range of direct non-potable reuse programs has been identified in the major metropolitan areas that receive Colorado River water, including the following.

- Colorado Springs has practiced wastewater reuse since 1961 through a program that serves numerous commercial, industrial, and municipal customers. Uses include turf irrigation at parks, cemeteries, schools, and commercial buildings; industrial uses include power production and process water. The water is used through a central distribution system and through customer-operated standalone reuse facilities.
- To address declining groundwater levels, the City of Scottsdale in 1989 required certain golf courses to begin using reclaimed wastewater, rather than groundwater or potable water, for irrigation. An innovative partnership between the City and the golf courses was formed to expand the reclaimed delivery system and enhance the City's wastewater treatment process with advanced treatment techniques including microfiltration and reverse osmosis.

Reverse Osmosis Train
*Source: Kathy Rall, Water Resources Advisor*

- The City of San Diego has built and operates two reclamation plants capable of producing 50,000 AFY combined. The supply is primarily used for landscape irrigation on roadways, golf courses, and parks. The reuse supply reduces the City's dependence on imported supplies.
- Denver Water moved forward with a non-potable reuse system in 2004. The system currently serves more than 80 customers with a distribution system

in excess of 50 miles of purple pipe; this is the largest project in the Front Range. The project is expected to have a build-out demand of 17,500 AF by about 2030. Since 2004, Denver Water's recycled wastewater is used in the Denver Zoo for animal exhibits (for example, outdoor pools), as well as for landscape irrigation and cleaning (Case Study 33).

- Santa Fe's wastewater treatment plant produces reclaimed water that is used for irrigating turf at golf courses and recreational playing fields, watering educational landscaping, construction and dust control, and livestock. The reclaimed water also makes up the majority of the flows in the Santa Fe River downstream of the wastewater treatment plant.
- Arizona's Palo Verde Nuclear Generating Station and the Redhawk gas-fired power plants annually use for cooling purposes about 70,000 AFY of reclaimed water purchased from the cities of Phoenix, Mesa, Tempe, Scottsdale, and Glendale which jointly own and operate the 91st Avenue Wastewater Treatment Plant in southwest Phoenix. Palo Verde is the only nuclear generating facility in the world that uses reclaimed water for cooling water (Case Study 31).
- The cities of Mesa and Chandler, Arizona, have water exchange agreements with the Gila River Indian Community to provide reclaimed water for agriculture use. The cities receive a portion of the community's CAP water in exchange for reclaimed water. Five AF of reclaimed water are provided in exchange for 4 AF of CAP water.
- Crean Lutheran High School is the first high school in the Irvine Ranch Water District service area and in California with dual-plumbed buildings. The dual system serves two buildings with more than 500 students and 30 staff members. The recycled water is also used to irrigate its 9 acres of landscaped area. The District encourages the use of recycled water for non-potable purposes through customers discounts (of 10 to 40 percent) when purchasing recycled water (Case Study 32).
- The Phoenix Rio Salado Habitat Restoration Project opened in 2005. A series of five reclaimed water wells is the main source of water for the vegetation and wetland areas in the Rio Salado Habitat area. The wells recover reclaimed water stored underground at the Roosevelt Irrigation District Groundwater Savings Facility. The expected project requirement is about 4,000 AFY.
- In the Wasatch Front, water reuse projects are currently in the planning stages with implementation expected within the next 5 years to satisfy CUWCD reuse requirements under CUP repayment and water sales agreements. Heavy use of secondary (non-potable) water systems for outdoor irrigation purposes has helped to defer expensive water reuse projects. In JVWCD's service area, secondary water is delivered through the use of Utah Lake water that was historically diverted into myriad canal systems for agricultural irrigation purposes. As agricultural lands are developed for urban purposes, this water is being converted to secondary use purposes and placed into separate secondary water systems. Future reuse water is expected to be of similar water quality to the current Utah Lake water used in secondary systems.
- In Southern Nevada, the City of Boulder City, City of Las Vegas, City of North Las Vegas, and Clark County Water Reclamation District operate central and satellite wastewater treatment plants providing approximately 19,000 AF of water for direct non-potable reuse annually for the period 2008 through 2011.

Another method for direct non-potable reuse is through exchange agreements or water rights trades with downstream users. For example, Denver Water uses its reusable wastewater flows and lawn irrigation return flows in water rights river exchanges to increase its diversion of upstream water.

#### 3.5.4.1 Indirect Potable Reuse Programs

Indirect potable reuse programs include treated wastewater that is stored underground or in surface water reservoirs for subsequent use as a raw water supply to be treated again for potable purposes. In some cases, local exchange programs are used to recapture reusable wastewater, and credits are accrued through the delivery of effluent to storage facilities from which reclaimed water is indirectly used.

Unique indirect potable reuse programs within the major metropolitan areas include the following:

- In Central Arizona, indirect potable reuse has been widely implemented through underground storage of reclaimed water for future use to replace the use of the non-renewable groundwater supplies. The Salt River Project, working with partnering cities, has developed two underground storage facilities to ensure a reliable and adequate water supply for several cities near Phoenix: the 93,000 AFY Granite Reef Underground Storage Project (GRUSP) and the 75,000 AFY New River-Agua Fria River Underground Storage Project (NAUSP). In addition to water from the Salt and Verde Rivers and CAP water, the GRUSP receives reclaimed water via pipeline from the City of Mesa water reclamation facility, and the NAUSP receives reclaimed water from reclamation facilities of Glendale and Peoria. GRUSP was the state's first major underground storage facility, and one of the largest of its kind in the U.S.

- Indirect potable reuse is accomplished through the Colorado Springs Exchange program. The Southern Delivery System was built to increase the ability to deliver exchanged water from Pueblo Reservoir back to Colorado Springs, making the system a massive indirect potable reuse project. Colorado Springs, through the exchange program, currently reuses 100 percent of its legally reusable return flows and has done so for many years. Colorado Springs Utilities has also invested in water rights and infrastructure to recapture and reuse much of its reusable wastewater and outdoor irrigation return flows through exchanges on the Arkansas River. The Prairie Waters Project in Aurora, Colorado uses both natural cleansing processes and state-of-the-art purification technology to deliver an additional 10,000 AFY to its users. In most cases, Aurora's water rights in the South Platte allow the city to use the water "to extinction." Essentially, this means that the water residents use for washing, laundry, showering, as well as some of the water from lawn watering, can be recovered by diverting an equivalent amount from wells adjacent to the South Platte River.
- Southern Nevada currently reclaims most of its wastewater through Colorado River return-flow credits (Case Study 34). By treating Colorado River water after it is used and returning it to Lake Mead, via the Las Vegas Wash, SNWA is able to extend its Colorado River resources. For every gallon of treated Colorado River water returned to the Colorado River, SNWA can withdraw and use an additional gallon beyond Nevada's base allocation (SNWA, 2009).

#### *3.5.4.2 Direct Potable Reuse Programs*

By definition, direct potable reuse is the direct injection of purified municipal wastewater into either the drinking water distribution system or the intake of a water treatment plant without first subjecting the water to an environmental barrier such as an aquifer or reservoir. Direct potable reuse has been a topic of discussion for 50 years and numerous research studies, including two performed in San Diego County over the last 15 years, have provided evidence that it can be done safely. However, despite this fact, the U.S. currently has only two large public agency direct potable reuse treatment projects, and these projects have only recently been commissioned (Martin, 2014).

Studies are underway in some states to establish the feasibility and criteria for permitting direct potable reuse. For example, California Water Code Sections 13560 through 13569 require the California Department of Public Health in consultation with the California State Water Resources Control Board to investigate and report to the Legislature on the feasibility of developing uniform water recycling criteria for direct potable reuse by December 31, 2016. The law also requires an expert panel to be appointed to perform the following.

- Assess what, if any, additional areas of research are needed to be able to establish uniform water recycling criteria for direct potable reuse
- Advise the Department of Public Health on public health issues and scientific and technical matters regarding development of uniform water recycling criteria for indirect potable reuse through surface water augmentation
- Advise the Department of Public Health on public health issues and scientific and technical matters regarding the feasibility of developing uniform water recycling criteria for direct potable reuse

As a result of the Governor's Blue Ribbon Panel on Water Sustainability (2009-2010), WateReuse Arizona launched the Steering Committee on Arizona Potable Reuse in 2012 to identify opportunities to enhance the State's regulatory framework for potable reuse and develop a roadmap for communities to use in developing future water reuse projects. The Steering

Committee completed its Phase I efforts in 2014, including:

- Completion of advisory panel workshops on treatment technologies, unregulated constituents, public acceptance, and regulatory frameworks; and
- Planning for Phase II activities, which will include a public forum on potable reuse for small communities.

## 3.6 Planned Conservation and Reuse

This section evaluates the effects of future plans for water conservation and reuse in the Basin. Planned water conservation efforts were identified by reviewing water resource plans from major municipal water suppliers and estimating the potential overall impact of the programs or associated per capita water use targets. The total potential water savings by 2060 was estimated conservatively by assuming that planned targets would be met but that no other additional efforts would continue after meeting the established targets.

M&I water providers will continue to increase the efficiency of water use and reuse in the Basin and these efforts play an important role in reliably meeting future demand. Most water providers in the Basin have established long-range water management strategies that include both supply enhancement and demand reduction measures. Water reuse is practiced widely in these metropolitan areas as a supply augmentation or enhancement measure, while water conservation is generally described as a water demand reduction measure.

State water resource planning efforts and conservation targets are commonly used as the minimum conservation and reuse levels for water provider resource planning. The M&I water conservation and reuse tools included in these plans generally consist of programs and practices described in Section 3.5 of this report. The water reuse levels being targeted in each area are region-specific and are generally balanced with the increased water demands, available supplies, water rights and regulatory framework, and the costs associated with meeting the water needs of these individual communities.

The most relevant water resource and conservation planning documents for the metropolitan areas are summarized in the sections below. Comprehensive information on future water conservation goals was not identified for the Southeast Wyoming and Salton Sea Basin metropolitan areas.

### 3.6.1 Front Range

In 2006, Denver Water set a conservation goal to reduce water use to 165 GPCD by 2016. This reduction represents a 22 percent reduction from average pre-2002 drought use of 211 gallons per person per day. The estimated annual water conservation savings are approximately 55,000 AF. Denver Water is currently in the process of setting new conservation goals for beyond 2016. The Denver Water master plan identifies almost 300 potential customers (up from 100 in the 2004 update), which will help Denver Water reach its goal of delivering 17,500 AF of recycled water each year. The recycled water system will free up enough drinking water to serve nearly 43,000 homes by 2020. In addition to conservation and reuse practices, Denver Water has partnered with 17 other entities to form the Water, Infrastructure, and Supply Efficiency partnership that will provide new supply by combining unused capacities in Aurora Water's Prairie Waters Project with unused reclaimed water supply from Denver and Aurora. Then, during years when Denver and Aurora do not need all of the reclaimed water, the 15 Douglas County entities (South Metro Water Supply Authority) can buy the unused water to help reduce their reliance on nonrenewable groundwater.

Colorado Springs Utilities estimates that the amount of water that will be saved when the 2008-2012 Water Conservation Plan is fully implemented will equal approximately 7.6 percent of the 2007 demand forecast. The water conservation goals established for the 2008-2012 Water Conservation Plan include maintaining low residential use per capita, already among the lowest in Colorado. For the commercial market, the primary goal is to gain a better understanding of how commercial customers use water in an effort to reduce commercial use.

From 2005 through 2007, Colorado Springs Utilities went through the rigorous process of identifying and selecting water conservation programs for implementation. Colorado Springs Utilities developed and managed a portfolio of 23 water conservation programs starting in 2008. Colorado Revised Statute Section 37-60-126 requires that Colorado Springs Utilities consider nine specific measures and programs in the 2008-2012 Water Conservation Plan:

- Water-efficient fixtures and appliances, including toilets, urinals, showerheads, and faucets
- Low-water-use landscapes, drought-resistant vegetation, and removal of phreatophytes and efficient irrigation
- Water-efficient commercial and industrial water-using processes
- Water reuse systems
- Distribution system leak identification and repair
- Dissemination of information about water use efficiency measures, including public education, customer water use audits, and water-savings demonstrations
- Water rate structures and billing systems designed to encourage water use efficiency in a fiscally responsible manner
- Regulatory measures designed to encourage water conservation
- Incentives to implement water conservation techniques, including rebates to customers to encourage the installation of water conservation measures

Colorado Springs Utilities develops and maintains long-range plans for all water system facilities. Specific to water supply, they use an integrated resource approach to plan for facility improvements and additions.

In its 1996 Water Resource Plan, Colorado Springs Utilities identified four major components to help meet future water needs for Colorado Springs: conservation, non-potable water development, existing system improvements, and a new major water delivery system. The Southern Delivery System is a regional water project that transports stored water in Pueblo Reservoir to Colorado Springs and its project partners, Pueblo West, Security, and Fountain. With all major approvals and permits secured, construction of Phase 1 of the Southern Delivery System began in 2010.

### 3.6.2 Wasatch Front

Along the Wasatch Front and throughout Utah, the largest water districts have formed partnerships and combined resources to implement water conservation initiatives benefiting the State. These partners include JVWCD, CUWCD, Weber Basin Water Conservancy District, MWDSLS, Washington County Water Conservancy District, and the State Division of Water Resources. Examples of programs implemented include (1) a statewide water conservation education media campaign called Slow the Flow, Save H2O, and (2) a residential and large-user water audit program.

In 2012, JVWCD established a water conservation goal of reducing water use 25 percent by 2025, using 2000 as the baseline year for measurement purposes. If this goal is achieved in the JVWCD service area, water use will be reduced from 255 GPCD to 191 GPCD by 2025, facilitating a water savings of 52,000 AFY by 2025 and 71,000 AFY by 2050.

In Utah, state law provides that every water provider with more than 500 connections prepare a water conservation plan, update the plan every 5 years, and submit the plan to the Utah Division of Water Resources. JVWCD recently completed its 2014 Water Conservation Plan Update, which included a rigorous process of identifying water conservation programs and measures to implement over the next 5 to 10 years as it aggressively pursues its water conservation goal. JVWCD identified the following eight programs or measures to implement:

- Continue to build on and enhance existing programs including; provide leadership on the statewide Slow the Flow, Save H2O public education and media campaign; JVWCD’s local public relations outreach and education programming efforts; continued expansion and development of the water conservation education gardens, known as the Conservation Garden Park; the homeowner and large-user water audit program; and the Member Agency Grant Program.
- Encourage and incentivize member agencies to meter and provide for volumetric billing of all secondary water use.
- Assist and provide incentives for the construction of water reuse projects achieving 7,000 AFY in reuse of CUP water by 2025.
- Install Advanced Metering Infrastructure (AMI) in the JVWCD retail service area providing for effective customer feedback on water use, social norming, and high-use targeting.
- Encourage and incentivize all member agencies to install advanced metering infrastructure through

the grant program and JVWCD technical assistance.

- Pursue wide-scale adoption of water-wise landscape ordinances by member agencies.
- Provide additional JVWCD-operated service area-wide water conservation programs including high-flush toilet replacement programs, water-wise landscaping incentive programs, and a large-user water-efficiency grant program.
- Provide for increased water conservation staffing needs by adding approximately four new staff over the next 5 years.

To meet each of these initiatives, JVWCD projects increasing water conservation-related expenditures from an annual cost of about $1 million to $1.8 million over the next 5 years.

The CUWCD is the federal government's administrator for the CUP. Among other water delivery contracts, CUWCD has current contracts in place to deliver nearly 100,000 AF of CUP water to the service areas of JVWCD and MWDSLS.

Under the CUP Completion Act (CUPCA), CUWCD is empowered to administer and manage the completion of the CUP. Section 207 of the CUPCA authorizes a comprehensive program to study and improve water management within CUWCD and to achieve yearly water conservation goals through implementation of various water conservation measures.

These water conservation measures are implemented through the CUPCA Conservation Credit Program, which has now completed its 16th year of operation. Thirty-seven projects have been implemented. In 2013, 134,489 AF of conservation was realized, greatly surpassing the 2013 water conservation goal of 49,622 AF under the current CUPCA Water Management Improvement Plan. The program has provided partial funding for several JVWCD water conservation programs. In the near future, the program is expected to assist in funding reuse projects to meet goals and requirements in CUPCA repayment and water sales agreements.

Similarly, the Weber Basin Water Conservancy District has asked each member agency in its entire service area to reduce per capita consumption by at least the state conservation goal. Because the District has such a large secondary component, a separate conservation goal has been established for indoor and outdoor water use. Because outdoor water use has a larger potential for conservation, the District established a goal of reducing per capita outdoor water use by 34 percent by 2025. Correspondingly, the District established a goal of reducing per capita indoor water use by 10 percent by 2025. Based on the historical distribution of water use between indoors and outdoors, achieving these two goals will result in a total reduction in water use of 25 percent.

The Weber Basin Water Conservation District is actively pursuing opportunities for wastewater reuse. Based on preliminary discussions with each major wastewater treatment plant in the District, potential reuse projects could result in 8,000 AF of additional water supply. This water would be used in existing secondary systems and would yield the same amount of water in both dry and average water years. Even with the full development of all additional water supply sources currently being considered by the District, supply will be inadequate to meet projected demands without conservation. Therefore, conservation is essential to the District's supply plan. The water supply plan depends on significant agricultural water conversion and growth in the use of supplies from secondary water providers. This and the reduction in existing demand through conservation will allow a portion of Weber Basin Project water to be removed from secondary usage and transferred to potable use. Even if this goal is met, population in the District's service area is expected to double during the next 45 years and expensive, new water sources will be required. Conservation will help minimize and postpone the need for these new sources.

### 3.6.3 Middle Rio Grande

The ABCWUA's water conservation goals for 2024 are lower than those previously established because the Authority has already made significant reductions in water usage. The original conservation goal was to reduce use by 30 percent from 250 GPCD to 175 GPCD from 1995 to 2005. However, once the goal was reached in 2011, a further goal of reducing use by another 14 percent in 10 years was established with a GPCD goal of 150 by 2014. The current goal is to reduce use 10 percent over the next 10 years to reach a GPCD of 135 by 2024. The ABCWUA will begin implementation of six programs in fiscal year 2014 based on customer input. Programs that were not ranked in the top six may be considered for implementation in the future after the top six programs have been implemented and evaluated. The programs considered for immediate actions are:

- Increase education: Expand education programs to serve the Middle Rio Grande metropolitan area and a larger number of students in the service areas.
- Building codes: Work with state, municipal, and county agencies and area stakeholder groups to develop legislation to require updates to current building codes that will benefit conservation without being financially burdensome to new development.
- Test your toilet month campaign: Promote a month when all customers are encouraged to test their toilets for leaks and make repairs, with particular emphasis on multi-family housing.
- Rebate donation program: Provide customers the option to donate 10 to 100 percent of their water conservation rebate to help fund new conservation programs.
- Toilet rebate program: Have a licensed plumber sign off on the rebate form or have an ABCWUA inspection of the new toilet installation.
- Xeriscape rebate program changes:
  - Increase the rebate for commercial, institutional and industrial customers to $1.50 per square foot for all projects and to $2 per square foot for slopes and small areas.
  - Offer a rebate of $0.75 per square foot for converting high water use grass to lower water use grass, even if it uses spray irrigation.
  - Increase the rebate for landscapes irrigated with harvested rainwater to $2 per square foot.
  - Provide an additional $50 per tree credit to cover the cost of tree irrigation systems when xeriscape is installed and offer rebates for tree moisture sensors.

### 3.6.4 Southern Nevada

SNWA has a demonstrated record of establishing and achieving regional water conservation goals since the 1990s. The pace of conservation slowed in 2000, and SNWA launched additional conservation planning efforts. In the early 2000's, for the first time, Nevada needed its full Colorado River allocation as well as its return flow credits to meet demands. At the same time, drought conditions had been occurring for several years, so SNWA's conservation planning efforts evolved into a drought planning initiative. This drought planning effort resulted in the adoption of a drought plan and a suite of aggressive drought conservation measures. In 2005, SNWA made the major temporary drought measures permanent, and these programs remain in place as a means to achieve SNWA's water conservation goals.

SNWA's current water conservation goal adopted in its 2009 Water Resource Plan (SNWA, 2009) is to achieve a goal of 199 GPCD by 2035. The estimated total savings are 276,000 AF per year by 2035, including projected water reuse relative to historical water use patterns. A sampling of SNWA conservation programs is summarized below. Additional details are available in SNWA planning documents (SNWA, 2009 and SNWA, 2014).

- Water Pricing: SNWA's member agencies set water rates independently; all use similar principles to implement conservation-oriented water rates to encourage water conservation.
- Incentive Programs: SNWA offers rebates to assist residents with the purchase of pool covers, smart irrigation controllers, and rain sensors. SNWA also provides a Water Efficient Technologies Program with financial incentives available for commercial and multi-family customers for installation of water-efficient devices saving at least 250,000 gallons. The SNWA Water Smart Landscapes program developed in 1999 offers $1.50 per square foot to convert lawn to water-efficient landscaping. Since 1999, the program has resulted in the conversion of more than 170 million square feet at a $190 million savings, resulting in an estimated savings of 29,000 AF annually, with a total of nearly $200 million for all incentive programs.
- Regulations: SNWA and the member agencies adopted landscape and plumbing codes in the mid-1990s to limit water use. In 2003, the code adoptions were followed by drought-related policies limiting landscape watering schedules, vehicle washing, misting systems, golf course water budgets, and turf installation in new development. In 2009, based on input from a citizen's advisory committee, SNWA and member

agencies permanently adopted the 2003 drought-related policies as long-term conservation measures.

- Education: SNWA maintains an education and public outreach campaign to assist residents and businesses with conservation efforts. This campaign includes the Water Conservation Coalition, WaterSmart Innovations Conference (Case Study 11), H2O University, a conservation helpline, and several demonstration gardens.

Water reuse in Southern Nevada is driven by SNWA's ability to use the return of its treated wastewater to Lake Mead as return flow credits. These credits constitute approximately 40 percent of the area's Colorado River supply. The Las Vegas Valley returns most of its treated wastewater back to the Colorado River via the Las Vegas Wash for indirect reuse as return-flow credits. Treated wastewater is also directly reused for golf course and other turf irrigation as well as other non-potable uses. Although this direct reuse means the reclaimed water is not returned to treatment facilities and cannot be used for return flow credits, it does replace the use of potable water for purposes such as irrigation.

SNWA's shortage response plan outlines several scenarios to offset drought impacts based on the severity of Colorado River supply conditions. The plan includes tools to increase alternative water supplies such as Intentionally Created Surplus, banked resources, heightened conservation measures, and development of in-state groundwater resources. Meeting projected demands through 2060 will require both the efficient use of existing and future supplies and the development of additional water resources.

### 3.6.5 Central Arizona

In 1980, Arizona passed the Groundwater Management Act to reduce the state's heavy reliance on groundwater. As required by the Act, the ADWR is currently developing the management plans for the Fourth Management Period (2010- 2020) for the state's AMAs. The Central Arizona metropolitan area covers the Phoenix, Tucson, and Pinal AMAs, where all M&I uses of Colorado River water delivered by the CAP occur. The management plans are designed to reach the goal of each AMA by increasing conservation requirements for all water users. The management goal for the Phoenix and Tucson AMAs is safe-yield by 2025. Safe-yield is a long-term balance between the amount of groundwater pumped in the AMA and the amount of recharge in the AMA.

Because of decreased funding in recent years, ADWR is still drafting the Fourth Management Plans. Once ADWR formally proposes the plans, it will hold public hearings prior to plan adoption. ADWR's findings after the hearing and its order adopting a plan are subject to judicial review.

Projecting future water demand based on yet to be formalized management plans may seem speculative, but recent research has revealed that nearly all municipal water providers have been experiencing large, and often unanticipated, drops in demand over the last 15 to 25 years (Woodard, 2014a). Several cities have greatly exceeded their conservation targets set by ADWR's Third Management Plans.

Detailed analysis has revealed an array of factors that reduces indoor demand, including voluntary ENERGY STAR and WaterSense standards for appliances and fixtures, and state-enacted mandatory efficiency standards that appear to be causing retailers to stock only more efficient fixtures and appliances.

Outdoor demand has also dropped, reflecting the reduction of turf and number of backyard pools. In rapidly growing areas, average residential water demand has been reduced by the addition of new, more water-efficient homes to the housing stock.

Nearly every city analyzed has experienced annual household water use declines of 1.5 to 2.5 percent over the past 10 to 15 years. Tucson Water has seen an annual average decline of 2.3 percent in per-household demand, with nearby providers experiencing similar rates of decline. The figure for the Phoenix metropolitan area, based on analysis of demand patterns in Chandler, Gilbert, Glendale, Mesa, Peoria, Phoenix, Scottsdale, and Tempe, is 2.1 percent per year in per-household demand (Woodward, 2014b).

Some of these declines in demand can be attributed to specific conservation measures, but demand is also being reduced because of preferences for water-efficient fixtures, appliances, and landscapes. These changes in preferences have certainly been influenced, and even driven, by conservation measures designed and implemented to alter perceptions and facilitate the adoption of more efficient landscapes, fixtures, and appliances.

Despite a 29 percent increase in the number of homes, total deliveries to single-family residences in Maricopa County were 2 percent lower in 2013 than in 2000. Tucson Water's 2013 deliveries to single-family residences in 2013 equaled deliveries in 1989. Demand has become decoupled from population, and the downward trends will almost certainly continue for some time to come (Woodard, 2014b).

### 3.6.6 Coastal Southern California

Consistent with the State of California's municipal water provider reduction targets, MWD has established a conservation target based on a GPCD reduction of 20 percent by 2020. MWD's strategy for ensuring regional reliability is embodied in the 2010 update to the Integrated Water Resources Plan (IRP) (MWD, 2010). The IRP seeks to stabilize MWD's traditional imported water supplies and meet needs for the region's growth through a successful adaptive management approach with emphasis on conservation and local supply development. In fiscal year 1990, conservation and recycling represented 7 percent of supply, in fiscal year 2014, 28 percent, and by 2035, the planned share is 33 percent. Combined with the increase of other local supplies, the imported Colorado River share would decrease from 26 to 14 percent. The estimated annual conservation target is about 860,000 AF. Most of the previously described conservation and reuse programs will continue.

In 2011, MWD's Board of Directors adopted a Long-Term Conservation Plan that was developed in collaboration with its member agencies, retailers, and other stakeholders. The goals of the plan are to (1) achieve the conservation target in the 2010 IRP Update, (2) pursue innovation that will advance water-use efficiency, and (3) transform the public's perception of the value of water within the region. The plan identifies five key strategies to achieve these goals: use catalysts for market transformation, encourage action through outreach and education, develop regional technical capability, build strategic alliances, and advance water efficiency standards.

In 2013, MWD issued a request for proposals to its member agencies for technical studies and pilot projects that facilitate future production of recycled water, stormwater capture, seawater desalination, and groundwater resources. As an outgrowth of the MWD IRP, this "Foundational Actions Funding Program" involves low-risk actions that ensure the area's readiness to implement new water supply projects, if and when necessary. MWD entered into 13 contracts for technical studies and pilot projects totaling $3 million in matching funds. These projects are due to MWD in early 2016.

### 3.6.7 Summary of Planned Conservation and Reuse

Water providers in the metropolitan areas that receive Colorado River water have invested significantly in M&I water conservation and reuse programs over the past decades. As discussed in Section 3.4, M&I water conservation and reuse have played an important role in reducing demand by nearly 2.4 million AFY when comparing 1990 and 2010 use rates. Looking to the next several decades, water providers are planning to continue to advance water conservation and reuse programs to reduce water demand and more effectively manage their water supplies.

The main conservation and reuse targets for several water providers in the major metropolitan areas that receive Colorado River water are summarized in Table 3-7. These providers serve a population of more than 28 million, which represents nearly 85 percent of the population that receives Colorado River water for M&I purposes.

Many water providers establish conservation targets that include both overall per capita reduction goals and a suite of water conservation and reuse best management practices. As shown in Table 3-7, several water providers are reaching the end of their current water conservation planning periods, while others have targets that extend through mid-century. Plans are periodically updated to continue to advance water conservation through the next planning periods for these water providers. Per capita water use reductions of up to 25 percent by 2025 are planned by some water providers.

**TABLE 3-7**
Water Provider Planned Water Conservation Targets

| Agency or Management Area | Population Served (2010) | Projected Population Served (2030) | GPCD Reduction Target | Baseline Year | Target Year | Best Management Practices Target |
|---|---|---|---|---|---|---|
| Denver Water[1] | 1,310,000 | 1,733,900 | 22% (165 GPCD) | 2002 | 2016 | |
| Colorado Springs Utilities[2] | 445,700 | 626,400 | 19%* (149* GPCD) | 2010 | 2050 | No |
| Aurora Water[3] | 325,100 | 456,900 | 10% (140 GPCD) | 2002 | 2030 | |
| JWVCD[4] | 585,400 | 762,200 | 25% (191 GPCD) | 2000 | 2025 | Yes |
| MWDSLS[5] | 385,300 | 464,100 | 25% (228 GPCD) | 2000 | 2025 | No |
| ABCWUA[6] | 606,800 | 809,400 | 10% (135 GPCD) | 2011 | 2024 | No |
| SNWA[7] | 1,956,900 | 2,422,700 | 20%* (199 GPCD) | 2009 | 2035 | No |
| Phoenix AMA | 3,701,600 | 5,197,300 | *Conservation requirements in the Third Management Plans have been met. New requirements will be set in the Fourth Management Plan, currently under development.* | | | |
| Tucson AMA | 835,600 | 1,059,600 | | | | |
| MWD[8] | 17,977,900 | 20,753,600 | 20% (145 GPCD) | 1995-2005 | 2020 | Yes |

*Estimated values based on water plan documents because specific values were not provided.
[1] Denver Water, 2014
[2] Colorado Springs Utilities, 2008
[3] City of Aurora, 2007
[4] JVWCD, 2014
[5] MWDSLS, 2014
[6] ABCWUA, 2013
[7] SNWA, 2009
[8] MWD, 2014

Based solely on the reported conservation targets and population projections through 2030 (U.S. Census Bureau, 2013e), it is conservatively estimated that for the water providers for which numeric targets were identified, water demand in 2030 will be about 700,000 AFY lower than those estimated with 2010 per capita water use rates. Additionally, based on a national survey of planned water reuse programs (Association of California Water Agencies et al., 2013), it is estimated that approximately 400,000 AFY of new reuse supply may be added by 2030 to the water portfolios of water providers that receive Colorado River water. However, in some states such as California, reuse is included when calculating per capita water use, so adding the 2030 water conservation savings and reuse values for a total water use reduction may not be appropriate.

*Based solely on the reported conservation targets and population projections from the U.S. Census through 2030, for the water providers for which numeric targets were identified, water demand in 2030 will be approximately 700 KAFY lower than that estimated with 2010 per capita water use rates. Additionally, based on a national survey of planned water reuse programs, approximately 400 KAFY of new reuse supply may be added by 2030 to the water portfolios of water providers that receive Colorado River water.*

The M&I water conservation estimates provided here are considered conservative in that no further reductions in per capita water use were assumed after achieving the stated targets even if the time period for the achievement of the target was earlier than 2030. For example, MWD's conservation target is based on achievement by 2020. For this analysis, it is assumed that, after achieving the target in 2020, no further reductions in per capita use would be implemented for the next 10 years. M&I water providers that receive Colorado River water will continue to update and advance water conservation and reuse, and subsequently reduce water demands, over the coming decades and in response to evolving water supply conditions.

Although conservation and reuse is critical to helping ensure reliable water supplies in the Basin, their direct impact on the demand for Colorado River water is uncertain. The impact depends on economic, policy, legal, and environmental considerations that are integral to state and local water management decisions. Most of the major metropolitan areas in the Basin have multiple sources in their water supply portfolio. In total, Colorado River water constitutes less than half of the total supplies available to the major metropolitan areas that are situated outside of the hydrologic basin. M&I water conservation and reuse have reduced the growth in demand, despite large population growth in the major metropolitan areas that receive Colorado River water, and in some cases, M&I water use has not increased in the past decade. These efforts have reduced the amount of new water supply that may have been needed from the Colorado River or other sources. In some cases, groundwater management objectives or economic factors are the principal drivers in the selection of which of the water supplies are not used when demand levels do not increase as rapidly as projected. In other cases, water quality considerations may influence the selection of water sources.

*Municipal providers in the major metropolitan areas that receive Colorado River water manage their water supplies conjunctively and some must use surface water supplies first to protect groundwater or prevent groundwater mining and its consequences. Additional M&I conservation and reuse has the potential to reduce the amount of future development of Colorado River water. However, in many major metropolitan areas, conservation and reuse may not result in substantial reductions in diversions of Colorado River water because conservation is typically used to either meet future growth or offset/delay the need for future water supplies. Municipal water providers with entitlements to Colorado River water are planning to use their full entitlements, or already do so, though the future reliability is uncertain.*

Importantly, municipal providers with entitlements to Colorado River water are planning to use their full entitlements, or already do so, though future reliability is uncertain. In these areas, conservation and reuse have already been fully incorporated into the water supply portfolios of providers and are typically expected to slow the rate of growth in demands and provide a component of supply that will be needed in the future for these providers.

The Workgroup recognizes that M&I conservation and reuse efforts play a critical role in meeting future demands, reducing or delaying needs for additional water supplies, and increasing the future reliability of water delivery to M&I water providers that receive Colorado River water. Due to the complexities described above, the Workgroup did not attempt to quantify future water conservation and reuse savings beyond that described here for existing and planned programs, and a direct comparison with the findings of the Basin Study was not attempted.

> *M&I water providers in the major metropolitan areas that receive Colorado River water will continue to increase water use efficiency and reuse. These efforts play an important role in meeting future demands, reducing or delaying needs for additional water supplies, and increasing the future reliability of water supplies.*

## 3.7 Opportunities and Challenges for Expanding Successful Conservation and Reuse Programs

M&I water conservation and reuse has been practiced widely throughout the Basin, but opportunities exist to expand successful programs and implement new programs in the future. The Workgroup was charged with identifying opportunities that could advance water conservation and reuse, describing the challenges associated with these opportunities based on their collective experience, and identifying potential future actions that would advance the opportunities. Potential actions related to the identified opportunities were developed for further consideration by the Coordination Team or other parties interested in advancing water conservation and reuse opportunities in areas that receive Colorado River water. The Workgroup did not prioritize its opportunities or potential actions, therefore the ordering of the following list or lists in subsequent sections does not imply a prioritization.

The Workgroup identified 11 major opportunities to advance water conservation and reuse within the major metropolitan areas that receive Colorado River water:

1. Increase outdoor water use efficiency through technology improvements and behavior change, and increase the adoption of low-water-use landscapes.
2. Increase the end-user understanding of individual, community, and regional water use.
3. Increase the integration of water/energy-efficiency programs and resource planning.
4. Expand local and state goal setting and tracking to assist providers in structuring programs.
5. Increase funding for water use efficiency and reuse.
6. Increase integration of water and land use planning.
7. Develop and expand resources to assist water providers in water conservation efforts.
8. Implement measures to reduce system water loss with specific metrics and benchmarking.
9. Increase commercial, institutional, and industrial water use efficiency and reuse through targeted outreach and partnerships.
10. Expand adoption of conservation-oriented rates and incentives.
11. Expand adoption of regulations and ordinances to increase water use efficiency and reuse.

The Workgroup explored each opportunity to identify significant considerations and identify specific actions that could be taken in the future. The sections below describe each opportunity in greater detail.

### 3.7.1 Opportunity 1: Increase outdoor water use efficiency through technology improvements and behavior change, and increase the adoption of low-water-use landscapes

Outdoor water use represents the single largest use of water in the M&I sector. Reducing outdoor water use through technology improvements, behavior changes, and adoption of regionally appropriate, low-water-use landscapes will be one of the biggest opportunities to stretch the use of limited supplies.

#### 3.7.1.1 Considerations

Adoption of improved technology and/or changes to landscapes depends in large part on municipal water customer decisions and behavior. The landscape types adopted, the density of plantings, maintenance practices, irrigation system efficiency, and irrigation practices all influence actual water savings. Turf conversion rebate programs are relatively expensive for water agencies to implement. However, other measures that can promote turf conversion and low water use landscaping in new developments, can reduce or eliminate the costs to water agencies. While education, improved technology (such as climate-based irrigation controllers), and good system maintenance can reduce the amount of water applied to landscapes that have been historically over-irrigated, there is a growing recognition that proper irrigation scheduling based on plant requirements and the installation of improved technology often leads to increases in water use in instances where landscapes have been historically deficit-irrigated.

Low-Water-Use Landscaping
*Source: CH2M HILL*

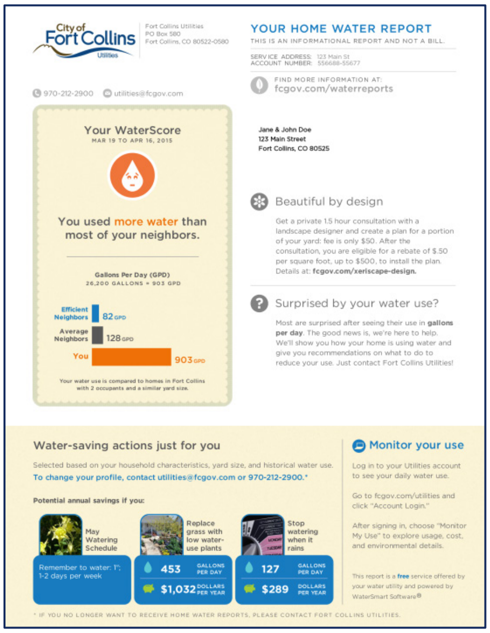
Successful programs have adopted a multi-pronged approach that includes improved information on water use to the end-user, conservation-oriented pricing, model landscapes, community and landscape professional outreach and training, rebates, and ordinances. Ordinances and technology improvements have been implemented in many communities to reduce outdoor water use in new developments. Some of the challenges associated with implementing such changes in existing developments are identifying and setting the appropriate price point for incentives, overcoming negative social perceptions of alternative landscapes, and limited municipal provider control over water use in some of the major metropolitan areas (Central Arizona and Wastach Front) due to vested water rights. Despite current education efforts, there is a knowledge gap for some end-users of how to reduce water use for outdoor landscaping. The preferred landscape choice in some communities continues to be turf even though there has been an increase in the number of contractor xeriscape companies. In some instances homeowner associations or other factors may limit adoption. The penetration of landscape conservation programs varies depending on socioeconomic situations and climate within cities and major metropolitan areas, as well as water reliability and the persistence of dry conditions.

#### 3.7.1.2 Potential Actions

- Expand social norming and budget-based pricing to reduce or improve the efficiency of outdoor water use of the most inefficient and largest users (examples: Fort Collins social norming and Eastern Municipal Water District budget-based).
- Develop a database of recommended outdoor landscape and outdoor irrigation best practices, including the cost effectiveness and application of each best practice for sharing across the major metropolitan areas that receive Colorado River water (example: California Urban Water Conservation Council).
- Promote model city landscapes in each major metropolitan area along with public outreach and education, demonstration gardens, best practices, professional training, and technical assistance.
- Actively encourage the application of model new development codes and regulations for outdoor landscape irrigation (example: SNWA land development codes).
- Develop revolving fund to provide matching grants for low-water-use landscape programs.

### 3.7.2 Opportunity 2: Increase the end-user understanding of individual, community, and regional water use

Water conservation is more effectively implemented with improved customer understanding. M&I users may not fully understand their water use, how it compares to others, and what can be done to reduce the use. This opportunity recognizes the importance of providing timely and customized water use information for end-users to support active water use reductions at the consumer level. Innovative use of the billing system provides an opportunity for tailored individual consumer educational information related to water use and resources and actions available to increase water conservation.




Home Water Report
*Source: City of Fort Collins Utilities*

#### *3.7.2.1 Considerations*

The majority of M&I water conservation ultimately occurs at the end-user level. While water agencies can educate and incentivize water conservation, it is consumers who must make decisions to increase their efficiency or reduce water use. Behaviors and cultural and social norms may be difficult and slow to change. However, in many of the major metropolitan areas discussed in this report, consumers have responded quickly to water agencies' drought advisories and requests to decrease water use, often exceeding agency goals; many of these water use reductions have continued even after the advisories were lifted. The persistence of such reductions is an area of active research.

The public may lack awareness, understanding, and knowledge about water use, supply, distribution, or potential conservation measures (for example, low-water-use landscapes). It often takes a concerted and extended process to overcome this challenge.

The concept of "social norming" is growing in its application to water conservation. The central idea of social norming is that much behavior is influenced by people's perceptions of what is normal or typical; if consumers view their behavior as outside of the norm, they will be motivated to change the way they behave so they conform more closely to the norm. Moreover, it is believed the effect can be enhanced by coupling information on social norms with actionable information that facilitates the desired behavioral change (Mitchell et al,. 2013). A growing number of water providers are using social norming concepts to encourage reductions in customer water use.

Installation of advanced metering and information systems, updated billing systems, and outreach requires funding and staffing at the water provider level. Successful water conservation programs will result in reduced water sales and potentially less total revenue for the provider despite providing similar or increased levels of service. In many cases, water conservation staffing requirements are not being met. Nonetheless, investments in water conservation often result in lower water costs to water providers and their customers than do investments in new capital-intensive water supply projects (AWE, 2013).

#### *3.7.2.2 Potential Actions*

- Promote adoption of advanced metering infrastructure technology in each major metropolitan area to improve data collection, understanding of demand trends, identification of high water use, facilitate improved feedback to customers regarding their water use, and improve leak detection (example: Fort Collins).
- Expand application of social norming (providing customers with water use information, comparisons, and possible reduction measures) to reduce water use.
- Speed implementation towards 100 percent metering.
- Increase access in all of the major metropolitan areas for direct water audits by water conservation staff to provide information on water use and savings potential.

- Provide funding and financial support for additional water conservation staff at water agencies.

### 3.7.3 Opportunity 3: Increase the integration of water/energy-efficiency programs and resource planning

Water and energy are significantly interrelated, yet the resources are rarely managed in an integrated fashion. While both water conservation and energy-efficiency programs are continuing in many of the major metropolitan areas, there is a general lack of coordinated effort among water and energy resource management agencies and utilities. Opportunities exist to increase the integration of water/energy-efficiency programs for the benefit of reduced intensity of use of both resources and economic benefits.

#### *3.7.3.1 Considerations*

Despite significant efforts by both water and energy utilities to improve water and energy use efficiencies, little integrated planning exists for water, wastewater, and energy production and distribution systems. Federal and state policy to promote water-energy integration is limited and little integration occurs between local or regional water and energy utilities. Water utilities generally consider energy as an external cost, while energy utilities consider water as an external cost. However, investments in water conservation almost always yield energy efficiencies (through reduced pumping and treatment) and investments in energy conservation can lead to reduced water needs (for example, reduced thermoelectric cooling water needs).

There are many more water providers than energy providers and each provider has separate regulatory and governance structures that make integration or coordination of programs challenging. Existing financial and staffing hurdles limit the coordinated effort that is required to identify and implement synergistic conservation programs.

#### *3.7.3.2 Potential Actions*

- Improve integration of federal and state water and energy programs that are simultaneously attempting to conserve resources (such as WaterSense, ENERGY STAR, WaterSMART, and Property Assessed Clean Energy programs) to reduce financial hurdles and create synergy for water-energy conservation programs.
- Develop partnerships between water and energy utilities, and their respective regulatory bodies, on synergistic programs, rebates and incentives, and customer outreach to more effectively target customers (example: Central Basin Municipal Water District partnership with U.S. Department of Energy).
- Continue research and development of alternative cooling and water treatment technologies.
- Document the financial, water, and energy benefits realized when water and energy conservation programs are integrated.

### 3.7.4 Opportunity 4: Expand local and state goal-setting and tracking to assist providers in structuring programs

Several states and many municipal water agencies have established water conservation targets that serve as guidance for measuring, monitoring, and encouraging M&I water use reductions over time. Expansion of these efforts, improved coordination and goal setting can lead to more effective incentives to increase water conservation and reuse.

#### *3.7.4.1 Considerations*


Local and state targets for per capita water use may assist providers and communities in structuring programs to achieve increased efficiency and measure progress over time. For example, California's 20 percent by 2020 reduction goals have helped utilities in that state measure and plan for future per capita water use. Most state and local water conservation targets are essentially incentivized goal setting with reporting mandates and funding opportunities available to those who plan to meet per capita use targets.

Per capita water use and targets are often measured inconsistently across the Basin, within states, and among municipalities. In some states, reuse of wastewater (alternative supply) is accounted for as a water use reduction when computing per capita water use. In addition, some municipalities include only residential water use when computing per capita water use, while others also include the industrial and institutional components. There are also significant variations in how water use is categorized and tracked by providers and agencies. These inconsistencies, along with climate and demographic differences, make Basin-wide comparisons of water use difficult. More beneficial, however, are targets of reductions in water use and adoption of locally relevant water conservation best practices. Regional, state, and local water conservation targets should acknowledge the local differences and provide for local flexibility in achieving the targets.

#### 3.7.4.2 Potential Actions

- Encourage establishment of state-wide, locally appropriate, or possibly regionally appropriate, reduction-based targets.
- Support the development of standard methods for water providers to quantify, monitor, and evaluate water conservation measures and actual savings.
- Encourage adoption of locally relevant water conservation practices.

### 3.7.5 Opportunity 5: Increase funding for water use efficiency and reuse

The lack of continuous, sustainable funding for water use efficiency and reuse is a factor limiting more rapid implementation. While sources of funding are available, these sources are limited and often narrow in application. Sustainable funding ensures that sufficient and stable revenue streams are available over the long term to accomplish a program's goals and help address the range of measures (from public education to infrastructure) necessary for water conservation and reuse.

#### 3.7.5.1 Considerations

Procuring sustainable funding from traditional federal and state sources for water conservation and reuse is challenging because funds are typically limited, competitive, and funding is often contingent upon prevailing economic conditions, the political climate, and uncertainties associated with the appropriations process (Mathieu, 2011). For instance, education and messaging measures are generally not supported through current funding programs.

Funding strategies for M&I water conservation and reuse should address municipality and water agency needs related to rate stabilization and long-term financial stability. Financial stability and rate structures are often challenged because water conservation programs typically result in reduced income from water sales, while requiring similar levels of service and requiring funding for the conservation program itself. However, properly designed conservation-oriented rate structures have been successful at managing the financial risks of reduced water sales. Some of the most successful programs have combined federal, state, and local funding with user-based incentives to reduce or delay the need for alternative supplies or infrastructure improvements. The insertion of increased outside funding allows these types of programs to be expanded.

#### 3.7.5.2 Potential Actions

- Document and publicize innovative funding and financing programs including public-private partnerships to provide incentives or funding of conservation programs (example: MWD's rate-based incentive program).
- Explore the establishment of a Basin Trust Fund for low-interest loans for specifically targeted water conservation programs.
- Investigate and implement a Basin-wide current database of available federal, state, and other funding sources for water conservation.
- Explore funding mechanisms to help providers minimize system water losses.
- Implement alternative rate structures to reduce financial risks associated with reduced water sales.

### 3.7.6 Opportunity 6: Increase integration of water and land use planning

Water and land use are highly interrelated; however, planning of water and land use is not typically integrated. Improved integration of water and land use planning would allow a better understanding of the effects of land use decisions on future water (and energy) use and would support a higher level of information to be made available to decision makers related to the tradeoffs of various land use decisions. Some of the most effective improvements in water use efficiency can be implemented in the design, layout, landscape choices, and codes associated with new developments or industries. Early integration of water use efficiency concepts can have long-term benefits.

#### *3.7.6.1 Considerations*

Land use authority such as decision making related to subdividing lots, setting zoning rules, and issuing construction permits often falls within the jurisdiction of municipal and county governments. Meanwhile, the primary responsibility for water supply falls within the jurisdiction of local water utilities. The authorities for these two entities are usually distinct and separate, despite the strong land use-water relationship. While some states and metropolitan areas are pursuing improved integration of water and land use authorities, the current state of practice is that land use authorities "plan the community" and water providers "ensure the water is reliably available" with little integration.

In some cases, local land use planners may not have the knowledge or the information available to effectively integrate water use in their planning decisions. Developers, who are often preparing new development plans, may be resistant to implementing additional water efficiency and conservation measures because of the added cost. A variety of water conservation ordinances, regulations, and building and green codes have been applied to varying degrees to strengthen these ties, but these actions may be met with resistance if not accompanied by community education and support.

#### *3.7.6.2 Potential Actions*

- Encourage land use codes, regulations, and ordinances that ensure water is an integral consideration in land use planning (examples: SNWA land development codes and Arizona Assured Water Supply rules).
- Encourage development, application, and monitoring of locally appropriate best practices for integrated land use and water conservation measures.
- Encourage state and local ordinances for new developments that set efficiency requirements for indoor and outdoor water uses.
- Improve integration of water-efficient landscapes into the approval process for new developments based on public preferences.
- Develop a database of successful efforts and model ordinances.

### 3.7.7 Opportunity 7: Develop and expand resources to assist water providers in water conservation efforts

While the water conservation resources available to the water providers have expanded in the past decade, information about available resources, data, and tools to assist water providers in effectively selecting, designing, and implementing water conservation programs in not always readily accessible. Improving ease of access to existing local and regional resources, or an integrated Basin-wide clearinghouse of water conservation and reuse resources would facilitate information sharing and advance the effectiveness of these programs.

#### *3.7.7.1 Considerations*

Any opportunity to expand the water conservation and reuse resources available in the Basin should recognize that organizations such as AWWA and the Alliance for Water Efficiency have developed useful resources that could be leveraged. Workgroup members have acknowledged that any advancement for the Basin should not duplicate efforts of these organizations or others, but rather provide access to a region-specific clearinghouse of data and tools.

#### *3.7.7.2 Potential Actions*

- Support water providers to develop standard methods to quantify, monitor, and evaluate water conservation measures with respect to actual savings.

- Encourage providers to adopt AWWA standards for water conservation programs, integrated water resource planning, and water loss management.
- Work with the Alliance for Water Efficiency and AWWA to facilitate access to resources, tools, and data that would be particularly useful to Basin providers, perhaps creating a subsection within existing clearinghouses, and to identify and address gaps that may be identified.
- Support permanent authorization of the EPA's WaterSense Program, along with necessary staffing and funding for the program.
- Encourage active engagement in and support of national organizations or programs that are driving water use efficiency, including AWWA, Alliance for Water Efficiency, WaterSense, Irrigation Association, and Smart Water Application Technology. Regional organizations can have similar benefits.
- Develop a database of recommended outdoor landscape and outdoor irrigation best practices, cost effectiveness, and application for sharing across Basin communities (example: California Urban Water Conservation Council).
- Develop a Basin-wide current database of available federal, state, and other funding sources for water conservation.

### 3.7.8 Opportunity 8: Implement measures to reduce system water loss with specific metrics and benchmarking

Measures are being taken throughout the major metropolitan areas that receive Colorado River water to quantify and characterize water system losses and reduce these losses as economically feasible. The AWWA's water audit process and water loss mitigation measures (AWWA, 2009) have been implemented by some water providers; however, systematic auditing and asset management programs need to be further implemented to address aging infrastructure and metering devices. In many cases, reduction in system water losses can result in financial incentives to the water provider by recovering lost revenue. Minimizing conveyance and distribution system losses is a fundamental aspect of water providers' water infrastructure management and represents an opportunity to increase both water conservation and revenue.

#### *3.7.8.1 Considerations*

System water loss measurement and characterization is an area of growing focus for many water providers; however, leak detection, pipeline replacement, and enhanced metering are capital-intensive efforts that are often integrated with the water provider's asset management programs. These programs are sometimes limited or delayed due to budget constraints. Investment to improve conveyance and distribution infrastructure and metering devices commonly requires funding from external sources. In some cases, distribution systems were not originally equipped with metering and plans for metering are implemented in stages over the upcoming decade. Currently, the AWWA's water audit process and water loss mitigation measures manual is not widely implemented. Economic levels of leakage have not been established by most water providers.

#### *3.7.8.2 Potential Actions*

- Promote advanced metering infrastructure.
- Speed implementation towards 100 percent metering and automated meters.
- Encourage providers to adopt AWWA standards for water conservation programs, integrated water resource planning, and water loss management.
- Promote comprehensive implementation of AWWA water audit measures (M36) as a foundational best practice and increase ease of access to these resources.
- Implement funding measures to accelerate asset management programs and replace aging infrastructure.

### 3.7.9 Opportunity 9: Increase commercial, institutional, and industrial water use efficiency and reuse through targeted outreach and partnerships

The CII sector accounts for a relatively small percentage of total water use in most water service areas; however, individual CII customers represent some of the largest individual water users. Therefore, focused water conservation and reuse outreach and partnerships can be effective investments.

Investments in water use efficiency and increased reuse can often provide a more sustainable and cost-effective method to meet existing and growing demands. Most water use by industry is associated with cooling process. In Arizona, the Palo Verde Nuclear Generating Station and Redhawk Power Plant use reclaimed wastewater from nearby cities as cooling water. Water is routed through condensers and cooling towers an average of 25 cycles until total dissolved solids levels are too high for further use. In Wyoming, the Supercomputing Center facility of the National Center for Atmospheric Research implemented a water conservation and efficiency technology for cooling towers that allowed a reduction of the total water use by nearly 40 percent over comparable facilities and with a 3- to 5-year payback period. These water use efficiency and reuse measures could be expanded further to reduce water use by the CII sector.

Palo Verde Nuclear Generating Station
*Source: Arizona Public Service Company*

#### 3.7.9.1 Considerations

Communities, through a range of planning decisions, determine the types and extent of CII uses within their jurisdictional boundaries. Water use differs across industry types and across the major metropolitan areas that receive Colorado River water. Water quantity and quality requirements for specific industries vary as do the types of technology improvements that could lead to higher water use efficiencies. The supply of reclaimed water for many industrial uses is promising, but additional conveyance and treatment costs are likely due to the distance of the industrial facilities from wastewater effluent sources.

#### 3.7.9.2 Potential Actions

- Promote the development of a greener industrial sector with reuse pilot projects with short payback periods (examples: National Center for Atmospheric Research Wyoming Supercomputing Center in Wyoming and water use efficiency at Palo Verde and Redhawk plants in Arizona).
- Increase partnerships and outreach between water providers and the largest CII customers to increase efficiency or expand reuse.
- Improve understanding of cost-effective water use efficiency measures through consistent documentation and measurement of specific best practices applicable for different types of industries and regions.
- Encourage management of water supplies to optimize the matching of water quality to intended uses.

### 3.7.10 Opportunity 10: Expand adoption of conservation-oriented rates and incentives

Water providers are increasing incentives and adopting water rate structures designed to encourage water conservation. The price signals provided by increasing rates with higher use (negative signal) and incentives for water conservation (positive signal) are valuable tools for rapidly expanding water conservation in many municipal service areas. Expansion of these programs, based on experiences in areas that have already adopted them, provides an opportunity to increase water conservation throughout the major metropolitan areas that receive Colorado River water.

#### 3.7.10.1 Considerations

Changing rate structures can be a lengthy process. Careful resource and financial planning is required to ensure that the financial stability of the water service provider is maintained even under the outcome of reduced water sales. Typically, water use is priced volumetrically. As water conservation efforts reduce the amount of water sold, water provider revenues will decline if providers do not adjust the method in which rates are set. Providers must still recover the fixed costs of treating and delivering the water, as well as funding the conservation staff and the program itself. Utilities must plan for the financial effects of increased conservation and design rate structures that collect sufficient revenue to cover costs in the short term as they incentivize conservation.

Educating consumers about the benefits of conservation, which could include reduced or avoided costs of new infrastructure or acquiring new supply (AWE, 2013) over the long-term, can help avoid the misperception that conservation is driving rate increases. Considerable public outreach is required to communicate the need for changes in rate structures and to assist in developing thresholds for tier setting, or user water budgets in the case of budget-based rates.

Incentives are often more adaptable in that they can be increased, removed, or tailored for other water use sectors as conditions change. However, a growing financial consideration among water providers is related to the provision of incentives to replace fixtures or to adopt changes that may occur even in the absence of the incentive.

#### 3.7.10.2 Potential Actions

- Encourage the application of conservation-oriented rate structures (tiered or budget-based) that incentivize water use efficiency, while ensuring revenue stability, avoiding negative impacts, and accounting for public preferences.
- Increase the awareness of successful and unsuccessful approaches for implementation of conservation-oriented rate structures among water providers receiving Colorado River water.
- Develop model conservation-oriented rate structures that could be reviewed and expanded upon by water providers considering this option.
- Implement innovative funding programs to provide incentives or funding of conservation programs (example: MWD's rate-based incentive program).

### 3.7.11 Opportunity 11: Expand adoption of regulations and ordinances to increase water use efficiency and reuse

Many cities and some water providers have adopted regulations and ordinances related to low-water-use fixtures and landscapes in new development, at time of resale of existing homes, and for reducing water waste at existing developments. Regulations for new developments are increasingly encouraging or requiring the use of reclaimed water for outdoor landscape irrigation. Continued efforts for targeted regulations and ordinances at the local level can help achieve lower M&I water use with little or no financial investment from the water provider.

#### 3.7.11.1 Considerations

One of the most important considerations for this opportunity is coordination among the water service provider and local regulatory authorities. Some water service providers lack jurisdiction or regulatory authority with respect to land development, building codes, zoning, and other local land use authorities; however, water providers understand the impact of these decisions on water use and often can inform regulating agencies on the effectiveness of a range of approaches. Some water providers have taken the innovative step of including some water conservation-related actions as part of the contract of provision of water service. Other considerations are the societal costs of regulations and ordinances that, while not having a direct cost to the water provider, may affect costs to the consumer or the regional economy.

#### 3.7.11.2 Potential Actions

- Encourage land use codes, regulations, and ordinances to ensure that water is an integral consideration in land use planning (examples: SNWA land development codes and Arizona Assured Water Supply rules).
- Encourage state and local ordinances for new developments that set efficiency requirements for indoor and outdoor water uses (such as connection fees).
- Explore inclusion of specific water conservation measures such as water-efficient fixtures and low-water-use landscapes in provision of water service contracts with new customers.
- Develop and share model land use codes, regulations, and ordinances that can be reviewed and expanded upon by water providers considering this option.

### 3.7.12 Summary of Potential Opportunities and Actions

The potential M&I water conservation and reuse opportunities and actions indicated in the previous sections emphasize specific areas to increase water use efficiency, reduce system losses, and maximize reuse of supplies. The opportunities were developed with a recognition of the areas of greatest potential benefit. The Workgroup's collective experience allowed the identification of the most promising measures to facilitate expansion of existing successful programs or the development of new programs.

Opportunities were identified that specifically address the critical M&I water use sectors of outdoor landscape irrigation, water use in existing and new residential developments, CII water use, and system water loss. Several opportunities emphasize the end-user with actions targeting education, incentives and rates, and social norming to encourage customer water use behavioral changes. Others emphasize increasing the efficiency of infrastructure and water use measurement and monitoring to reduce water distribution system losses and to identify specific technologies related to reducing industrial water use. The interaction between water use, energy use, and land use was recognized. Several opportunities promote integrated resource planning and program development and encourage enhanced partnerships between resource management agencies and water and energy utilities. The role of ordinances, regulations, and local-regional water use reduction targets was recognized as important to facilitate common implementation of water use efficiency measures, establishing standard methods, and tracking progress over time. Improved access to existing or expanded networks of data, resources, and tools was identified as necessary to help select the most appropriate and efficient measures at the local water provider levels. Finally, the lack of funding and financing was recognized as a significant hurdle that currently limits the rate or extent at which M&I water conservation and reuse measures are taken, and innovative funding approaches were identified.

Many of the potential actions identified in this section can support multiple opportunities, to varying degrees. For example, several actions related to innovative funding and conservation-oriented pricing, additional or consolidated water conservation resources and tools, and improved integration across water, energy, and land use agencies support several of the opportunities that have been identified. The degree to which these actions are most appropriate for a particular metropolitan area will depend on factors such as the extent to which these measures have already been implemented in an area, cost of existing and new water supplies, public acceptance, laws and regulations, and other factors. The Workgroup was tasked with identifying promising opportunities and actions that could help expand successful M&I water conservation and reuse programs in the future. However, it was beyond the scope of the Workgroup to develop specific projects in specific geographies for implementation.

*Opportunities and potential actions exist to increase water conservation and reuse by metropolitan areas that receive Colorado River water and, in many cases, are currently being pursued. However, these opportunities will vary depending on many factors, including the extent to which these measures have already been implemented in an area, the cost of these conservation measures, cost of existing and new water supplies, public acceptance, laws and regulations, and other factors.*

## 3.8 Summary

The *Moving Forward* effort recognized the importance of M&I water conservation and reuse in the future planning and management of the Colorado River. The Workgroup documented historical trends in M&I water conservation and reuse in the major metropolitan areas that receive Colorado River water, identified current and planned efforts to continue these efforts, and identified opportunities and considerations associated with expansion of water conservation and reuse programs in the future.

The major metropolitan areas that currently receive Colorado River water include a population of more than 29 million, most of which (about 27 million) reside in areas located outside of the hydrologic basin or where water does not return to the mainstem Colorado River. These metropolitan areas have experienced significant population growth in the past decades and projections for future growth remain high. At the same time, climate conditions in most of these major metropolitan areas cause outdoor water uses to be relatively high. CII activities vary considerably among these metropolitan areas, but are expected to increase in the future to continue to support vibrant economies. Population and CII growth, and the semiarid climate of most of the metropolitan areas significantly influences M&I water demand.

For most major metropolitan areas that receive Colorado River water, the M&I water use has increased over the past two decades due to population increases. However, over the same period, water providers in these areas have implemented significant water conservation and reuse that has substantially decreased per capita water use. In some areas, this has allowed the total M&I water demand to remain relatively stable while the population has increased significantly.

On average, per capita water use rates have decreased by 12 to 38 percent since 1990 in these metropolitan areas. Water use in 2010, for the areas included in this report, would have been 1.7 million AFY higher had per capita use rates not been reduced. Water conservation has played an important role toward these savings; however, other factors such as economic, social, and behavioral changes also influence use changes over time. Water reuse was also found to be practiced in nearly all of the Basin states, and a total of 709,000 AFY of reuse supply was identified in 2012, reducing the need for development of new supplies.

Over the most recent decade, water use has either remained stable or decreased in many of the major metropolitan areas. During this period, the U.S. experienced a steep economic downturn, the Basin experienced its most severe drought in the past 100 years, and some water providers have increased water conservation efforts to reduce water use in response to reduced water availability.

Current and planned water conservation and reuse programs identified for the major water providers in these metropolitan areas will further improve the water-use efficiency. A review of the documented water conservation programs with numeric per capita targets suggests that more than 700,000 AFY of additional water conservation is planned by 2030, and an additional 400,000 AFY of water reuse is planned.

Based on the information compiled from water providers and from the deliberations of the Workgroup, several key findings were identified.

- Available data demonstrate that municipal providers in the major metropolitan areas that receive Colorado River water have implemented a wide range of conservation measures that have increased water use efficiency and reduced per capita demand. Comprehensive data on conservation and reuse programs implemented to date in the major metropolitan areas that receive Colorado River water are not available. It is often difficult or impossible to attribute quantifiable savings to specific programs or measures.
- While population has increased over the recent decades, the per capita water use has decreased, partially attenuating the effect of population growth on M&I water use. Since 2000, M&I water use has either remained stable or decreased for many of the major metropolitan areas that receive Colorado River water, despite increases in population. Per capita water use rates for these metropolitan areas decreased by 10 percent to 26 percent since 2000 (1998-2002 average). During this period, the U.S. experienced a steep economic downturn and the Colorado River Basin experienced its most severe drought in the past 100 years, influencing water use.
- The types of water conservation measures and the extent to which they have been implemented vary extensively among municipal providers and the major metropolitan areas that receive Colorado River water based on water supply portfolios and reliability, climate, demographics, and available funding.
- Municipal water providers in the major metropolitan areas that receive Colorado River water have also implemented water reuse to varying degrees depending on geographic, legal, regulatory, and other considerations.
- M&I water providers in the major metropolitan areas that receive Colorado River water will continue to increase water use efficiency and reuse. These efforts play an important role in meeting future demands, reducing or delaying needs for additional water supplies, and increasing the future reliability of water supplies.
- Municipal providers in the major metropolitan areas that receive Colorado River water manage their water supplies conjunctively and some must use surface supplies first to protect groundwater or prevent groundwater mining and its consequences. Additional M&I water conservation and reuse has the potential to reduce the amount of future development of Colorado River water. However, in many of the major metropolitan areas, conservation and reuse may not result in substantial reductions in diversions of Colorado River water because conservation and reuse are typically used to meet future growth or offset or delay the need

for future water supplies. Municipal water providers are planning to use their full entitlements to Colorado River water.

- Based solely on the reported conservation targets and population projections from the U.S. Census through 2030, for the water providers for which numeric targets were identified, water demand in 2030 will be about 700 KAFY lower than that estimated with 2010 per capita water use rates. Additionally, based on a national survey of planned water reuse programs, approximately 400 KAFY of new reuse supply may be added by 2030 to the water portfolios of water providers that receive Colorado River water.
- Opportunities and potential actions exist to increase water conservation and reuse in the major metropolitan areas that receive Colorado River water and, in many cases, are currently being pursued. However, these opportunities will vary depending on many factors, including the extent to which these measures have already been implemented in an area, the cost of these conservation measures, cost of existing and new water supplies, public acceptance, laws and regulations, and other factors.

Based on the collective experience of the Workgroup members and through exploration of the innovative case studies, the following 11 major opportunities were identified as having the potential to increase or expand M&I water conservation and reuse.

1. Increase outdoor water use efficiency through technology improvements and behavior change, and increase the adoption of low-water-use landscapes.
2. Increase the end-user understanding of individual, community, and regional water use.
3. Increase the integration of water- and energy-efficiency programs and resource planning.
4. Expand local and state goal-setting and tracking to assist providers in structuring programs.
5. Increase funding for water use efficiency and reuse.
6. Increase integration of water and land use planning.
7. Develop and expand resources to assist water providers in water conservation efforts.
8. Implement measures to reduce system water loss with specific metrics and benchmarking.
9. Increase commercial, institutional, and industrial water use efficiency and reuse through targeted outreach and partnerships.
10. Expand adoption of conservation-oriented rates and incentives.
11. Expand adoption of regulations and ordinances to increase water use efficiency and reuse.

Potential actions associated with each opportunity were identified and documented. Several actions related to innovative funding and conservation-oriented pricing, additional or consolidated water conservation resources and tools, and improved integration across water, energy, and land use agencies were found to support several opportunities that were identified. In many cases, the potential actions represent an acceleration of activities that have already begun in some of the major metropolitan areas, but require a significant investment in resources to increase the adoption of practices or to expand the geographic coverage. In other cases, significant gains are possible by changing end-user water use behavior through education and financial incentives. Still others require improved coordination across resource agencies from the local to national scale to provide more targeted information, funding, and tools to enable improvements in integrated resource planning.

This chapter represents the work product from a unique, Basin-wide collaboration of experts in the M&I water conservation and reuse fields. The considerable experience related to local and regional water conservation and reuse and genuine collaborative effort on technical and water management issues allowed this Workgroup to offer new insights into the state of, and possible future pathways for, M&I water conservation and reuse in the major metropolitan areas that receive Colorado River water.

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