This technical memorandum is a draft working document. It is undergoing agency review and is intended for discussion purposes. The proposed approach and findings have not been endorsed by any agency on the "20X2020 Team". It is expected that the information will be updated as the work progresses. The content of this and other technical memoranda will be used in the preparation of an overall report, and a draft of the overall report will be shared with the public. Please submit comments on this draft technical memorandum by September 22, 2008 to 2020comments@ccp.csus.edu

Public Draft Technical Memorandum

Task 1 – Establishing Baseline

September 5, 2008

This Technical Memorandum (TM) presents the methodology for establishing a baseline for urban water use in gallons per capita per day (GPCD) as part of the 20x2020 Program. Statewide baseline and regional baseline for each of California's ten hydrologic regions have been determined and the results are presented in this TM.

This TM is organized by the following sections:

1 Introduction

On February 28, 2008, Governor Schwarzenegger introduced a seven-part comprehensive plan for improving the Sacramento-San Joaquin Delta. As part of the plan, the Governor directed state agencies to prepare and implement a program to achieve a 20 percent reduction in statewide average per capita water use by year 2020 (20x2020 Program or Program). Several state agencies involved in water planning and management have joined together to form an agency team (20x2020 Team) to direct the development and implementation of the 20x2020 Program. The 20x2020 Team consists of five state agencies: Department of Water Resources (DWR), State Water Resources Control Board (SWRCB), California Energy Commission (CEC), Department of Public Health (DPH), and California Public Utilities Commission (CPUC). The US Bureau of Reclamation (USBR), a federal agency, is also participating on the team.

The 20x2020 Program is compatible with and further supports other California statewide water planning efforts such as the Delta Vision and the California Water Plan Update (Bulletin 160). These programs share the common goals of identifying and implementing strategies for sustainably managing the valuable water resources of California to support both its environmental and economic functions. Demand management and water conservation have been identified as priorities in each of these separate efforts. Legislative, regulatory and administrative agencies at the federal, state, regional and local levels are now focusing more actively on water conservation in a primary position for responding to California's current climate conditions and challenges for future water supply.

2 Program Scope and Scale

California's developed water is mainly consumed by three sectors: urban use, agricultural use, and environmental use. To achieve a reduction in overall water use while protecting the Delta's ecosystem, it is recognized that reductions in urban and agricultural water use need to be achieved.

There are many differences between California's urban and agricultural supplies and demands. These differences in water qualities and quantities, delivery systems, and other use characteristics; coupled with the differences in data availability and resources, water rights issues, politics, and conservation reduction mechanisms have led the 20x2020 Team to recommend that separate mechanisms be developed to address urban and agricultural use reduction. The focus on urban use for this Program is not meant in any way to diminish the relevance of agricultural use to the state's total developed water use or to ignore the potential for significant reductions in overall state water use from the agricultural sector.

In keeping with this recommendation, this Program is currently focused solely on **urban** use reductions. Urban use includes all residential, commercial, institutional and industrial users as well as system losses. This urban use separation also allows for a more focused and clearer examination of per capita use.

This Program is also focused solely on the urban demand of **potable water**. The use of recycled water (or other potable water offset supplies) is not included in determining either the baseline or target per capita use for the Program. The use of recycled water is considered to be a method of reducing per capita potable water use and should not appear to increase per capita demand in areas with high recycled water use nor to be excluded as a future means for obtaining per capita use reductions.

The need for efficient and appropriate use of water for agriculture and recycled water is recognized but will need to be addressed in future local, regional, state and Federal venues.

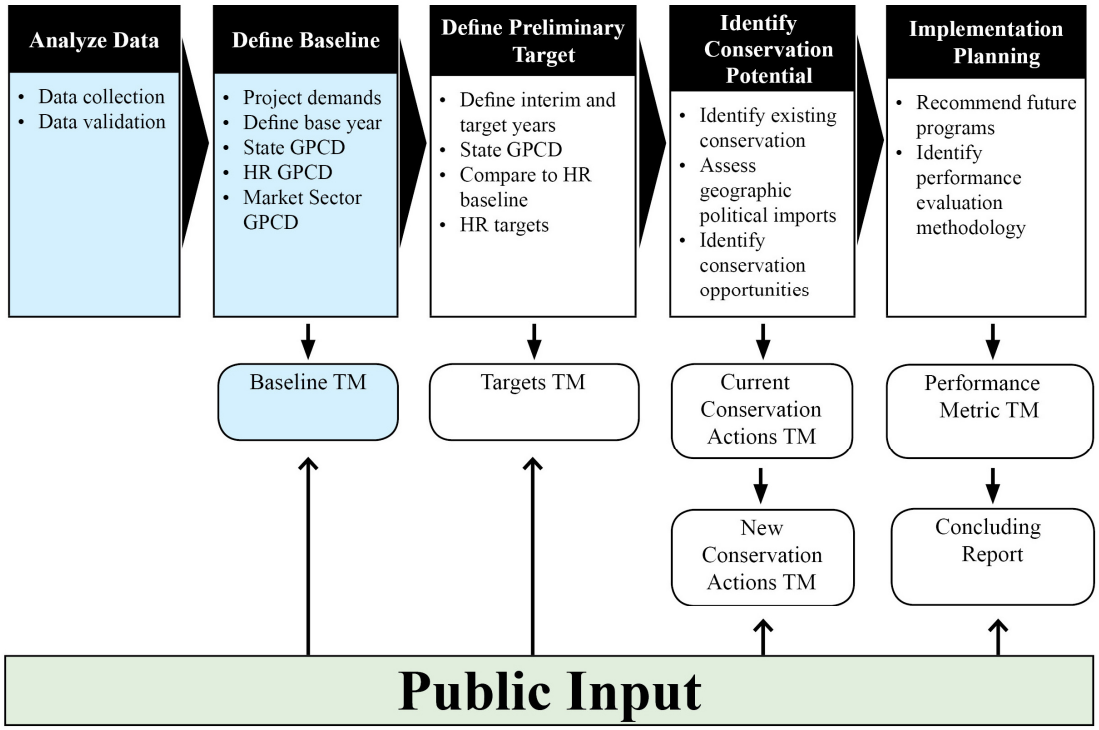
Program Scope

The focus of the 20x2020 Program is to understand the current urban water use patterns in order to propose a practical and effective conservation strategy. The process of developing this program is illustrated in Figure 2-1. The process used to develop this Program strategy involves five steps:

- Data Analysis
- Baseline Definition
- Preliminary Targets Development
- Conservation Potential Identification
- Implementation Planning

This TM presents the results of the first two steps of the Program: Data Analysis and Baseline Definition, as highlighted in Figure 2-1.

Figure 2-1: 20x2020 Program Development Process



Each step provides associated Technical Memoranda and other deliverables that will be available as interim steps for public input throughout the Program's process. This Baseline TM will focus on the methodology and results used to collect and analyze relevant data as well as define a baseline demand on both a state and hydrologic region (HR) level.

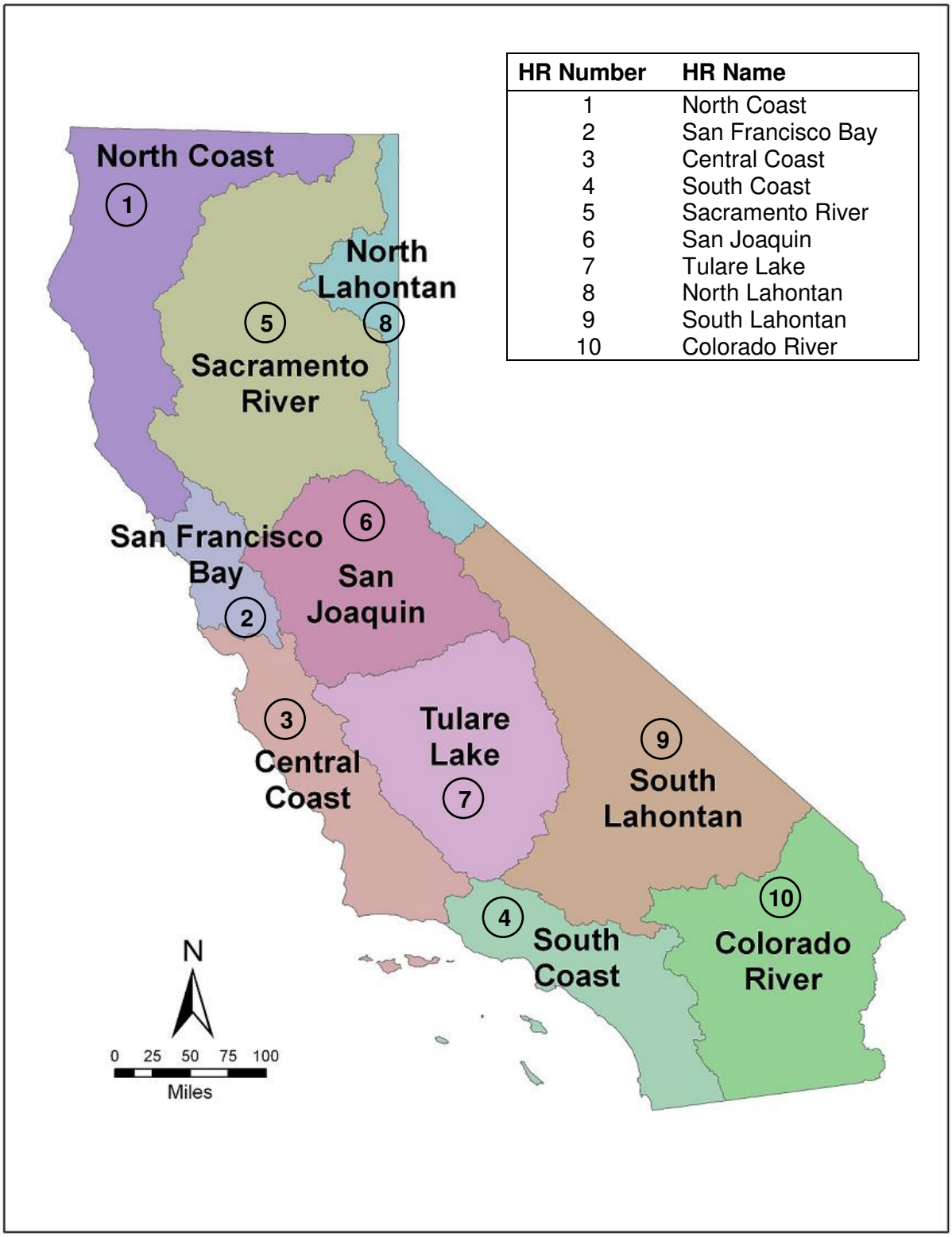
The baseline GPCD values presented herein are intended to illustrate the initial level of urban water use from which a 20 percent reduction can be projected and planned, general conservation potential of a region, and to help establish general guidelines and benchmarks for local water suppliers when planning conservation efforts for their systems. The analysis is not intended to be used to support regulatory decisions, and is independent of the development of regulatory or legislative actions on the subject of water conservation, but may inform those processes over time.

Program Scale

Given that the initial phases of this Program are on an aggressive schedule, the 20x2020 Team is conducting analyses on a **regional** scale and a statewide scale. There was no individual or local entity analysis other than to assist with validating regional data.

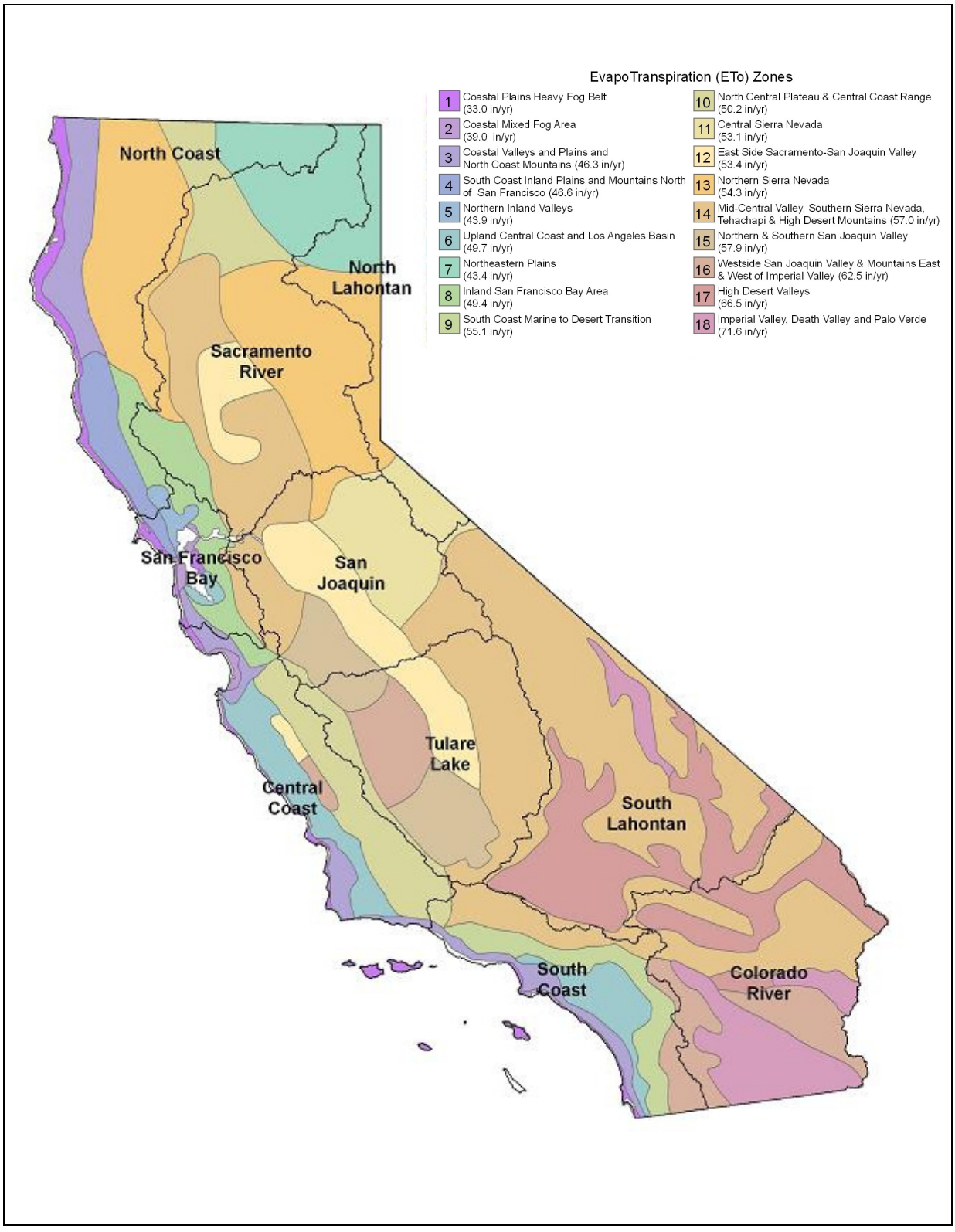
The team considered two regional approaches – hydrologic regions (HR) and evapotranspiration (ET) zones. HRs are 10 regions delineated by DWR based on topographic and hydrologic characteristics (Figure 2-2). ET zones are 18 zones delineated by DWR based on climate characteristics (Figure 2-3). ET zone delineation may have been preferable given that outdoor irrigation accounts for a considerable portion of urban water use, and that irrigation demand depends at least in part on the ET rate of the area. However, because available water use and population data has only been compiled according to HRs, it was determined that the analysis would need to be conducted according to HRs in order to meet this initial phase of the Program's process. Fortunately, there appears to be a reasonable correlation between GPCD values generated based on HRs as compared to expected values based on ET zones.

Figure 2-2 California Hydrologic Regions



HR Number	HR Name
1	North Coast
2	San Francisco Bay
3	Central Coast
4	South Coast
5	Sacramento River
6	San Joaquin
7	Tulare Lake
8	North Lahontan
9	South Lahontan
10	Colorado River

Figure 2-3 California Evapotranspiration Zones Overlapping Hydrological Regions



3 Baseline Methodology

Water consumption or water use is a dynamic process that depends on various factors such as the population density, climate, land use, and socioeconomic pattern of a region. To project a potential urban water use reduction (or conservation target) of 20 percent per capita, it is essential to define a baseline. The baseline is the per capita use dataset that is the best representation of current conditions from which a target can be applied. It is defined by first determining the base year and then the associated gallons per capita per day use (GPCD) values that will serve as a frame of reference for assessing the starting point of the 20x2020 program, evaluating its directions, and measuring its progress.

3.1 Data Selection and Validation Methodology

Data selection and validation are critical in establishing a justifiable baseline. Over the years, many agencies and organizations including DWR, DPH, California Urban Water Conservation Council (CUWCC), and CPUC, have collected urban water use data. Depending on the different goals of the data collection programs and the different needs of these agencies, there are strengths and limitations related to this project with each of the databases. Table 3-1 summarizes the strengths and limitations of each database.

Table 3-1: Dataset Strengths and Limitations

Data Source	Strength	Limitation
DWR – Public Water Systems Survey (PWSS)	• Detailed water production, water delivery, population, and connections data. • Categorized by market sectors (e.g. residential, commercial, industrial, etc.). • Compiled into a central database	• Collected voluntarily, which impacts data completeness and accuracy. • Recent data (2005-present) has not yet been compiled and validated, and is not available for use for this program.
DWR – Land and Water Use Program (LWUP)	• An extension from PWSS database, with data validated and modified at a sub-county level and validated using professional judgment. • Every area has a water use value	• Only 3 years of data is available (1998, 2000, and 2001).
CUWCC	• Recent urban water use data readily available.	• Limited data points.
CPUC	• Recent urban water use data readily available.	• Limited data points • Only residential data available • Data for connections and water use only. • Data was reported on annual basis, which limits the analysis for residential indoor/outdoor water use.
DPH	• More complete database since the Safe Drinking Water Act requires water suppliers to report water use data annually.	• Not available electronically. • Has not been compiled into a central database. Stored as hard copies in each DPH office across the state.
Urban Water Management Plans (UWMPs) prepared for DWR by Water Suppliers	• Could provide higher level of detail on water use since it is prepared by individual water suppliers. • Water suppliers serving more than 3,000 connections or more than 3,000 AFY are required by law to develop and submit UWMPs.	• Developed only once every 5 years. • Not compiled into a central database, and therefore not available electronically. • No data from small water suppliers that serve fewer than 3,000 connections or 3,000 AFY.

Supply and Demand Data

Review of the strengths and limitations associated with the available databases revealed that data provided by DWR (both the PWSS and LWUP databases) contains the most relevant information that could be used for this Program.

The PWSS database consists of raw data collected from water suppliers across the state. It provides an understanding of trends in water use and GPCD values of each hydrologic region over a ten-year period (1995 to 2005).

The LWUP database (available for 1998, 2000 and 2001 only) is developed based on the PWSS database. PWSS data was validated and adjusted by DWR staff based on their professional judgment where data is

sparse or problematic. The validation was conducted at the sub-county level where county lines intersected with Detailed Analysis Units (delineated by DWR for analysis purposes).

Review and validation of the PWSS and LWUP databases against the CUWCC and CPUC databases suggested that the PWSS database is more in-line with the other databases. Some of the differences could be due to self-supplied water being counted in the LWUP database, which was not counted in the PWSS database.

The PWSS database includes the following information:

- Monthly water production of groundwater and surface water sources
- Monthly water production from wholesale
- Monthly water delivery categorized into market sectors such as single family residential, multi-family residential, commercial, industrial, large landscape, agricultural, reclaimed water, and others
- Population data estimated by the water suppliers based on census, number of connections, or their general understanding of the service area

Since data submittal is voluntary, the completeness and accuracy of the data could vary substantially between entities. Some entities did not provide data for certain market sectors and/or certain years. Water suppliers also used different methods in measuring water production and delivery.

Most of the entities did not provide data on recycled water. If recycled water data was provided, it was removed from the demand data used to calculate per capita use. For the purposes of this Program, recycled water is considered a form of demand management and should not increase the baseline GPCD of regions that use recycled water supplies. Water production of private water suppliers (residents with private water wells) is not captured in the PWSS database and is therefore also excluded from this analysis.

Population Data

Since population directly governs the GPCD values, consideration was given to the accuracy of the population data. Population data from the Department of Finance (DOF) was considered for use in the analysis. However, the DOF database obtained for this program has population data compiled based on county level, and the population of counties that overlap multiple hydrologic regions was divided proportionally based on the geographic area of each region that falls within the county. The weakness of this methodology is that it does not provide accurate allocation of water use for the purpose of the analysis.

For example, the South Coast region covers approximately 66 percent of San Diego County, and the Colorado River region covers approximately 34 percent. However, approximately 90 percent of the county's population is in the South Coast region, the remaining 10 percent is in the Colorado River region. If the population was allocated based on geographical area, the South Coast region would be under-allocated by 24 percent, or approximately 700,000 people.

Another example of the weakness in DOF population data is illustrated by San Bernardino County. The county overlaps three hydrologic regions. In this case, the majority of the population is concentrated in the southwest corner of the county, which happens to be within the South Coast region. However, the other two regions, the Colorado River and South Lahontan, cover over 90 percent of the county but have only a small population. Using the geographic area allocation method, the South Coast region's population would be significantly under-allocated, and the Colorado River and South Lahontan regions would be over-allocated.

It was therefore determined that the baseline GPCD evaluation would be based on the population data provided in the PWSS database. The DOF population data and the 2000 Census (by multiplying average household population with the number of connections reported in the PWSS database) were used for data validation.

Data Development

For the purpose of performing analysis for the 20x2020 Program, a complete dataset is defined as a set of data provided by a water entity in a certain year that contains all of the following information:

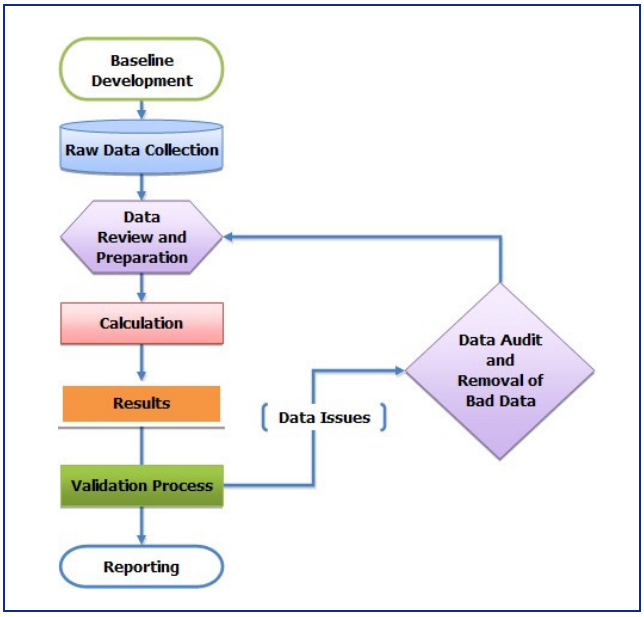
- Total water production data of the system
- Water delivery data for all market sectors
- Service population

Each dataset is validated through the following steps:

1. Datasets with all "0" values are eliminated.
2. Datasets that contain no water delivery data are eliminated.
3. For datasets that contain water delivery data but no water production data, volume of water produced is assumed to be the same as volume of water delivered. This allows more usable data points, but assumes that the agency does not have any unreported water use (e.g., system leaks).
4. Datasets from the same entities that significantly differ from the year before and year after are adjusted based on best estimates or linear interpolation.
5. For datasets that contain no population data, population is either estimated based on the year before and after, or calculated based on the reported number of connections.
6. The CUWCC and CPUC databases are used to cross-reference selected datasets. UWMPs by selected major water suppliers are also used to cross-reference some datasets.

The process of developing the database is illustrated in Figure 3-1. An expanded flow chart depicting this complex process in more detail is provided in Appendix A.

Figure 3-1: Data Development Process



3.2 Defining a Base Year

Defining a Base Year is limited by factors such as available data, level of precipitation of that year compared to historic average, and socioeconomics.

1. Data Limitations

The PWSS database consists of 10 years of water use data from year 1995 to 2005. Since many datasets were deemed incomplete or inaccurate and were eliminated, it was not viable to isolate any one year from the database because it would result in inadequate usable data points to calculate for representative baseline GPCD values. As such, all ten years of data was used for analysis. The resulted GPCD values therefore represent an average water use pattern of an average water year between 1995 and 2005.

2. Climatic Variations

Water demand is a dynamic process that greatly depends on the climate of the region. For example, more water is needed for irrigation in a dry year when precipitation is lower. Year 1998 was a wet year for most of the regions with a statewide annual precipitation at 171 percent of historic average. Year 2001 reflected drier water year conditions with annual precipitation at 72 percent of historic average. The most current known average water year for the state is year 2000, which represents a normal hydrologic condition with an annual precipitation at 98 percent of historic average.

3. Socioeconomic Variations

California is a pioneer in water conservation activities with many water suppliers in the state having established a long history of water conservation programs. It is possible that some water suppliers have already lowered their water use through past and ongoing conservation efforts, and it could be challenging for them to further reduce the GPCD by another 20 percent. To adequately account for the investment and contribution made by these entities, the Base Year should preferably be a year when water conservation activities across the state were at a starting level (i.e., a time when the GPCD values of pioneer water suppliers had not yet been significantly reduced by conservation activities), or when the level of conservation was known and could be documented. The 1976/1977 drought initiated many water conservation activities, but much of the per capita reduction "disappeared" with the plentiful water of the early 80's. The multi-year drought in 1987-1992 reinitiated the water conservation programs across the state and many have been continued to date. The 1995-2005 period provides a good timeframe for a new baseline to be established.

Since the Governor called for a water conservation goal in 2008, it would have been appropriate to define 2008 as the Base Year. However, during the initial phase of the Program, 2008 was not yet complete and therefore the data unavailable. Even 2006 and 2007 data was not technically available or may not have been appropriate based on the reasons outlined above.

In conclusion, since the analysis had to be conducted using ten years of data, the results represent average water use GPCD values for an average water year between 1995 and 2005; and since year 2000 is the most current average water year, and also that the conservation activities in 2000 were, to some extent, at an early stage across the state – especially among the majority of water suppliers that were not adversely impacted by the 1987 to 1992 drought. Therefore, year 2000 was defined as the Base Year for this 20x2020 Program.

3.3 Calculating Baseline GPCD

Each region has on average about 70 percent of reported datasets (representing about 60 to 80 percent of the regional population) complete or usable for the analysis of the total system GPCD values. The GPCD

values computed based on these usable datasets were deemed representative to the water use pattern of a region as a whole. This was the case for all regions, except Region 8.

The analysis of data from the PWSS database did not provide enough usable datasets to develop reasonable sector or total GPCD data for Region 8. In review of other databases, the LUWP data from DWR seemed to be an appropriate alternative. This data included estimates of water use extrapolated from small datasets and adjacent county or sub-county areas, to those areas with little or no data in this Region. Therefore, the GPCD values for region 8 were developed using the three years of LUWP data (1998, 2000, and 2001).

The baseline GPCD value for the state and each hydrologic region (except Region 8) is calculated as follow:

Eq. 3-1:
$$\text{Baseline} = \left[\frac{\sum \text{Water Delivered}_x}{\sum \text{Population}_x \times 365\ \text{d/yr}} \right]_{x=\text{usable datasets (1995-2005)}}$$

Since the analysis was conducted using all ten years of data in order to reduce single-year abnormalities, the methodology inherited the assumption that GPCD has not been increased (or decreased) with the population growth over the 10-year period. This assumption is deemed acceptable because a preliminary analysis of the data confirmed that there is no apparent GPCD trend over the ten years on a statewide basis.

Further, the population data in the PWSS database was estimated by water suppliers, which may represent either service population, transient population (i.e. included tourists in population count) or total population. To reasonably simplify the analysis, it was assumed that all residents of a region are customers of water purveyors of that region, and that there is no private water supplier. It was further assumed that the population is confined within a single hydrologic region. That is, the residents of a hydrologic region contribute to the water demands of that region only.

To assist in determining the conservation potential of each region, the baseline GPCD values are further broken down into several market sectors, as explained below. The equations used to calculate for these sectors' GPCD values are included in Appendix B.

Residential Water Use

Residential water use consists of water delivered to and consumed by single family residential (SFR) and multi-family residential (MFR).

Single family residential (SFR) consists of indoor water uses and outdoor water uses. Indoor water uses include essential daily water demand such as drinking, cooking, and washing. Outdoor water uses are mainly irrigation and exterior water features such as swimming pools.

To reasonably simplify the analysis, it was assumed that all single family residential houses have individual lawns and the same irrigation demand, and that their irrigation demand is zero during the wettest month of the year (February, based on general statewide climate trend). During this month, water delivered to SFR houses is assumed to be solely used for indoor uses. This assumption may not apply to certain regions with high ET rates that require year-round irrigation.

To make the baseline more standardized, a maximum indoor value of 71 GPCD was imposed on all regions[1]. For regions with SFR indoor values under 71 GPCD, the original values were used in this

[1] The value of 71 GPCD was obtained from the **1999 Residential End Uses of Water Study** (Aquacraft, Inc. and American Water Works Association Research Foundation, http://www.aquacraft.com/Publications/resident.htm). The study sites were: Boulder, CO; Denver, CO; Eugene, OR; Seattle, WA; San Diego, CA; Tampa, FL; Las Virgenes, CA; Walnut Valley, CA; Phoenix, AZ; Tempe and Scottsdale, AZ; Waterloo, Canada; and Lompoc, CA.

analysis as-is; for regions with SFR indoor values over 71 GPCD, the values were reduced to 71 GPCD. The resulting GPCD reductions were reallocated to SFR outdoor water use for that region. For example, if a region has indoor and outdoor water use at 80 GPCD and 50 GPCD, respectively, the revised values would be 71 GPCD for indoor water use and 59 GPCD for outdoor water use.

Indoor and outdoor water uses for the MFR sector are not evaluated because it is assumed that MFR houses share common irrigation areas such that the outdoor use per capita would be negligible.

It is acknowledged that SFR and MRF GPCD values should not be calculated using the total population since they do not share the same customers. The 2000 census data was obtained from the U.S. Census Bureau and provided the number of MFR structures in the state and also individual counties. The general statewide distribution of SFR and MFR are 70 percent and 30 percent, respectively[2].

Commercial, Industrial, and Institutional (CII)

The commercial, industrial, and institutional (CII) sectors are defined to account for all non-residential water uses. Commercial water use includes water delivered to restaurants, shopping malls and office buildings. Industrial water use includes water delivered to industries such as food service and beverage manufacturers, paper mills and oil refineries. Institutional water use includes water delivered to universities, schools, hospitals, and other public buildings. The PWSS database combined institutional use with commercial use.

Unreported Water

Unreported water (URW) consists of water delivered to the Large Landscape and Other sectors (as reported by the PWSS database) and also unaccounted-for water.

The water delivered to this sector is not as clearly defined as for the residential and CII sectors. For example, the Large Landscape sector refers to large open area such as parks and golf courses, but it is possible that irrigation for commercial plazas, which should have been reported under the commercial sector, was reported under this sector.

The Other sector usually refers to water used by water suppliers for system operation and maintenance, such as street cleaning, system flushing, and fire hydrant testing.

Unaccounted-for water, or non-revenue water, is calculated by the difference between what was produced and what was sold. This may include system leaks, meter errors, emergency use (e.g. fire fighting), and/or unauthorized use.

[2] The regional distributions (%SFR/%MFR) are: North Coast: 78/22; San Francisco Bay: 69/31; Central Coast: 74/26; South Coast: 68/32; Sacramento River: 77/23; San Joaquin: 80/20; Tulare Lake: 77/23; North Lahontan: 76/24; South Lahontan: 63/37; Colorado River: 70/30.

4 Results

California has a diverse population, climate, socioeconomic, and land use patterns. This section describes the demographic patterns, water resource characteristics, and current water conservation status of each region, and presents the baseline GPCD with a discussion on how the values correlate to the realistic situation of each region.

4.1 Statewide Summary

Figure 4-1 presents a histogram that shows the distribution of GPCD values of all validated datasets in the PWSS database. The ranges of GPCD were shown on the x-axis, and the number of agencies that fall within the range is shown on the y-axis.

As shown in Figure 4-1, almost half of the water suppliers demonstrate an overall water use between 100 and 199 GPCD. Water suppliers with high water use values above 200 GPCD are mostly small entities with low population, while many major entities with large population demonstrate lower water uses. After taking population into consideration, the weighted average of statewide water use between 1995 and 2005 is **192 GPCD**.

Figure 4-1: Summary of Statewide Urban Water Use

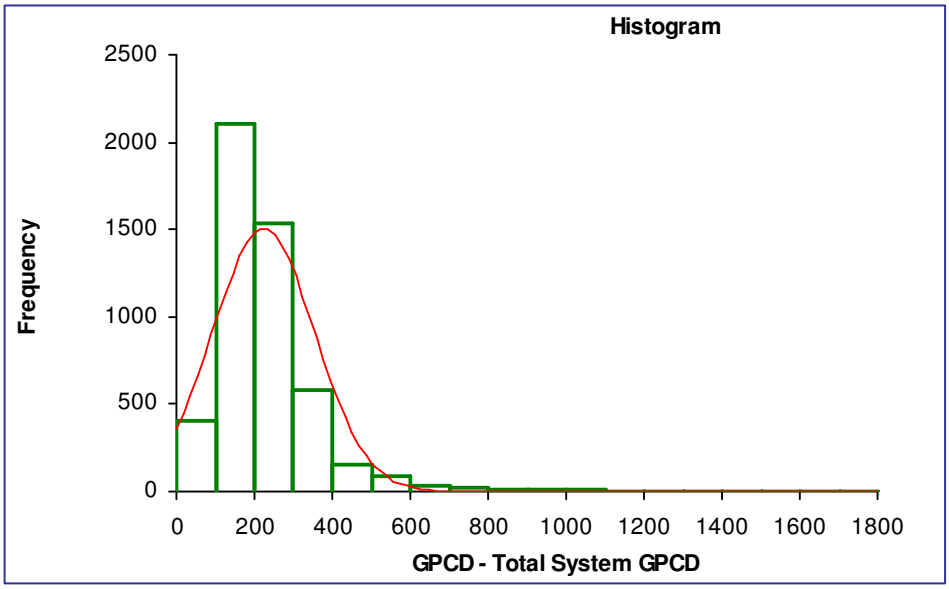


Figure 4-2 presents a summary of the regional GPCD values. The GPCD values of individual market sectors are summarized in Table 4-1.

Figure 4-2: Regional Urban Water Use Patterns

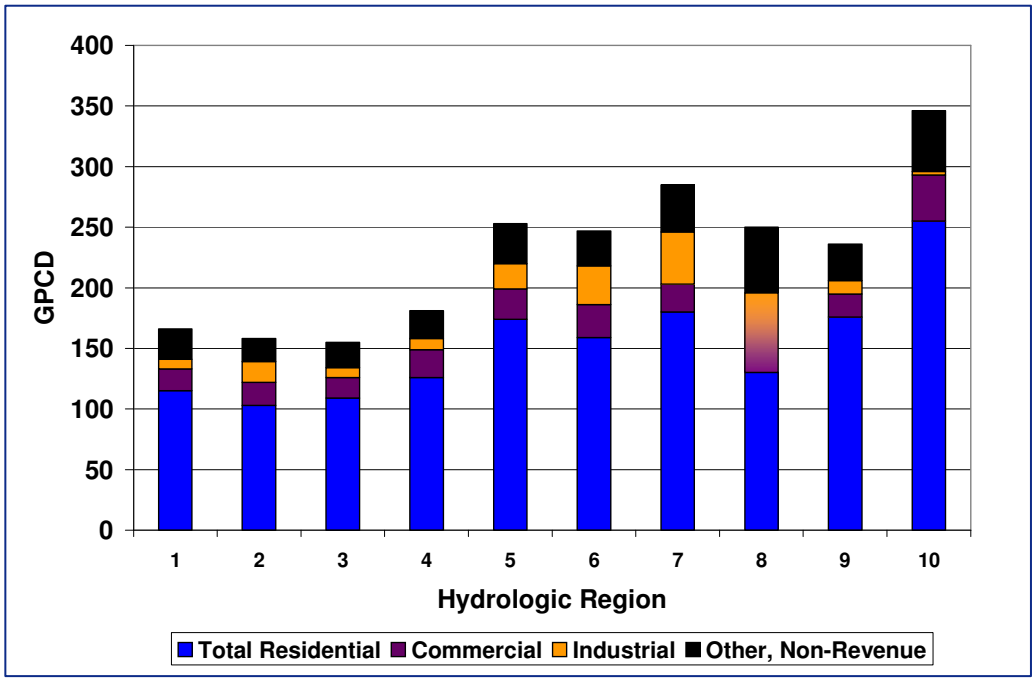


Table 4-1: Regional Urban Water Use Pattern

	Hydrologic Region									
Sector Water Use (GPCD)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8[3]**	**9**	**10**
Residential (SFR and MFR) [4]	115	103	109	126	174	159	180	130	176	255
Commercial [5]	18	19	17	23	25	27	23	66	19	38
Industrial [6]	8	17	8	9	21	32	43	ND	11	3
Un-Reported Water (URW) [7]	24	18	20	22	33	30	39	54	31	50
Total Baseline [8]	165	157	154	180	253	248	285	248	237	346

[3] Region 8 does not have enough usable data in the PWSS database to compute for baseline values. The LUWP database was used instead. Note that the LUWP database only contains data for 1998, 200, 2001. The baseline values for this region may not be as reliable as values computed for the other regions.

[4] Calculated using equations B-2a and B-2b (see Appendix B), except for Region 8 (see footnote 3)

[5] Calculated using equation B-3a (see Appendix B) except for Region 8 (see footnote 3)

[6] Calculated using equation B-3b (see Appendix B) except for Region 8 (see footnote 3)

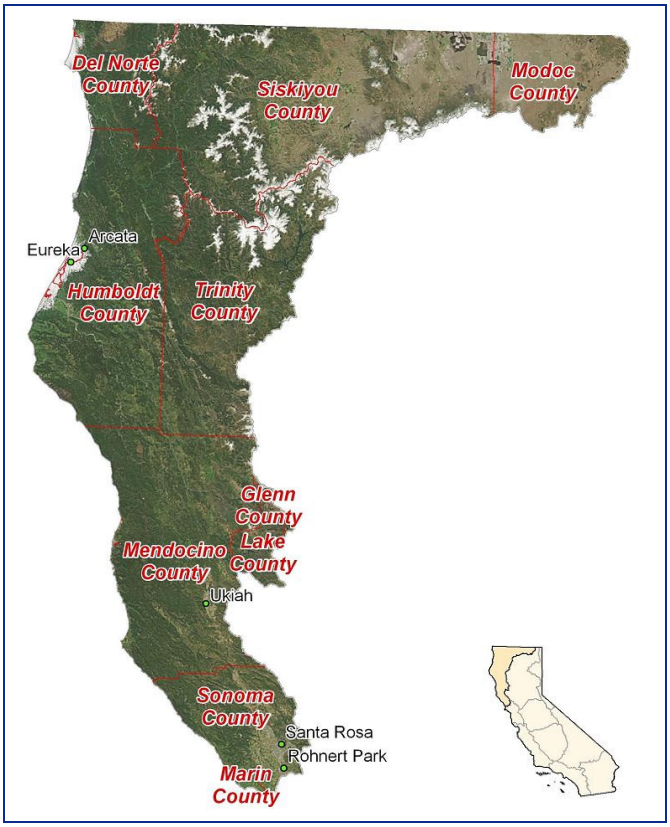
[7] Calculated using equation B-4 (see Appendix B) except for Region 8 (see footnote 3)

[8] Calculated using equation 3-1, except that for Region 8 (see footnote 3). These values are the sum of the sector values.

4.2 North Coast Hydrologic Region (Region 1)

The North Coast Hydrologic Region covers approximately 19,470 square miles, which accounts for more than 12 percent of California's land area. It includes all or large portions of Modoc, Siskiyou, Del Norte, Trinity, Humboldt, Mendocino, Lake, and Sonoma counties (Figure 4-3). The region had a population of approximately 643,000 in 2000 (DWR 2005), which is less than two percent of California's total population. More than half of this population resides in Santa Rosa and surrounding communities in southern Sonoma County.

Figure 4-3: North Coast Hydrologic Region



Climate and Land Use

Weather conditions and temperatures vary dramatically across the region. Average daytime high temperatures in Fahrenheit range from the mid-30s to mid-80s along the coastal areas to a range from the low-30s to above 100-degrees in the inland regions of Siskiyou and Modoc counties. Region-wide, the average rainfall is about 51 inches per year. However, heavy rainfalls in the coastal mountain ranges, sometimes above 100 inches, make this portion of the region the most water-abundant area of California, while rainfall average is sometimes less than 15 inches in the Lost River drainage area of Modoc County. Southern Sonoma County, where the majority of the population in the region is located, averages around 30 inches per year.

Forest and rangeland occupy about 98 percent of this region's land area, with much of the region identified as national forests and state and national parks. The major land uses in this region consist of timber production, agriculture, fish and wildlife management, parks, recreational areas, and open space. About two percent of the region is irrigated primarily in the Sonoma County vineyard areas, which accounts for 81 percent of the region's water use.

Water Portfolios

Although it has the most water resources of any region of the State, the North Coast region faces many water quality and water supply challenges. Only about 10 percent of surface water runoff occurs in the summer and water supplies are limited throughout much of the area. Many of the smaller communities and rural areas in the North Coast region are generally supplied by small local surface water and groundwater systems. Two of the largest water reservoirs in the region are the 2.4 million acre-foot Trinity Lake on the Trinity River, and the 380,000 acre-foot Lake Sonoma in the Russian River watershed. Groundwater development is sporadic throughout the mountainous areas of the region, and wells are generally along the valleys of rivers and streams. Water exports to other regions are generally greater than the volume of water that is consumed for agricultural and urban purpose within this region.

Current Water Conservation Status

Given potential shortages due to drought, low supply reservoir levels, and system capacity constraints, many water suppliers in Region 1 have implemented major conservation programs. Recycled water is increasingly being developed as a way to meet RWQCB discharge requirements limiting discharges into the Russian River. The supplies generated as a result of the recycling are being used to offset potable water demand. According to the California Water Plan 2005 Update, the region produces about 12,000 AFY of recycled water.

Urban Water Use

The histogram in Figure 4-4 presents the distribution of GPCD values of all usable datasets in this region. Approximately 80 percent of the reported datasets was deemed acceptable and was used in calculation, representing about 65 percent of the population in this region. Most water suppliers in this region demonstrate an overall water use between 100 and 199 GPCD. After taking population into consideration, the weighted average of this region is **165 GPCD**.

Figure 4-4: North Coast Region Urban Water Use Data Histogram

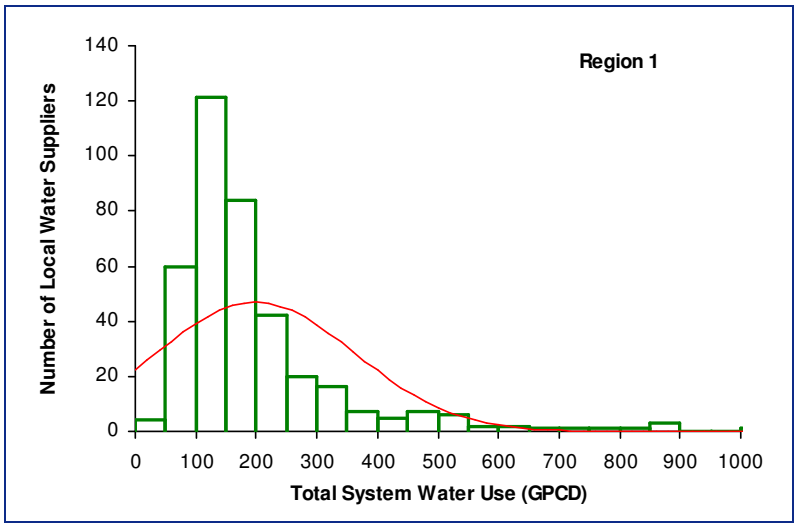


Figure 4-5 presents the distribution of the region's urban water use among residential, CII, and URW sectors (For detailed calculations of these values, refer to Appendix B).

Figure 4-5: North Coast Region Urban Water Use Distribution

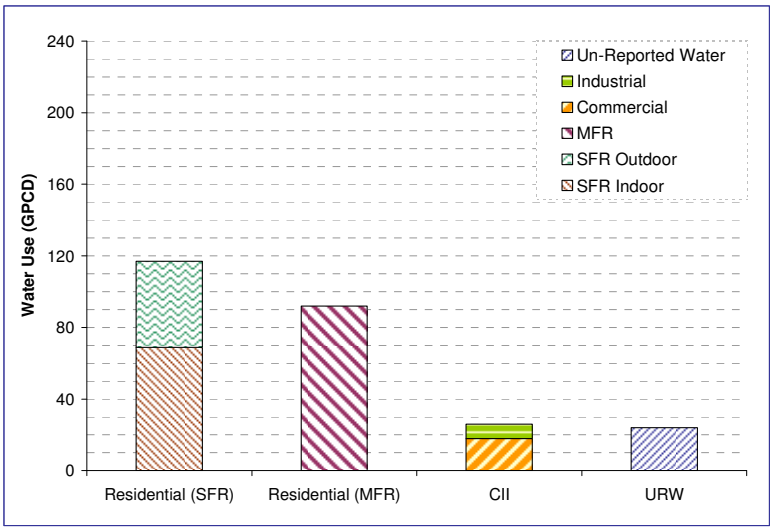


Figure 4-5 is relatively complete and realistic in reflecting the accurate water use pattern expected for Region 1. Given that the majority of urban use occurs in the southernmost area, in and around the City of Santa Rosa, the water use patterns there greatly outweigh the rest of the water use patterns exhibited by the more rural northern areas. However, given that Region 1 does have a more rural residential sector than its southern neighbor Region 2, the 92 GPCD for MFR relative to the 117 GPCD for SFR could be too high and should continue to be validated in future steps.

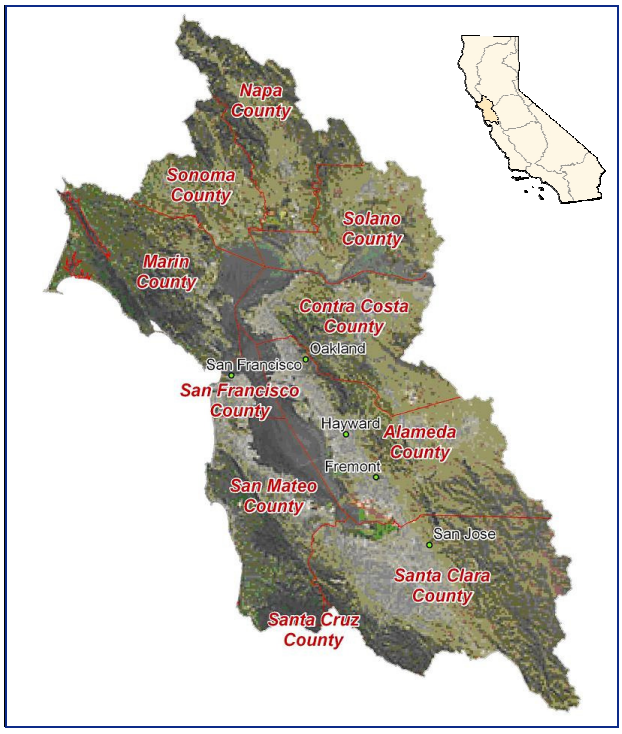
The 26 GPCD allocated for CII use is most likely due to paper mills that operate in the more forested areas of the region. Unreported water at 25 GPCD seems within reason given that the region has the lowest ET rate in the state, which limits the amount of open storage or distribution losses as well as the amount served to large land users. It is however slightly more than some of the more urbanized regions, which is in keeping with other more rural regions.

With calculations representing 80 percent of the population, it is not likely that data sets from major water suppliers were excluded. For future data collection surveys, extra attention should be paid to validate the data with major local water suppliers in this region such as some of retail agencies for SCWA (primarily the City of Santa Rosa) as well as the Humboldt Bay Municipal Water District for direct industrial use and its retailers (including the cities of Eureka, Arcata and Humboldt Community Services District).

4.3 San Francisco Bay Hydrologic Region (Region 2)

The San Francisco Bay Hydrologic Region (Region 2) covers approximately 2.88 million acres (4,500 square miles) and encompasses nine counties, including all of San Francisco county and portions of Marin, Napa, Sonoma, Solano, San Mateo, Santa Clara, Contra Costa, and Alameda counties (Figure 4-6). It extends from southern Santa Clara County north to Tomales Bay in Marin County, and inland to the confluence of the Sacramento and San Joaquin rivers. The region has the second largest population in the State at about 6.1 million in 2000 (DWR 2005). Approximately half of the people reside in Alameda and Santa Clara counties.

Figure 4-6: San Francisco Bay Hydrologic Region



Climate and Land Use

The climate within Region 2 varies significantly from west to east. Coastal areas are typically cool and foggy throughout the year, and inland valleys are warmer with a Mediterranean-like climate. Precipitation (mostly rain) varies throughout the region and is highly influenced by coastal topography and marine influences.

Portions of the region are highly urbanized and include the San Francisco, Oakland, and San Jose metropolitan areas. Agricultural acreage occurs mostly in the north and northeast in Napa, Marin, Sonoma, and Solano counties.

Water Portfolios

In the early 1900s, local water suppliers developed significant imported water supplies from the Mokelumne and Tuolumne rivers to meet anticipated demands. At the same time, local reservoirs and watersheds were being developed to capture surface supplies, to recharge the groundwater basins, and to act as terminal reservoirs for the larger projects. Later, State and Federal water projects brought water to the northern, eastern, and southern parts of the region through a number of canals. Local groundwater accounts for only about 5 percent of the region's average water year supply. Throughout the region

additional groundwater resources continue to be investigated and developed to help offset dependence on imported water supplies.

Current Water Conservation Status

Urban water districts in the Bay Area are generally signatories to CUWCC's Memorandum of Understanding Regarding Urban Water Conservation in California (MOU) that commits them to make a good faith effort to implement water conservation BMPs. Recycled water in the Bay Area is used in a full spectrum of applications, including landscape irrigation, industrial cooling, agricultural needs, and as a supply to the area's many wetlands. According to the California Water Plan Update 2005, nearly 50-million gallons per day of recycled water is currently produced in the Bay Area, and future planned projects have the potential to increase this amount to 100 million gallons per day (mgd) by the year 2020. MOU participating entities conducted a study recently and concluded that as a whole, their members had reduced the per capita water use by 16 percent since 1986 and decreased total water use by 1.4 percent despite a 17 percent increase in population served during the same period.

Urban Water Use

The histogram in Figure 4-7 presents the distribution of GPCD values of all usable datasets in this region. Approximately 80 percent of the reported datasets was deemed acceptable and was used in calculation, representing about 70 percent of the population in this region. Most water suppliers in this region demonstrate a total system water use between 100 and 199 GPCD. After taking population into consideration, the weighted average of this region is **157 GPCD**.

Figure 4-7: San Francisco Bay Region Urban Water Use Data Histogram

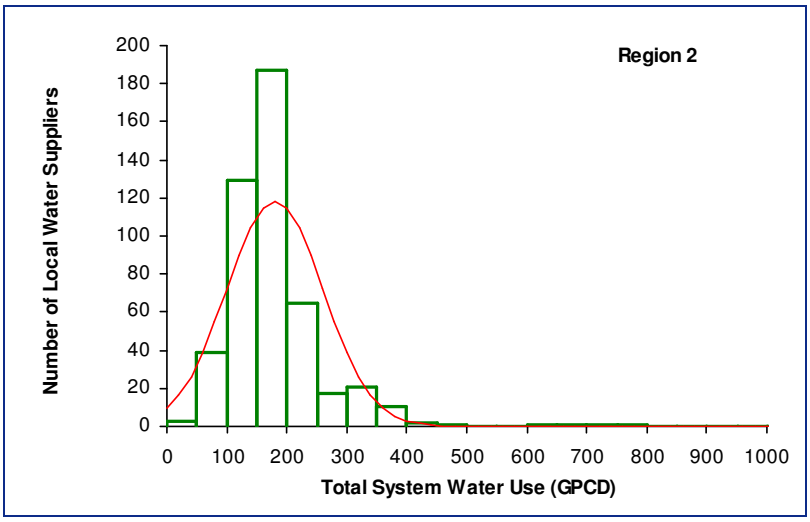
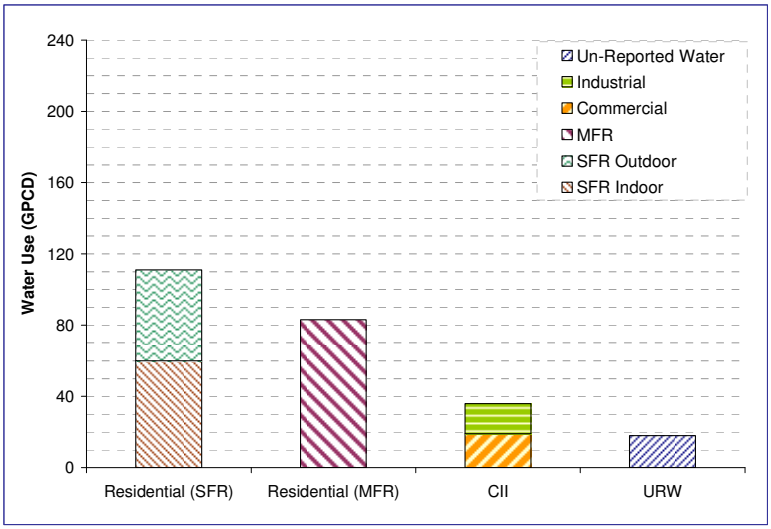


Figure 4-8 presents the distribution of the region's urban water use among residential, CII, and URW sectors (For detailed calculations of these values please refer to Appendix B).

Figure 4-8: San Francisco Bay Region Urban Water Use Distribution



With calculations based on 80 percent of local water suppliers representing 70 percent of the population, the data presented in Figure 4-8 is relatively complete and realistic in reflecting the accurate water use pattern expected for Region 2. Lower residential water use (due to higher-density housing and more MFR) and higher CII water use are usually the case for highly urbanized areas like Region 2. The lower residential water use is likely the result of ongoing water conservation programs.

The residential SFR indoor water use (61 GPCD) is lower than expected (usually around 70 GPCD) but is reasonable given the on-going water conservation programs in this region. The residential SFR outdoor water use (51 GPCD) is very low compared to other regions. This could be attributed partly to the well-established water conservation programs and also the lower ET rates of this region. Region 2 is along the Pacific Coast, with ET rates generally low along coastal areas that share foggy and cool weather, with slightly higher rates towards inland where many areas have drier, Mediterranean-like weather.

Being highly urbanized, Region 2 has more commercial and industrial activities. Therefore the higher GPCD value for CII sectors (total of 36 GPCD) meets the expectation. Heavy industries such as primary metal manufacture and wood and paper mills, which are major water users, are not typical in Region 2, which explains why the industrial sector (17 GPCD) has a low water use rate compared to those of inland regions. Industries in Region 2 that may use large amounts of water include oil refineries and chemical plants. Institutional water use, which is not reported in the PWSS database, could also account for a large portion of water use because Region 2 has relatively more public institutional water users such as universities and schools.

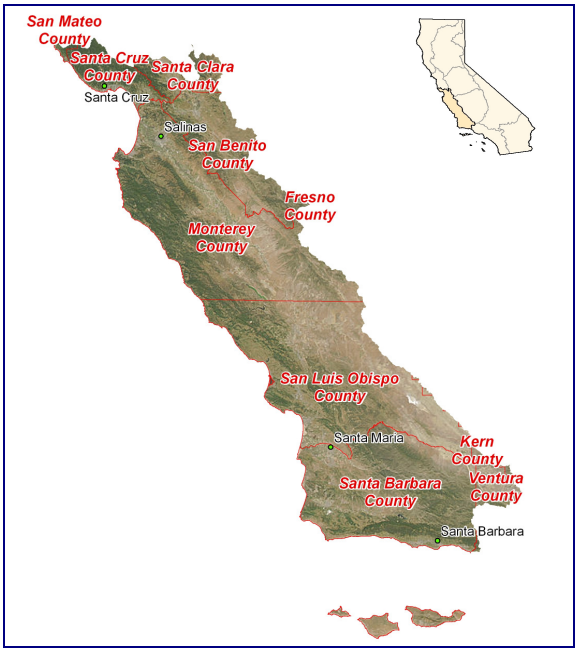
The unreported water (URW) sector at 19 GPCD seems high for Region 2 because it does not have as many large open spaces compared to other regions. The GPCD values could be the result of misreporting commercial landscape irrigation into the Large Landscape or Other sectors. Future PWSS surveys should specifically state the definition of each market sectors and provide examples to help guide the water suppliers in reporting to the surveys.

With calculations representing 70 percent of the population, it is possible that datasets from certain major water suppliers in this region were eliminated during the validation process. For future data collection surveys, extra attention should be paid to validate the data with major water suppliers in this region such as East Bay Municipal Utility District and San Francisco Public Utilities Commission.

4.4 Central Coast Hydrologic Region (Region 3)

The Central Coast Hydrologic Region (Region 3) covers approximately 7.25 million acres (11,326 square miles) and encompasses eight counties, including all of Santa Cruz, Monterey, San Benito, San Luis Obispo, and Santa Barbara counties, and portions of San Mateo, Santa Clara, and Ventura counties (Figure 4-9). It extends from southern Santa Barbara County north to San Mateo County, inland to the Gabilan and Diablo ranges in the north and to the Temblor and La Panza ranges in the south. The region had a population of about 1.5 million in 2000, slightly more than four percent of California's population.

Figure 4-9: Central Coast Hydrologic Region



Climate and Land Use

The climate within Region 3 is Mediterranean-like with mild, wet winters, and warm, dry summers. Adjacent to the Pacific Ocean, this region experiences fog and low clouds near the coast. Precipitation, mostly rain, varies through the region with a median rainfall of about 30 inches per year.

Water Portfolios

About 75 percent of the water supply for this region comes from groundwater. Groundwater recharge programs from rivers and reservoirs are vital in keeping up with the demand in this region. The remaining water supply comes from other sources including imported water from State and Federal projects. This region has tried to diversify its water supply portfolio including the construction of several seawater desalination plants.

Current Water Conservation Status

This region is challenged by its dependence on groundwater and continues to look at alternative sources in conjunction with its aggressive water conservation programs. To manage their groundwater resources more effectively, they have implemented conjunctive use projects that combine groundwater and surface water, and watershed programs that help reduce nonpoint pollution and stream erosion, and improve riparian vegetation. Water recycling has also played a significant role in helping the region develop another viable water resource. Region 3 has implemented some of the most successful conservation

programs in the state. Many water suppliers in this region are signatories to the MOU. Per capita urban water use in many parts of the region remains at or below late 1980s level, partially attributed by the aggressive conservation program triggered by the multi-year drought in 1987-1992.

Urban Water Use

The histogram in Figure 4-10 presents the distribution of GPCD values of all usable datasets in this region. Approximately 83 percent of the reported datasets was deemed acceptable and was used in calculation, representing about 64 percent of the population in this region. Most water suppliers in this region demonstrate an overall water use between 100 and 149 GPCD. After taking population into consideration, the weighted average of this region is **154 GPCD**.

Figure 4-10: Central Coast Region Urban Water Use Data Histogram

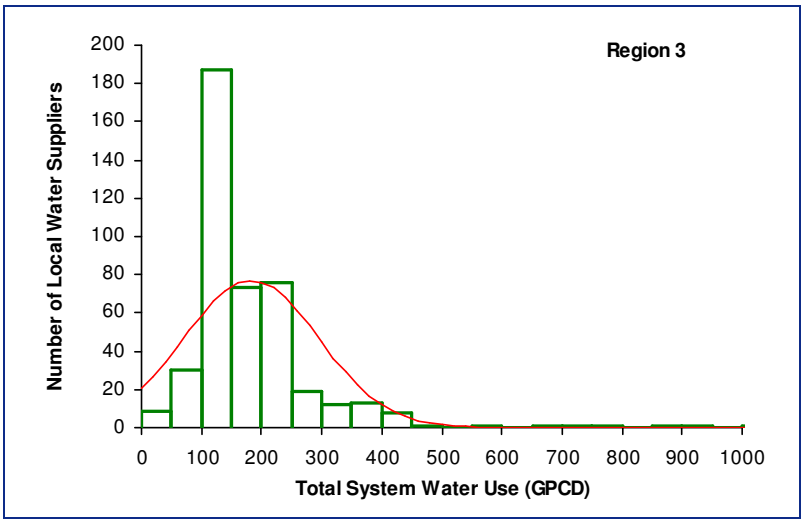
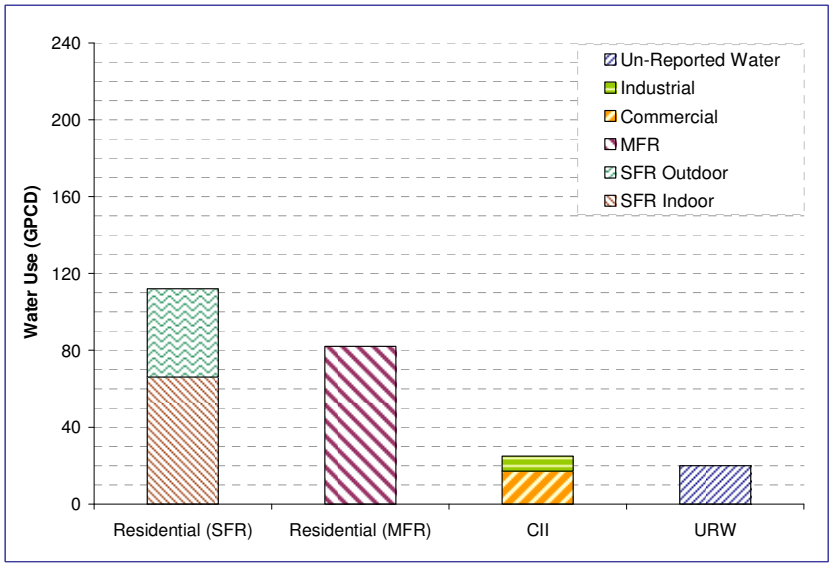


Figure 4-11 presents the distribution of the region's urban water use among residential, CII, and URW sectors (For detailed calculations of these values please refer to Appendix B).

Figure 4-11: Central Coast Region Urban Water Use Distribution



Region 3, to some extent, should have a water use pattern similar to Region 2 since they are both highly urbanized areas with similar climates. Figure 4-11 reflects a relatively accurate water use pattern expected for Region 3, except for industrial water use.

SFR indoor water use (66 GPCD) is higher compared to that of Region 2, but within reasonable range. MFR and URW water uses are both within expected range and are both similar to Region 2. The overall water use (154 GPCD) is the lowest among all regions in the state, and is mainly due to the low industrial water use (8 GPCD). It is unclear why the industrial water use rate of Region 3 is significantly lower than other regions.

It is important to note that 17 percent of available data representing 36 percent of the population was eliminated during the data validation process. This makes the GPCD values of this region less statistically reliable than that of Region 2 or other regions.

4.5 South Coast Hydrologic Region (Region 4)

The South Coast Hydrologic Region comprises the southwest portion of the state and is California's most urbanized and populous region. It contains slightly more than half of the state's population (54 percent), but covers only 7 percent of the state's total land area. The region's population totaled over 18.2 million people in 2000.

The topography includes a series of nearly flat coastal plains and valleys, many broad but gentle interior valleys, and several mountain ranges of low and moderate elevation. The region extends about 250 miles along the Pacific Coast from the Ventura-Santa Barbara County line in the north to the international border with Mexico in the south. The region includes all of Orange County, and portions of Ventura, Los Angeles, San Bernardino, Riverside, and San Diego counties (Figure 4-12).

Figure 4-12: South Coast Hydrologic Region

Climate and Land Use

The region has a mild, dry subtropical climate where summers are virtually rainless, except in the mountains where late summer thunderstorms sometimes occur. About 75 percent of the region's precipitation falls from December through March. The coastal plains and the interior valleys receive on average 12 to 18 inches of annual precipitation, depending on location, but the climate allows for a much wider variation from year to year. Much of the 20 to 40 inches of annual precipitation in the higher mountains falls as snow.

The mild climate and ample expanse of gentle landscapes in the South Coast region have encouraged a variety of land uses since the first great development boom of the late 1880s. The expansion of new single- and multi-family homes, commercial services, businesses, and highway systems into the warmer sections of the region continues onto lands that were historically pastoral, if not agricultural. Although pockets of open space and agricultural uses still exist, the urban area now extends southward from Ventura County to the international border with Mexico, and eastward from the coast to beyond the cities of Riverside and San Bernardino.

Agricultural acreage has continued to decline in recent years, yet it is still economically important for the region. And although agricultural uses occur throughout the region, the major areas continue to be the Oxnard Plain and the adjacent hills and valleys in Ventura County; the coastal and interior valleys in San Diego County; and the Chino area in San Bernardino County.

Water Portfolio

The South Coast region has developed a diverse mix of both local and imported water supply sources. Local water resources development over the last fifteen years includes water recycling, groundwater storage and conjunctive use, conservation, brackish water desalination, water transfers and storage, and infrastructure enhancements to complement imported water supplies. The region imports water through the State Water Project, the Colorado River Aqueduct, and the Los Angeles Aqueduct. This diverse mix of sources provides flexibility in managing supplies and resources in wet and dry years.

Current Water Conservation Status

Water use efficiency measures, which are partnering wastewater treatment entities and energy utilities with wholesale and retail water districts, will continue to have important impacts on the region's supplies and demands. A combination of active and passive measures has contributed to decreases in urban demands in the region. Recent examples of active water use efficiency programs include the installation of water efficient appliances for residential, industrial, commercial, and institutional uses, and the promotion of water-efficient landscaping and irrigation. Even greater water supply savings are being achieved from passive water use efficiency measures. Passive water measures involve changes in the plumbing code that require manufacturers to offer customers water-saving devices. A large part of the success of the region's water efficiency efforts are attributed to regional water conservation programs that cover most of the South Coast region. In addition, a high number of the region's water suppliers implemented the water conservation BMPs, making future conservation savings, particularly in the area of indoor conservation, more challenging.

The use of recycled water, which brings wastewater agencies into partnerships with surface and groundwater managers, is playing an increasingly significant role in meeting the region's water needs. A 2002 survey by the SWRCB estimated that recycled municipal water delivery was about 275,000 acre-feet per year in Southern California. By the year 2010, it is expected that the total will increase to about 410,000 acre-feet per year through water recycling, groundwater recovery, and seawater desalination.

Urban Water Use

The histogram in Figure 4-13 presents the distribution of GPCD values of all usable datasets in this region. Approximately 82 percent of the reported datasets was deemed acceptable. Most water suppliers in this region demonstrate an overall water use between 100 and 249 GPCD. After taking population into consideration, the weighted average of this region is **180 GPCD**.

Figure 4-13: South Coast Region Urban Water Use Data Histogram

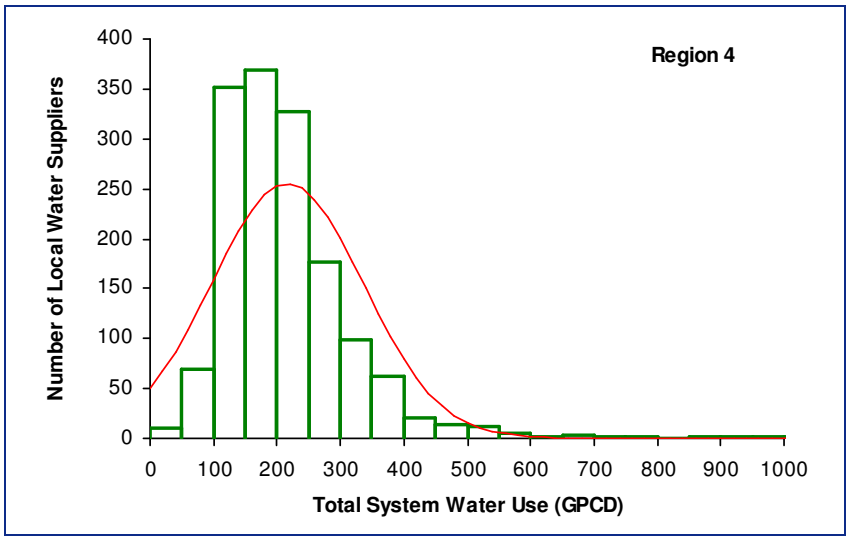
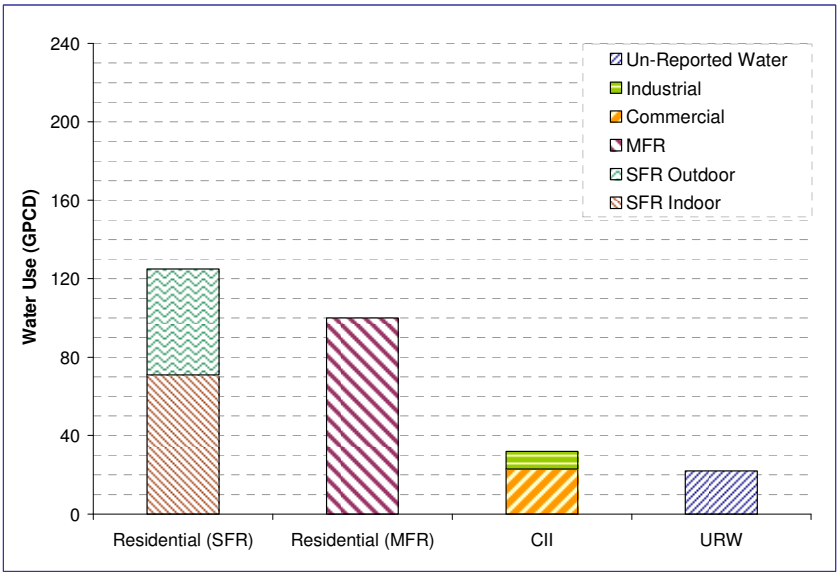


Figure 4-14 presents the distribution of the region's urban water use among residential, CII, and URW sectors (For detailed calculations of these values please refer to Appendix B).

Figure 4-14: South Coast Region Urban Water Use Distribution



The region's overall average deliveries of **180 GPCD** represent water deliveries to communities in the cooler, coastal zones, as well as deliveries to communities in the warmer, inland areas of the region. When evaluating the overall GPCD for this region, it is important to note that climate and land use have a major impact on water use, and the climate and land use in the region vary significantly. In addition, the large non-residential population, such as tourists, also has a major impact on water use, although it is difficult to quantify the impact.

Single family residential deliveries average 125 GPCD, and include both indoor and outdoor water use. Multifamily residential GPCD deliveries average 100 GPCD. And although data gaps exist in the region's

data, the GPCD totals are reasonable given the region's past water efficiency efforts. Historically, residential water efficiency efforts in the region focused on indoor devices that offer long-term, reliable water savings through device retrofits or changes in the plumbing code. However, in many areas of the region, the ability to achieve additional indoor water savings through these measures was diminished due to market saturation. In response, outdoor water efficiency programs were implemented to improve landscape and irrigation efficiency. It is important to note though, that the majority of future growth is likely to occur in the hot, dry inland areas of the region which may increase the region's GPCD total even if aggressive outdoor water efficiency programs are implemented.

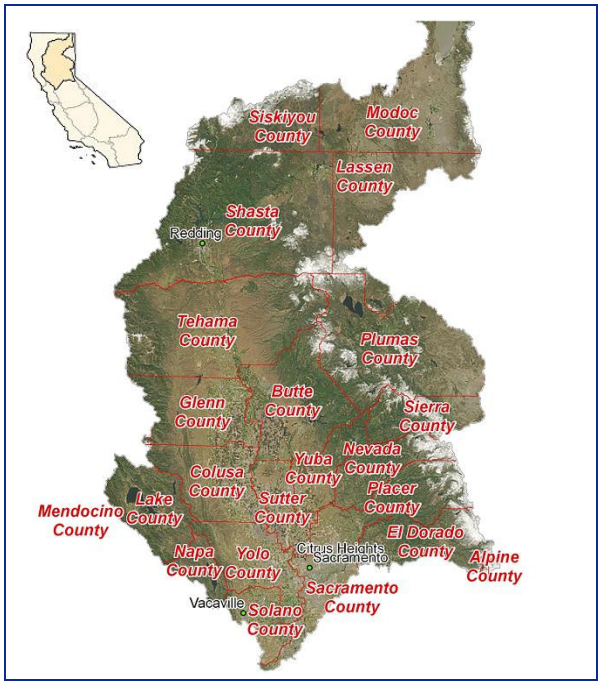
A large portion of the economy of the South Coast region is driven by commercial, industrial, and institutional water customers. Total deliveries to these customers average 32 GPCD. Major users of water include petroleum refining, electronics, beverages, and food processing, all of which require water as part of the manufacturing process. The region's remaining category of water use includes both non-revenue water and "other" water, and totals 22 GPCD. The "other" water includes water used to irrigate properties with large areas of landscape.

4.6 Sacramento River Hydrologic Region (Region 5)

Region 5, the Sacramento River Region, includes the counties of Butte, Colusa, El Dorado, Lake, Modoc, Nevada, Placer, Plumas, Sacramento, Shasta, Sierra, Sutter, Tehama, Yolo, and Yuba (Figure 4-15). The watershed encompasses basins draining into the Sacramento River system in the Central Valley from the Oregon border south through the American River drainage basin.

The climate ranges from high desert plateau in the northeast with cold, snowy winters, moderate rainfall and hot, dry summers; to the Sierra Nevada Mountains and Foothills with cold, wet winters and large amounts of snow; to the Sacramento Valley floor with mild winters, less precipitation and hot dry summers. Annual average ET rate ranges from a low of 49 inches to a high of 57 inches. The region's annual average precipitation is 36 inches.

Figure 4-15: Sacramento River Hydrologic Region



Climate and Land Use

The region is composed of predominantly rural counties in the north coupled with rapidly growing urban areas in the south, including Sacramento, Placer, El Dorado and Yolo counties. Six national forests and agriculture (rice, grain, tomatoes, field crops, fruits and nuts) dominate the rural landscape.

Water Portfolio

While a few of the larger cities in the region divert most of their water from the larger rivers, the principal source of water for most of the communities is groundwater. Major state and federal water project reservoirs are sited in this region.

Current Water Conservation Status

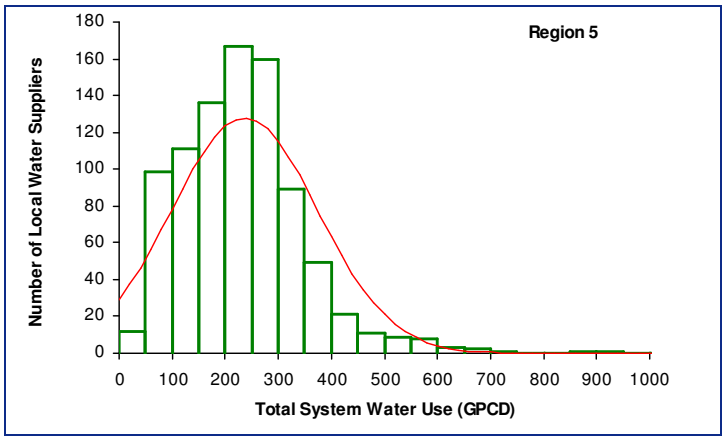
Many water suppliers in this region have just recently begun the installation of water meters for their residential customers. The combination of lack of information about how much water they actually use, low rates, and the perception of ample water supplies, this region has not been as aggressive in adopting water use efficiency programs as other areas of the state. Therefore, there is ample opportunity to reduce

per capita water use in this region due to a rapidly rising population combined with lower than average implementation of existing water conservation measures and high ET rates in the region. Cost effectiveness considerations, however, may be a limiting factor in terms of implementing effective water conservation programs. Recycled water makes up a very small portion of the total water supply in this region.

Urban Water Use

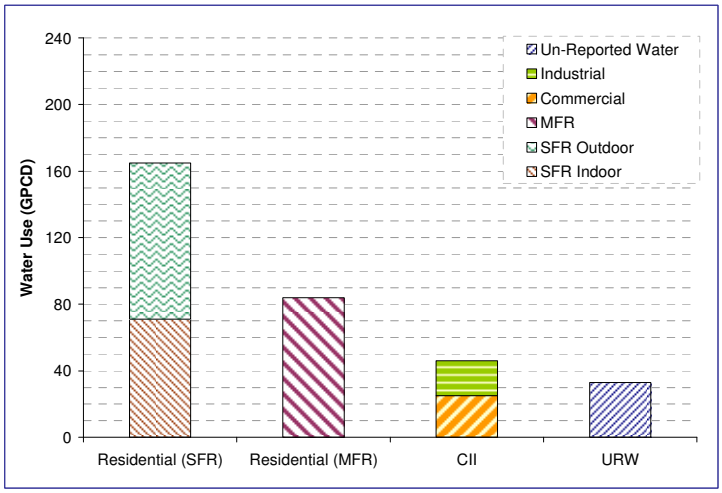
The histogram in Figure 4-16 presents the distribution of GPCD values of all usable datasets in this region. Approximately 77 percent of the reported datasets was deemed acceptable and was used in calculation, representing about 65 percent of the population in this region. Most water suppliers in this region demonstrate an overall water use between 200 and 299 GPCD. After taking population into consideration, the weighted average of this region is **253 GPCD**.

Figure 4-16: Sacramento River Hydrologic Region Urban Water Use Data Histogram



The overall water use GPCD for Region 5 is **253 GPCD**. Figure 4-17 presents the distribution of the region's urban water use among residential, CII, and URW sectors.

Figure 4-17: Sacramento River Region Urban Water Use Distribution



Residential water use is the highest percentage of use, as would be expected. Food processing and forestry contribute toward the industrial water use of the region. Overall, the breakdown of water use by sector for Region 5 appears to be representative.

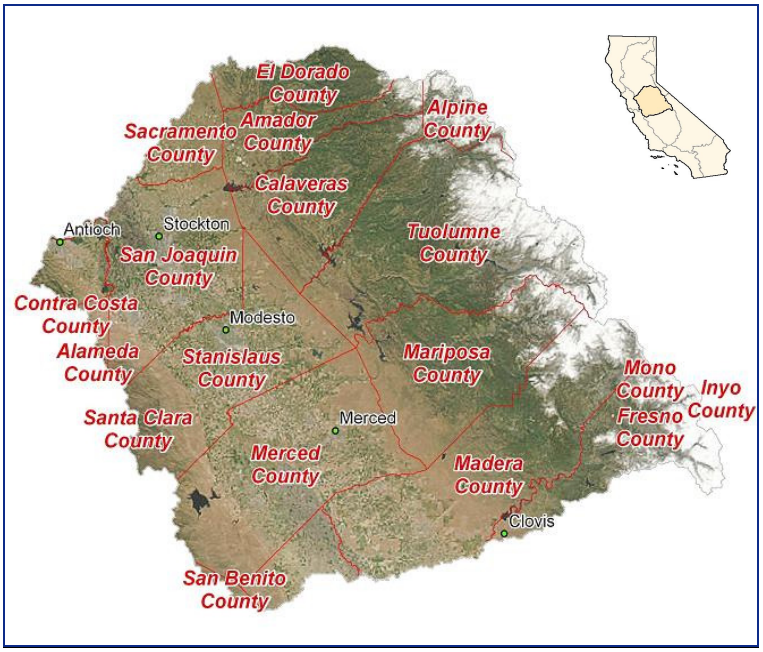
4.7 San Joaquin River Hydrologic Region (Region 6)

Region 6, the San Joaquin River Region, includes the counties of Amador, Calaveras, Madera, Mariposa, Merced, San Joaquin, Stanislaus, and Tuolomne (Figure 4-18). The watershed encompasses basins draining into the San Joaquin River system, from the Cosumnes River basin on the north through the southern boundary of the San Joaquin River watershed.

The northern portion of the San Joaquin Valley is bordered on the east by the Sierra Nevada and on the west by the coastal mountains of the Diablo Range. Hot, dry summers and mild winters characterize the valley floor sections, with cooler, wetter climate distinguishing the foothill and mountain sections.

Annual average ET rate ranges from a low of 53 inches to a high of 63 inches. The region's average annual precipitation is 26 inches, ranging from 35 inches in the mountain areas to 6 inches in the dry southwestern corner of the region.

Figure 4-18: San Joaquin River Hydrologic Region



Climate and Land Use

The agricultural land in the valley floor areas, recognized as one of the most important agricultural regions in the state is being challenged by rapidly growing urban areas. Public lands account for one-third of the region's total land area. Urban water use accounts for less than five percent of the total applied water in the region.

Water Portfolio

The rivers that drain the western slope of the Sierra Nevada are the primary sources of surface water for the region. In 2000, about 44 percent of the region's developed water supply came from local surface sources, 23 percent from imported surface supplies, and 33 percent from groundwater.

Current Water Conservation Status

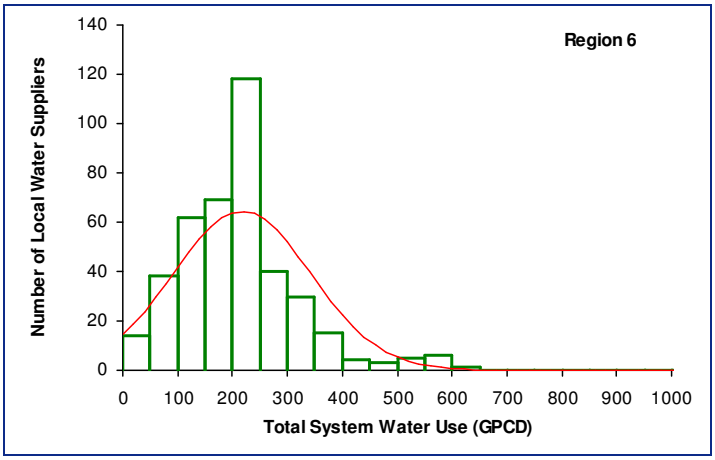
There is ample opportunity to accomplish per capita water reductions in this region due to a rapidly rising population combined with lower than average implementation of existing water conservation measures

and high ET rates in the region. Cost effectiveness considerations, however, may be a limiting factor in terms of implementing effective water conservation programs. Recycled water makes up a very small portion of the total water supply in this region.

Urban Water Use

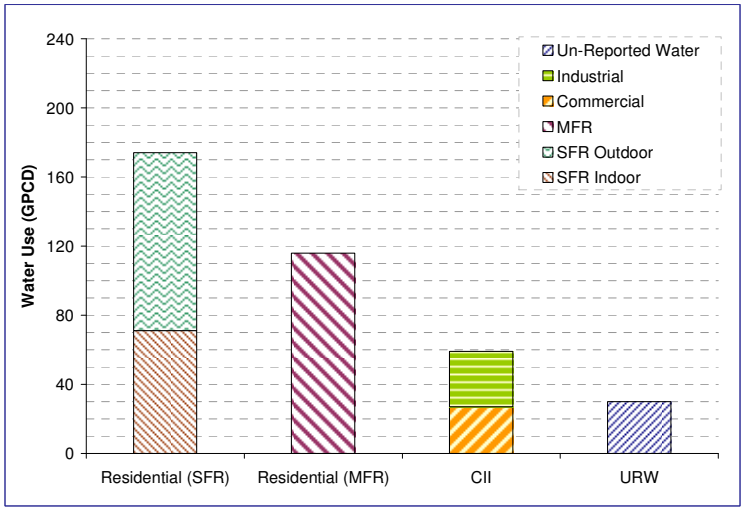
The histogram in Figure 4-19 presents the distribution of GPCD values of all usable datasets in this region. Approximately 78 percent of the reported datasets was deemed acceptable and was used in calculation, representing about 50 percent of the population in this region. Most water suppliers in this region demonstrate an overall water use between 250 and 299 GPCD. After taking population into consideration, the weighted average of this region is **248 GPCD**.

Figure 4-19: San Joaquin River Hydrologic Region Urban Water Use Data Histogram



The overall water use GPCD for Region 6 is **248 GPCD**. Figure 4-20 presents the distribution of the region's urban water use among residential, CII, and URW sectors.

Figure 4-20: San Joaquin River Hydrologic Region Water Use Distribution



As in Region 5, residential water use is the highest percentage of use, as would be expected. Food processing and forestry contribute toward the industrial water use of the region. Overall, the breakdown of water use by sector for Region 6 appears to be representative.

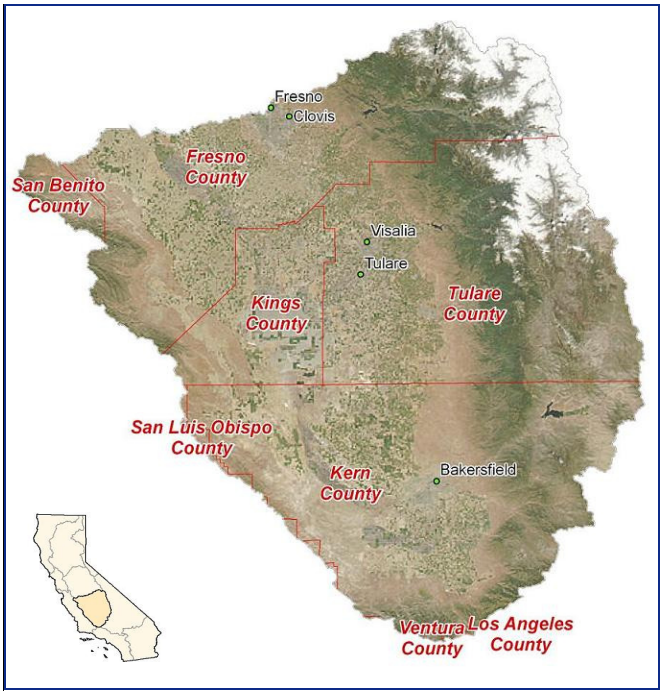
4.8 Tulare Lake Hydrologic Region (Region 7)

Region 7, the Tulare Lake Region, includes the counties of Fresno, Kern, Kings, and Tulare (Figure 4-21). The watershed is composed of the closed drainage basin at the south end of the San Joaquin Valley, south of the San Joaquin River watershed, encompassing basins draining to Kern Lakebed, Tulare Lakebed, and Buena Vista Lakebed

The southern end of the San Joaquin Valley is bordered on the east by the Sierra Nevada and on the west by the coastal range. The southern boundary is the Tehachapi Mountains. Hot summer months, due in part to the region's isolation from marine effects, are coupled with mild winter months.

Annual average ET rate ranges from a low of 53 inches to a high of 63 inches. The region's annual average precipitation is 15 inches.

Figure 4-21: Tulare Lake Hydrologic Region



Land Use and Climate

As with Region 6, Region 7 is an important agricultural area with high population growth rates. Public lands account for 30 percent of the region's total land area.

Urban water use accounts for less than five percent of the total applied water in the region. However, there is ample opportunity to accomplish per capita water reductions in this region due to a rapidly rising population combined with lower than average implementation of existing water conservation measures and high ET rates in the region.

Water Portfolio

The four main rivers that flow out of the Sierra Nevada provide most of the surface water to the region. Water from the State Water Project and Central Valley Project are delivered to this region. Groundwater has also been an important source for both urban and agricultural uses, accounting for 33 percent of the region's total annual supply, and also accounting for 35 percent of all groundwater use in the state.

Current Water Conservation Status

There is ample opportunity to accomplish per capita water reductions in this region due to a rapidly rising population combined with lower than average implementation of existing water conservation measures and high ET rates in the region.

The significant increase in population in the Tulare Lake region has resulted in a rising volume of recyclable water. Most of the recycled water is used for irrigation and groundwater recharge.

Urban Water Use

The histogram in Figure 4-22 presents the distribution of GPCD values of all usable datasets in this region. Approximately 77 percent of the reported datasets was deemed acceptable and was used in calculation, representing about 60 percent of the population in this region. Most water suppliers in this region demonstrate an overall water use between 150 and 249 GPCD. After taking population into consideration, the weighted average of this region is **285 GPCD**. Figure 4-23 presents the distribution of the region's urban water use among residential, CII, and URW sectors.

Figure 4-22: Tulare Lake Hydrologic Region Urban Water Use Data Histogram

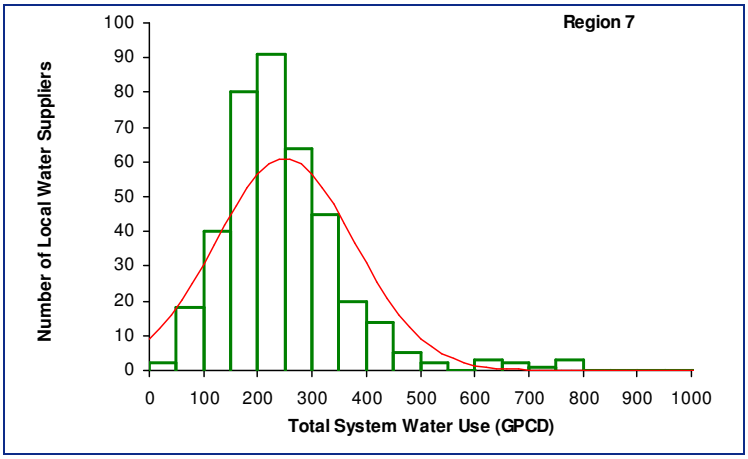
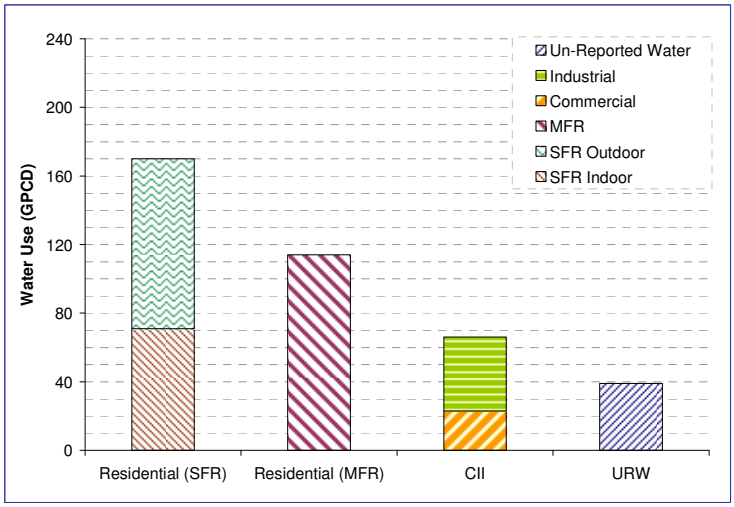


Figure 4-23: Tulare Lake Region Water Use Distribution



The overall data and sector breakdowns are quite consistent across regions 5, 6 and 7, which would be expected due to similar climatic, socio-economic and land use patterns. The Industrial use sector is higher in Region 7, perhaps due to oil production and other high water use industries. Overall, the breakdown of water use by sector for Region 7 appears to be representative.

4.9 North Lahontan Hydrologic Region (Region 8)

Region 8, the North Lahontan Region, is composed primarily of the county of Lassen (Figure 4-24). The watershed includes basins east of the Sierra Nevada crest and west of the Nevada state line, from the Oregon border south to the southern boundary of the Walker River watershed.

Land Use and Climate

Hugging the Nevada border this narrow region stretches from the Oregon border to Mono County. High desert with flat valleys characterize the northern portion of the region with the eastern slopes of the Sierra Nevada dominating the central and southern portions. Annual average ET rate ranges from a low of 43 inches to a high of 54 inches. Annual average precipitation is 23 inches.

Public land management, tourism and recreation compose most of the activity in this region. Less than one percent of California's population lives in this region.

Figure 4-24: North Lahontan Hydrologic Region

Water Portfolio

Most locally developed water supplies are from groundwater or small surface water diversions. Most of the region is chronically short of water.

Current Water Conservation Status

The opportunity for urban water use efficiency is limited in this region due to the low population and low per capita water use.

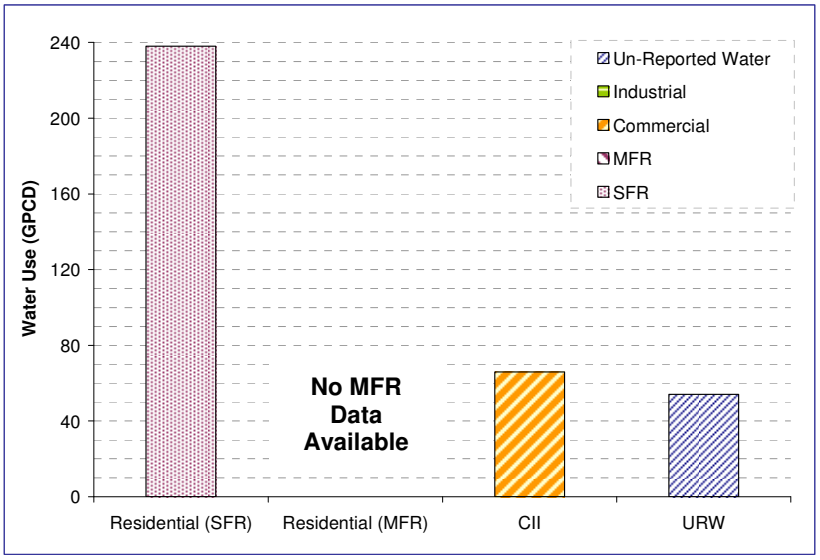
Urban Water Use

Between 1995 and 2005, up to only 10 water suppliers in Region 8 provided water production and water delivery data to DWR in a single year, and only one entity provided residential water use data. This represents about 15 percent of the 2000 population in this region.

The analysis of data from the PWSS database did not provide enough data points to develop reasonable sector or total GPCD data for Region 8. In review of other databases, the LUWP data from DWR was deemed an appropriate alternative database. This data included estimates of water use extrapolated from small datasets and adjacent county or sub-county areas, to those areas with little or no data in this Region. Averages of total system, SFR, MFR, and Commercial and Industrial (CI combined) were developed using averages from the three years of data (1998, 2000, and 2001).

The overall water use GPCD for Region 8 is **248 GPCD**. Figure 4-25 presents the distribution of the region's urban water use among residential, CII, and URW sectors.

Figure 4-25: North Lahontan Region Urban Water Use Distribution



4.10 South Lahontan Hydrologic Region (Region 9)

The northern half of the South Lahontan Region includes Mono Lake, Owens Valley, Panamint Valley, Death Valley, and the Amargosa River Valley. The Mojave Desert occupies the southern half of the region, and is characterized by many small mountain ranges and valleys with playas, or dry lakes. The region has the highest and lowest elevation points in the continental United States: Mount Whitney with an elevation of 14,495 feet and Death Valley at 282 feet below sea level. The region includes all of Inyo County and parts of Mono, San Bernardino, Kern, and Los Angeles counties (Figure 4-26).

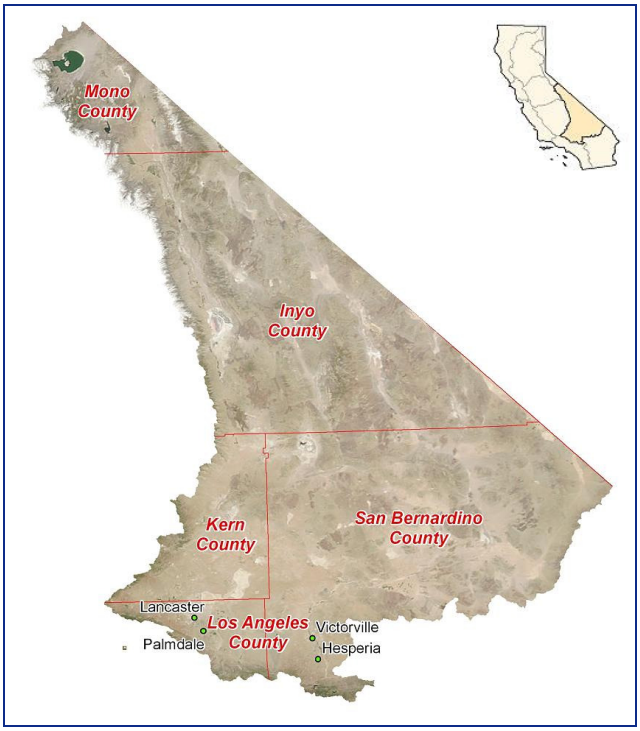
Land Use and Climate

The region has few permanent rivers and streams due to the dry hydrology on the east side of the Sierra Nevada. And although the region covers 17 percent of the land mass of the state, its 2000 population was 721,490, roughly two percent of California's total population. Nearly 450,000 people now live in the southern portion of the region, in the areas of Antelope, Apple, and Victor valleys. The cities of Palmdale and Lancaster were among the fastest-growing cities in the state in the 1990s.

The region supports a variety of urban and agricultural uses, including a moderate amount of agricultural acreage around the Antelope and Owens valleys and several growing cities. Much of the land in the region remains undeveloped and is under protected or managed status for recreational, scenic, environmental, or military purposes. Even though 18,000 acres in the Antelope Valley remain agriculturally productive, that area and Victor Valley have now become moderately urbanized.

The climate of the South Lahontan Region is generally arid. Annual average precipitation is less than 10 inches, except for the higher mountains. Annual average precipitation in the higher elevations of the Sierra Nevada ranges from 25 to 50 inches. Some of the central and eastern portions of the Mojave Desert average 4 inches of precipitation annually.

Figure 4-26: South Lahontan Hydrologic Region



Water Portfolio

The Los Angeles Aqueduct, which exports water from the Owens Valley to Los Angeles, is the South Lahontan Region's major water development feature. More recently, exports have been modified and reduced as a result of litigation to preserve Mono Lake and to mitigate the dust problems that resulted from the diversion of water from Owens Lake.

Groundwater provides about 41 percent of the average annual water supply in the region. Groundwater is used conjunctively with surface water in the more heavily pumped basins that underlie about 55 percent of this hydrologic region. The total estimated demand met by groundwater in the region is about 239,000 acre-feet per year. Most of the groundwater production is concentrated, along with the population, in basins in the southern and western parts of this hydrologic region. Many other areas of the hydrologic region are designated as public land and have low population density. As such, many of the groundwater basins have not been significantly used and there is little data available about groundwater volume and quality.

Current Water Conservation Status

To address the needs of expanding urban areas in the southern portion of the region, many water districts are taking a proactive approach to the water reliability problems by initiating studies and projects that could provide partial or complete solutions. These include water conservation programs, water recycling projects, groundwater exchanges and recovery, water marketing, and other water supply augmentation strategies.

In the area of water conservation, twenty-five regional organizations formed a coalition to educate the local communities on the importance of water conservation and provide the tools to reduce per capita consumption levels. Targeted customers include new and existing homeowners, landscape suppliers, professional and commercial landscapers, developers, commercial, industrial, and institutional entities, retail water providers, and cities. Numerous water suppliers in the region have also implemented the water conservation BMPs. Water recycling activities in the region are focused in the Antelope Valley area. The majority of the recycled water is used for crop irrigation, environmental purposes, and to maintain lakes at a regional park.

Urban Water Use

Figure 4-27 presents the histogram that shows the distribution of GPCD values of all usable datasets in this region. Most entities demonstrated an overall water use between 200 and 249 GPCD. After taking population into consideration, the weighted average of this region is **237 GPCD**.

Figure 4-27: South Lahontan Region Urban Water Use Data Histogram

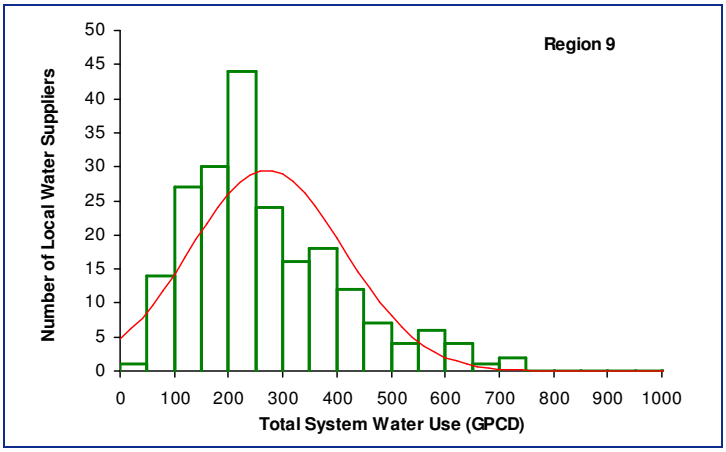
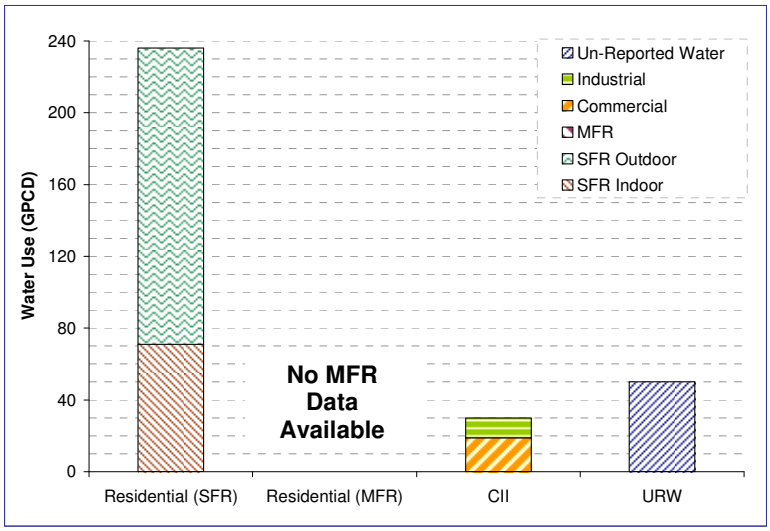


Figure 4-28 presents the distribution of urban water use among the selected sectors. About 28% of the data points were deemed invalid because of missing or incomplete data. An average overall water use of this region was computed based on the rest of the data points. The data points represent approximately 35% of the region's population, which makes the GPCD totals less representative of the entire region than desired. Additional data points need to be included in future calculations if the GPCD totals are to better represent the entire region.

Figure 4-28: South Lahontan Region Urban Water Use Distribution



In the region, overall deliveries average **237 GPCD**. When evaluating the GPCD for this region, it is important to note that climate has a major impact on water use, and the climate in the southern half of the region is generally dry, with little rainfall and high temperatures which increases GPCD water use.

Single family residential deliveries average 236 GPCD, and include both indoor and outdoor residential water use. This total represents water deliveries to single family housing units, mostly in the populated areas in the southern portion of the region. The unusually high GPCD total reinforces that the data used to calculate the single family residential GPCD deliveries is suspect and needs further evaluation. Data was not available to calculate the region's multifamily residential average GPCD.

Commercial, industrial, and institutional deliveries average 30 GPCD, and represent water use by manufacturing facilities, several large aerospace companies located in the southern end of the region, and mining operations. Tourism in the northern part of the region also contributes to the CII GPCD, which is below average for the state. The final category of water use combines non-revenue water and "other" water, and is 31 GPCD.

4.11 Colorado River Hydrologic Region (Region 10)

The Colorado River Hydrologic Region covers the southeast portion of California and contains 12 percent of the state's land area. The Colorado River forms most of the region's eastern boundary and the international boundary with Mexico forms its southern boundary. The region includes all of Imperial County, about the eastern one-fourth of San Diego County, the eastern two-thirds of Riverside County, and the southeastern one-third of San Bernardino County. It has a variety of arid desert terrain that includes many bowl-shaped valleys, broad alluvial fans, sandy washes, hills, and mountains.

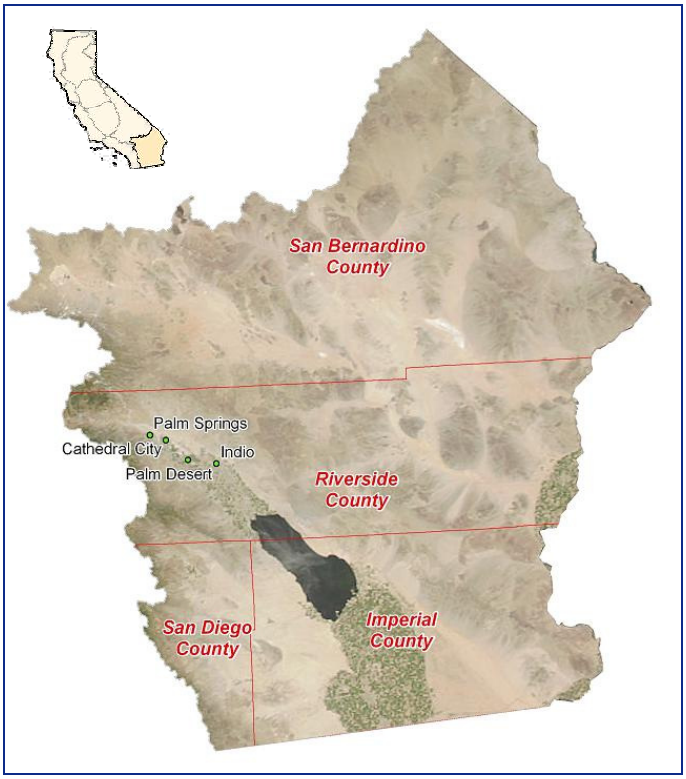
Nearly all of the Colorado River Region has a subtropical desert climate with hot summers and generally mild winters. Average annual rainfall is very low and precipitation ranges between 3 to 6 inches per year, most of which occurs in the winter months. However, summer storms do occur and can generate significant rainfall in some years. Winter maximum temperatures are mild, but summer conditions are generally very hot, with more than 100 days with temperatures of over 100 degrees Fahrenheit each year in the Imperial Valley.

Land Use and Climate

The federal government administers a large portion of the region's land. And despite the region's arid conditions, significant areas of agricultural land exist in the region. Agriculture is the most prominent land use, with over 600,000 acres of land farmed each year. The largest agricultural areas occur in the Imperial Valley, Palo Verde Valley, and Coachella Valley (Figure 4-29).

More than half of the region's residents reside in the Coachella Valley. Most of the remaining population is in the Imperial Valley and in the corridor between the cities of Yucca Valley and Twentynine Palms. By 2030, the California Department of Finance projects that the regional population will almost double from its 2000 population of approximately 600,000 people to over 1.1 million people.

Figure 4-29: Colorado River Hydrologic Region



Water Supplies

About 85 percent of the region's urban and agricultural water supply comes from surface water deliveries from the Colorado River. Water from the river is delivered into the region through the All-American and Coachella canals, local diversions, and the Colorado River Aqueduct by means of an exchange for State Water Project water. The Colorado River is an interstate and international river whose use is apportioned among the seven Colorado River Basin states and Mexico by a complex body of statutes, decrees, and court decisions known collectively as the "Law of the River." Local surface water and groundwater also provide water to the region. In addition, many of the alluvial valleys in the region are underlain by groundwater aquifers that are the sole source of water for local communities. The use of some of this groundwater may not be included in the region's urban use totals since the data is not readily available.

Current Water Conservation Status

Water districts and users in the Colorado River Region are well aware of the importance of water conservation programs to efficiently use and manage water. The agricultural growers in all of the districts do precision land forming for specific crops and use plastic and other mulches to reduce evapotranspiration and improve productivity.

Additional efficiency improvements include the construction of lateral interceptors, regulatory and interceptor reservoirs, concrete-lining of nearly 200 miles of lateral canals, and delivery of water to agricultural customers through metered, underground pipelines. These infrastructure upgrades complement other programs including farmer-initiated measures, canal lining, canal seepage recovery, and regulatory reservoirs.

Although most of the water conservation in the region has been directed to agriculture, water districts in the region provide technical assistance to the managers of large landscaped areas, such as golf courses, to evaluate and offer suggestions about irrigation hardware and operations. Loans to retail customers are available for irrigation upgrades, and classes in English and Spanish are offered to homeowners, property managers, and government and school personnel on irrigation efficiency strategies and tools.

A significant amount of the recycled water use that occurs in the region is used to irrigate golf courses and other areas of large landscape, primarily in the Coachella Valley.

Urban Water Use

Figure 4-30 presents the histogram that shows the distribution of GPCD values of all usable datasets in this region. Most entities demonstrated an overall water use between 150 and 249 GPCD. After taking population into consideration, the weighted average total system GPCD of this region is **346 GPCD**.

Figure 4-30: Colorado River Hydrologic Region Urban Water Use Data Histogram

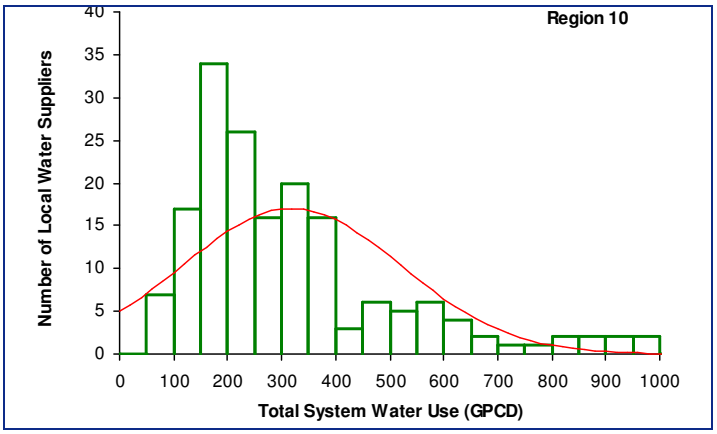
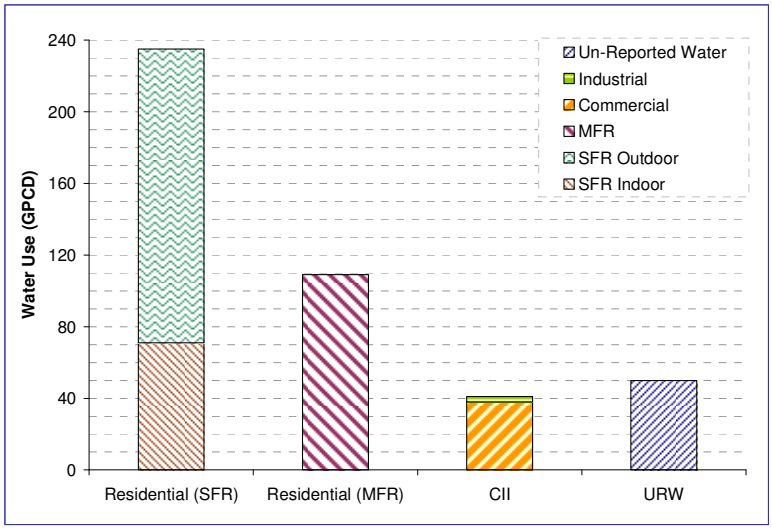


Figure 4-31 presents the distribution of urban water use among the selected sectors. Twenty-three water suppliers in Region 10 reported water production and water delivery data. Of which, about 18% of the data points were deemed invalid because of missing or incomplete data. An average overall water use of this region was computed based on the rest of the data points which represented 92% of the region's population.

Figure 4-31: Colorado River Region Urban Water Use Distribution



In the region, overall deliveries average **346 GPCD**, the highest of any region. When evaluating the GPCD for this region, it is important to note that climate has a major impact on water use, and the climate in the region is generally dry, with little rainfall and high temperatures. This is a significant factor in the region's high GPCD water use.

Single family residential deliveries average 235 GPCD, and include both indoor and outdoor residential water use. Indoor water use totals 71 GPCD, and outdoor water use totals 164 GPCD. This total represents water deliveries to single family housing units which are primarily concentrated in the Coachella Valley and Imperial Valley areas of the region. In addition to the climate acting as a driver for the region's high outdoor GPCD total, the GPCD total may be increased by part-time residents who own second homes in those areas and irrigate throughout the year, but are not included in the permanent population since they only reside in the region during the winter months. Multifamily residential deliveries average 109 GPCD which is reasonable given the region's climate and is consistent with other inland regions. Commercial, industrial, and institutional deliveries average 41 GPCD, which is about average for the state. The final category, non-revenue water and "other" water use, is 50 GPCD. The GPCD is high when compared to other regions, but is plausible since it includes the water used to irrigate golf courses in the Coachella Valley, as well as other properties with large landscaped areas.

5 Conclusions and Recommendations

Establishing the baseline is a dynamic process. The methodology used to develop the baseline in this TM was based on the data and resources available at this time and is a good first step towards accomplishing the Program's goals. There is ample room for improvement and refinement of the baseline values as new information and datasets become available as well as additional resources to process and incorporate this data can be allocated.

The baseline values for each region represent the starting point of the 20x2020 Program to keep the entities and interested parties informed and motivated, and help determine the progress in achieving the Governor's goal of this program. It is recommended that both the data and the methodology used to calculate these values be updated when feasible. To facilitate this process, several specific tasks and activities are identified in this section as next steps to further improving the 20x2020 Program baseline values.

5.1 Data Collection

Modifications to the DWR data request survey could help obtain more accurate and complete data from water suppliers. The following requests and instructions should be incorporated into future surveys:

1. The surveys should request that the water suppliers, to the extent that the accounting and data collection systems would allow, report *all* of the following items. If any of the items do not have data or is not feasible to provide the data, the water suppliers should include an explanation so that the data master can decide how to factor the data into analysis.
    - Total potable water produced (i.e., raw water taken from groundwater or surface water).
    - Total recycled or other non-potable water produced.
    - Total water delivered to individual sectors: SFR residential, MFR residential, commercial, industrial, institutional, water system use (e.g., system flushing, hydrant testing, etc.), and non-revenue water.
    - Number of connections of all market sectors, especially the SFR and MFR residential sectors. This should also include both metered and unmetered connections. This would help verify the population data provided by the entities against data from the US Census Bureau.
    - Information on billing system type (flat rate, inclining or declining block rates).
    - Water audit information (see AWWA Water Audit Software and California BMP 3):
        - Imported and exported water
        - Cost of water (retail and the electrical and chemical costs)
        - Apparent losses (unauthorized consumption, meter in-accuracies, data errors)
        - Real losses (leakage and overflows)
        - Miles of distribution system main pipelines
        - Distribution system pressures
2. The survey should request that water suppliers report all values in a single standard measurement, preferably in million gallons (MG). Standardizing the units across all entities will make it easier to identify abnormal data points and trends, and requires less of a data validation effort.
3. The survey should specifically explain that the population should not be the general population of residents according to the Census, and should not include tourists. The population should be

the customers served by the water system. This would help eliminate the inclusion of private water suppliers in the analysis.

4. The survey should specifically state that the Total Municipal Potable Water data do *not* include agriculture or wholesale water.
5. After reviewing the recycled water data, it appears that some of the results exactly or nearly match the potable water amount. It is suspected that some entities are misinterpreting the meaning of recycled water. Future surveys need to include explanation of each type of water supply and use sector.
6. It appears that some water suppliers were unclear regarding the definition of the MFR sector. Some referred to this sector solely as apartment complexes, while others included multi-unit buildings such as offices. Future surveys need to state clearly that MFR refers to multiple-residence-only structures such as apartment complexes, and that other multi-unit buildings should be included in either the "Commercial" sector (e.g., office buildings) or the "Institutional" sector (e.g. universities).
7. Some referred to this sector as solely apartment complex, while others included multi-unit buildings such as offices. Future surveys need to clearly state that MFR refers to multiple residence only structures such apartment complexes, and that other multi-unit buildings should be included in either the "Commercial" sector (e.g. office buildings) or the "Institutional" sector (e.g. universities).

5.2 Data Validation

Given that water suppliers will realize that data reported to DWR is being used to establish water use baselines and eventually conservation targets, there could be an increase in the amount and quality of data provided to DWR. Ongoing data validation exercises can be time-intensive, but are critical to ensuring that data reported is consistent and is in line with known activities and ongoing changes in the region. Continued data evaluation and validation are recommended for future stages of the Program. The following suggestions should be considered:

1. Conduct basic annual review of data, such as check the Public Water System (PWS) ID numbers, associated counties, measurement units, and population.
2. One state (or federal) agency could be charged to act as the data repository for the water use and audit information. This should be an agency with regulatory jurisdiction to mandate data submission. While this may seem onerous, it will reduce the reporting workload for the individual entities and also significantly improve the completeness of the datasets. At the moment at least four agencies (DWR, DPH, CUWCC, and CPUC) collect similar data. While this step may not be practical given the time available for the initial phase of this Program, it merits consideration for future phases in order to manage the data and resources more effectively.
3. When feasible, improve the data management techniques to include:
    - Preparation of a single water-audit database
    - Repository management by one state (or federal) agency
    - Peer review of data to make sure the data is valid and sensible
    - Personal communication with utilities that either do not report or have trouble with reporting
    - Impose mandatory annual reporting of data to reduce errors inherent in voluntary reporting

Given the quality of the available database to develop the baseline, meeting the targets presented in this Program (presented in the subsequent Target TM) should be voluntary for the water suppliers until a more

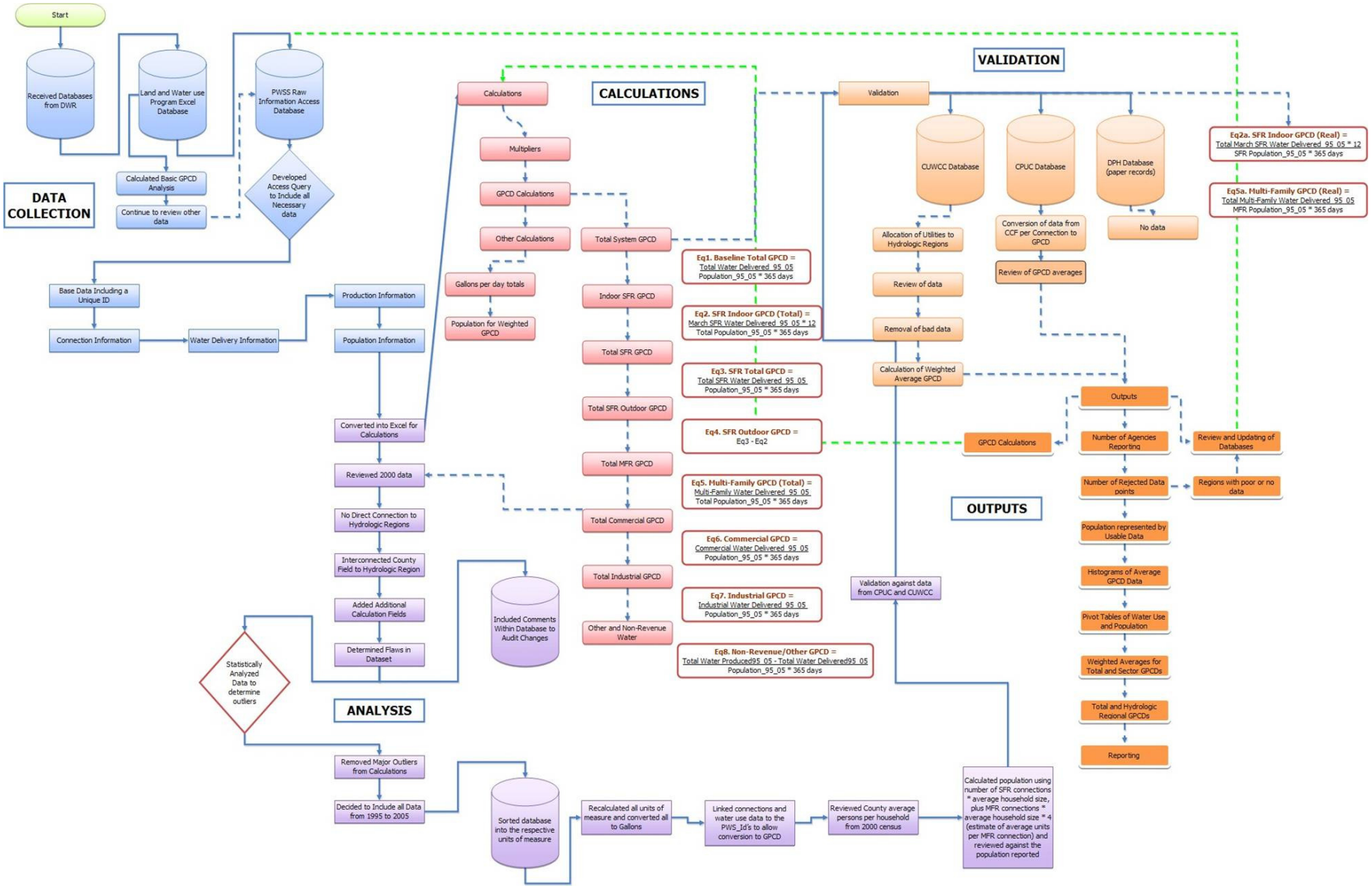
complete and valid database can be developed for mandatory reporting. It is also recommended that the targets be reviewed by the 20x2020 Team, with input from stakeholders, every five years.

It must be emphasized again that due to various constraints with the database, the baseline values presented in this TM are for planning purposes only, and should not be used for making regulatory decisions at this time.

6 References

- California Water Plan Update 2005, Department of Water Resources
- Bulletin 118, California's Groundwater, Update 2003, Department of Water Resources
- Public Water System Survey Data (1995-2005), Department of Water Resources
- Land and Urban Water Program Data (1998, 2000, 2001), Department of Water Resources
- Urban Water Use Data, California Public Utilities Commission
- Urban Water Use Data, California Urban Water Conservation Council
- 2000 Census Data, U.S. Census Bureau
- Residential End Uses of Water Study (1999), Aquacraft, Inc. and American Water Works Association Research Foundation

Appendix A – Data Development Process Flow Chart


Start
Received Databases from DWR
Land and Water use Program Excel Database
PWSS Raw Information Access Database
DATA COLLECTION
Calculated Basic GPCD Analysis
Continue to review other data
Developed Access Query to Include all Necessary data
Base Data Including a Unique ID
Connection Information
Water Delivery Information
Production Information
Population Information
Converted into Excel for Calculations
Reviewed 2000 data
No Direct Connection to Hydrologic Regions
Interconnected County Field to Hydrologic Region
Added Additional Calculation Fields
Determined Flaws in Dataset
Included Comments Within Database to Audit Changes
Statistically Analyzed Data to determine outliers
ANALYSIS
Removed Major Outliers from Calculations
Decided to Include all Data from 1995 to 2005
Sorted database into the respective units of measure
Recalculated all units of measure and converted all to Gallons
Linked connections and water use data to the PWS_Id's to allow conversion to GPCD
Reviewed County average persons per household from 2000 census
Calculated population using number of SFR connections * average household size, plus MFR connections * average household size * 4 (estimate of average units per MFR connection) and reviewed against the population reported
Calculations
CALCULATIONS
Multipliers
GPCD Calculations
Other Calculations
Gallons per day totals
Population for Weighted GPCD
Total System GPCD
Indoor SFR GPCD
Total SFR GPCD
Total SFR Outdoor GPCD
Total MFR GPCD
Total Commercial GPCD
Total Industrial GPCD
Other and Non-Revenue Water
Eq1. Baseline Total GPCD = Total Water Delivered_95_05 / Population_95_05 * 365 days
Eq2. SFR Indoor GPCD (Total) = March SFR Water Delivered_95_05 * 12 / Total Population_95_05 * 365 days
Eq3. SFR Total GPCD = Total SFR Water Delivered_95_05 / Population_95_05 * 365 days
Eq4. SFR Outdoor GPCD = Eq3 - Eq2
Eq5. Multi-Family GPCD (Total) = Multi-Family Water Delivered_95_05 / Total Population_95_05 * 365 days
Eq6. Commercial GPCD = Commercial Water Delivered_95_05 / Population_95_05 * 365 days
Eq7. Industrial GPCD = Industrial Water Delivered_95_05 / Population_95_05 * 365 days
Eq8. Non-Revenue/Other GPCD = Total Water Produced95_05 - Total Water Delivered95_05 / Population_95_05 * 365 days
VALIDATION
Validation
CUWCC Database
CPUC Database
DPH Database (paper records)
Allocation of Utilities to Hydrologic Regions
Conversion of data from CCF per Connection to GPCD
No data
Review of data
Review of GPCD averages
Removal of bad data
Calculation of Weighted Average GPCD
Validation against data from CPUC and CUWCC
Eq2a. SFR Indoor GPCD (Real) = Total March SFR Water Delivered_95_05 * 12 / SFR Population_95_05 * 365 days
Eq5a. Multi-Family GPCD (Real) = Total Multi-Family Water Delivered_95_05 / MFR Population_95_05 * 365 days
GPCD Calculations
OUTPUTS
Outputs
Number of Agencies Reporting
Review and Updating of Databases
Number of Rejected Data points
Regions with poor or no data
Population represented by Usable Data
Histograms of Average GPCD Data
Pivot Tables of Water Use and Population
Weighted Averages for Total and Sector GPCDs
Total and Hydrologic Regional GPCDs
Reporting

Appendix B – Market Sector Water Use Analysis

Overall Urban Water Use

The baseline GPCD value for the state and each hydrologic region is calculated as follow:

Eq. B-1:

$$\text{Baseline} = \left[\frac{\sum \text{Water Delivered}_x}{\sum \text{Population}_x \times 365\ \text{d/yr}} \right]_{x=\text{usable datasets (1995-2005)}}$$

Since analysis was conducted using all ten years of data in order to reduce single year abnormalities, the methodology inherited the assumption that GPCD has not been increased with the population growth over the 10-year period. This assumption is deemed acceptable because a preliminary analysis of the data confirmed that there is no apparent GPCD trend over the ten years.

Residential Water Use

Residential water use consists of water delivered to single family residential (SFR) and multi-family residential (MFR).

Single family residential (SFR) consists of indoor water uses and outdoor water uses. Indoor water uses are essential daily water demand such as drinking, cooking, and washing. Outdoor water uses are mainly irrigation and exterior water features such as swimming pools.

The total SFR residential water use is calculated as follow:

Eq. B-2a:

$$\text{SFR} = \left[\frac{\sum \text{Water Delivered to SFR}_x}{\sum \text{Population}_x \times 365\ \text{d/yr}} \right]_{x=\text{usable datasets (1995-2005)}}$$

Eq. B-2b:

$$\text{MFR} = \left[\frac{\sum \text{Water Delivered to MFR}_x}{\sum \text{Population}_x \times 365\ \text{d/yr}} \right]_{x=\text{usable datasets (1995-2005)}}$$

Commercial, Industrial, and Institutional (CII)

The commercial, industrial, and institutional (CII) sectors are defined to account for all non-residential water uses. Commercial water use includes water delivered to restaurants, shopping malls and office buildings. Industrial water use includes water delivered to industries such as food service and beverage manufacturers, paper mills and oil refineries. Institutional water use includes water delivered to universities, schools, hospitals, and other public buildings. The PWSS database combined institutional use with commercial use.

Eq. B-3a:

$$\text{Commercial} = \left[\frac{\sum \text{Water Delivered to Commercial}_x}{\sum \text{Population}_x \times 365\ \text{d/yr}} \right]_{x=\text{usable datasets (1995-2005)}}$$

Eq. B-3b:

$$\text{Industrial} = \left[\frac{\sum \text{Water Delivered to Industrial}_x}{\sum \text{Population}_x \times 365\ \text{d/yr}} \right]_{x=\text{usable datasets (1995-2005)}}$$

Eq. B-3c:

$$\text{CII} = \left[\frac{\sum \text{Water Delivered to Commercial and Industrial}_x}{\sum \text{Population}_x \times 365\ \text{d/yr}} \right]_{x=\text{usable datasets (1995-2005)}}$$

Unreported Water

Unreported water (URW) consists of water delivered to the Large Landscape and Other sectors (as reported by the PWSS database) and also unaccounted-for water.

This sector is calculated as follow:

Eq. B-4: $$\mathrm{URW} = \left[\frac{\sum \mathrm{Landscape}_x + \mathrm{Other}_x + (\mathrm{Produced}_x - \mathrm{Delivered}_x)}{\sum \mathrm{Population}_x \times 365\,\mathrm{d/yr}} \right]_{x=\text{usable datasets (1995-2005)}}$$

The water delivered to this sector is not as clearly defined as for the residential and CII sectors. For example, the Large Landscape sector refers to large open area such as parks and golf courses, but it is possible that irrigation for commercial plazas, which should have been reported under the commercial sector, was reported under this sector.

The Other sector usually refers to water used by water suppliers for system operation and maintenance, such as street cleaning, system flushing, and fire hydrant testing.

Unaccounted-for water, or non-revenue water, is calculated by the difference between what was produced and what was sold. This may include system leaks, meter errors, emergency use (e.g. fire fighting), and/or unauthorized use.

Statewide Results Summary

Figure B-1 and Table B-1 presents a summary of the regional GPCD values. Note that the residential (SFR and MFR) GPCD values presented in this figure are not representative of the realistic water use of these sectors since they do not share the same customers. The revised residential water use values are shown in Figure B-2.

Figure B-1: Regional Urban Water Use Patterns

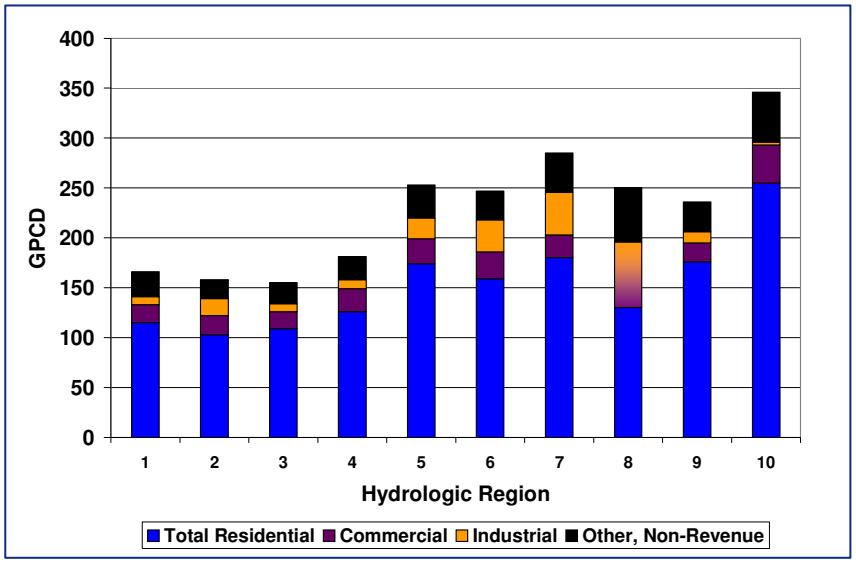


Table B-2: Regional Urban Water Use Patterns

	Hydrologic Region									
Sector Water Use (GPCD)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8[1]**	**9**	**10**
Residential (SFR and MRF) [2]	115	103	109	126	174	159	180	130	176	155
Commercial [3]	18	19	17	23	25	27	23	66	19	38
Industrial [4]	8	17	8	9	21	32	43	ND	11	3
Un-Reported Water (URW) [5]	24	18	20	22	33	30	39	54	31	50
Total Baseline [6]	165	157	154	180	253	248	285	248	237	346

[1] Region 8 does not have enough usable data in the PWSS database to compute for baseline values. The LUWP database was used instead. Note that the LUWP database only contains data for 1998, 200, 2001. The baseline values for this region may not be as reliable as values computed for the other regions.

[2] This SFR values were calculated using equation B.2a and B.2b, except for Region 8 (see footnote 1).

[3] Equation B.3a, except for Region 8 (see footnote 1)

[4] Equation B.3b, except for Region 8 (see footnote 1)

[5] Equation B.4, except for Region 8 (see footnote 1)

[6] Equation B.1, except that for Region 8 (see footnote 1). This values should be the sum of the sector values above.

Further Analysis Regarding Residential Water Use

To assist with the eventual evaluation of the conservation potential within the SFR sector, the SFR GPCD values are further broken down to indoor and outdoor water uses:

Eq. B-5a:
$$SFR_{Indoor} = \left[\frac{\sum \text{Lowest Monthly SFR Water Use}_x \times 12\text{mo/yr}}{\sum \text{Population}_x \times 365\text{d/yr}} \right]_{x = \text{usable datasets (1995-2005)}}$$

Eq. B-5b:
$$SFR_{Outdoor} = \left[\frac{\text{Water Delivered to SFR}_x - SFR_{Indoor,x}}{\sum \text{Population}_x \times 365\text{d/yr}} \right]_{x = \text{usable datasets (1995-2005)}}$$

Equation 3-5a and 3-5b assumed that all single family residential houses have individual lawns and all have the same irrigation demand, and that their irrigation demand is zero during the wettest month of the year (February based on general statewide climate trend). During this month, water delivered to SFR houses is assumed to be solely used for indoor uses. This assumption may not apply to certain regions with high ET rates that require year-round irrigation. To make the baseline more reliable, a maximum indoor GPCD value of 71 GPCD was imposed on all regions[7]. For regions with SFR indoor values under 71 GPCD, the original values were used in this analysis as-is; for regions with SFR indoor values over 71 GPCD, the values were reduced to 71 GPCD. The resulting reductions were reallocated to SFR outdoor water use for that region. For example, if a region has indoor and outdoor water use at 80 GPCD and 50 GPCD, respectively, the revised values would be 71 GPCD for indoor water use, and 59 GPCD for outdoor water use.

Indoor and outdoor water uses for MFR sector are not evaluated since it is assumed that MFR houses share common irrigation areas such that the outdoor use per capita would be negligible.

It is acknowledged that SFR and MRF GPCD values should not be calculated using the total population since they do not share the same customers. The 2000 census data was obtained from the U.S. Census Bureau and provided the number of MFR structures in the state and also individual counties. The general statewide distribution of SFR and MFR are 70 percent and 30 percent, respectively[8]. The revised SFR and MFR GPCD values were calculated using Equations 3-6(a-d).

Eq. B-6a:
$$SFR_{revised} = SFR \times \left(\text{Population}_{avg} \times 70\%\right)$$

Eq. B-6b:
$$SFR_{Indoor,\ revised} = SFR_{revised} \times \left(\frac{SFR_{Indoor}}{SFR} \right)$$

Eq. B-6c:
$$SFR_{Outdoor,\ revised} = SFR_{revised} \times \left(\frac{SFR_{Outdoor}}{SFR} \right)$$

Eq. B-6d:
$$MFR_{revised} = MFR \times \left(\text{Population}_{avg} \times 30\%\right)$$

[7] The value of 71 GPCD was obtained from the **1999 Residential End Uses of Water Study** (Awwa Research Foundation**,** http://www.aquacraft.com/Publications/resident.htm). The study sites were: Boulder CO, Denver CO, Eugene OR, Seattle WA, San Diego CA, Tampa FL, Las Virgenes CA, Walnut Valley CA, Phoenix AZ, Tempe and Scottsdale AZ, Waterloo Canada, and Lompoc CA.

[8] The regional distributions (%SFR/%MFR) are: North Coast: 78/22; San Francisco Bay: 69/31; Central Coast: 74/26; South Coast: 68/32; Sacramento River: 77/23; San Joaquin: 80/20; Tulare Lake: 77/23; North Lahontan: 76/24; South Lahontan: 63/37; Colorado River: 70/30.

Figure B-2 and Table B-2 present the revised GPCD values for residential water use.

Figure B-2: Regional Urban Water Use Patterns

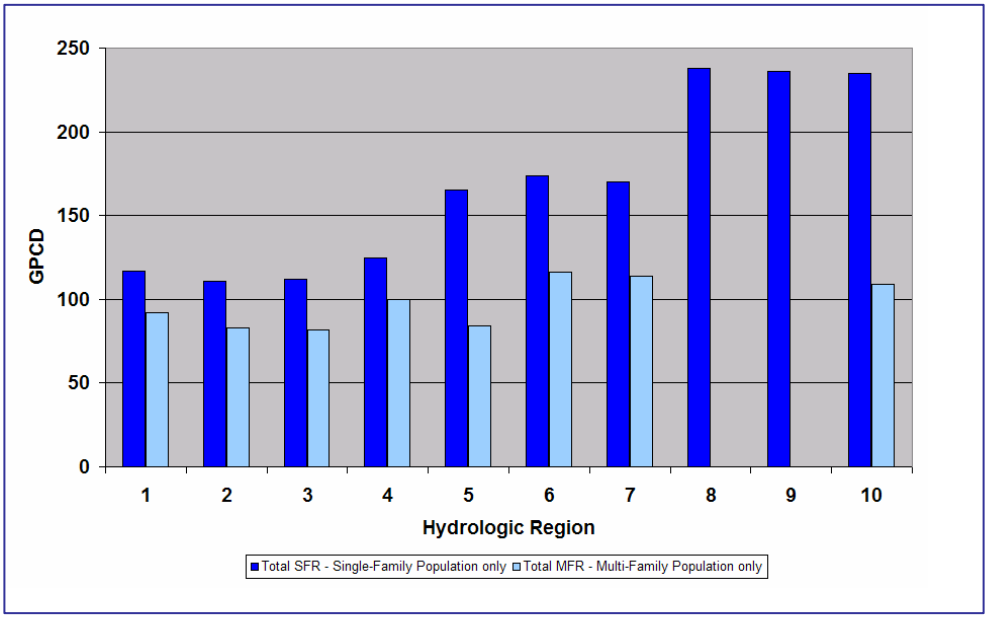


Table B-2: Regional Urban Water Use Patterns

	Hydrologic Region									
Sector Water Use (GPCD)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8[9]**	**9**	**10**
SFR Indoor [10]	69	60	66	71	71	71	71	ND	71	71
SFR Outdoor [11]	48	51	46	54	94	103	99	ND	165	164
MFR [12]	92	83	82	100	84	116	114	ND	ND	109

[9] Region 8 does not have enough usable data in the PWSS database to compute for baseline values (see footnote 1). The overall (SFR indoor, SFR outdoor, and MRF) water use is 130 GPCD, according to the LUWP database.

[10] Equation B.6b, except for Region 8 (see footnote 9)

[11] Equation B.63c, except for Region 8 (see footnote 9)

[12] Equation B.6d, except for Region 8 (see footnote 9)

Appendix C – Abbreviations & Acronyms

ABBREVIATIONS & ACRONYMS

AWWA	American Water Works Association
AWWARF	American Water Works Association Research Foundation
BMP	Best Management Practice
CEC	California Energy Commission
CII	Commercial, Industrial, Institutional
CPUC	California Public Utilities Commission
CUWCC	California Urban Water Conservation Council
DOF	Department of Finance
DPH	Department of Public Health
DWR	Department of Water Resources
ET	Evapotranspiration
GPCD	Gallons per capita per day
HR	Hydrologic Region
LWUP	Land and Water Use Program
MGD	Million Gallons per Day
MOU	Memorandum of Understanding Regarding Urban Water Conservation in California
MRF	Multi-Family Residential
PWSS	Public Water Systems Survey
SFR	Single Family Residential
SWRCB	State Water Resources Control Board
TM	Technical Memorandum
URW	Unreported Water
USBR	U.S. Bureau of Reclamation
UWMP	Urban Water Management Plan