DRAFT Demand and Supply Assessment

November 3

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Phoenix Active Management Area

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EXECUTIVE SUMMARY

The *Water Demand and Supply Assessment 1985-2025, Phoenix Active Management Area* (Assessment) is a compilation and study of historical water demand and supply characteristics for the Phoenix Active Management Area (AMA) for the years 1985 through 2006. In addition, the Assessment calculates eight water supply and demand projection scenarios to the year 2025. The Arizona Department of Water Resources (ADWR) conducted this Assessment as preparation for the *Fourth Management Plan for Phoenix Active Management Area* as required by the *1980 Groundwater Management Code (Code)*.

The statutory management goals established for each of the five AMAs are the foundation for the implementation of the groundwater management programs established by the Code. The statutory management goal of the Phoenix AMA is to attain safe-yield, on an AMA-wide basis, by the year 2025. Safe-yield is a balance between the amount of groundwater pumped from the AMA annually, and the amount of water naturally or artificially recharged. Groundwater withdrawals in excess of natural and artificial recharge leads to an overdraft of the groundwater supply in the AMA basin. The Code identified management strategies which relied, in part, on continuing mandatory conservation by all water major water using sectors to reduce total groundwater withdrawals in the AMAs, identified in the Management Plan for the AMA, and on increasing the use of renewable water supplies in place of groundwater supplies. Five management periods were identified for the development of these Management Plans which were to assist in moving the AMA closer to its management goal by 2025.

A review of historical annual water demand, supply and overdraft in the Phoenix AMA from 1985 to 2000 shows that overdraft fluctuated somewhat; in a few years the AMA experienced surplus primarily as a response to high streambed infiltration and lagged agricultural incidental recharge, but in most years overdraft occurred. In spite of this, success seems to be attainable. After the year 2000, groundwater overdraft in the Phoenix AMA began a steady decline with the increased utilization of CAP water and increased conservation activities across all water using sectors. Artificial Recharge activities have resulted in large volumes of water that would have otherwise gone unused being stored for future use.

ADWR has evaluated several different possible scenarios for future groundwater overdraft. The three baseline scenarios for future water use in this Assessment indicate that without additional reductions in groundwater pumping, increased demands and a lack of sustainable growth patterns combined with a finite supply of CAP water may result in continued groundwater overdraft in the Phoenix AMA in the future. Three additional shortage scenarios examine the effects of a possible shortage of CAP supplies due to possible climate effects for several years before 2025, which could exacerbate groundwater overdraft. However, a seventh scenario demonstrates that increasing the use of available reclaimed water supplies could result in a significant reduction in overdraft, and in some years, the statutorily mandated management goal of safe-yield could be achieved by 2025. Interestingly, utilizing 100 percent of the available reclaimed water, either directly or via USF recharge, could also result in achievement of the goal but would actually be less beneficial to the AMA, as there is no discharged water percolating to the aquifer and no cut to the aquifer.

The purpose of this Assessment is to identify the success through 2006 with achievement of the Phoenix AMA management goal. By developing future projections, ADWR can analyze different supply and demand mechanisms that may affect the AMA's ability to achieve safe-yield by 2025. While ADWR recognizes these future projections are not exact representations of what will occur in the future, they do identify a range of possibilities that provide valuable information that benefits decisions regarding water management in the Phoenix AMA. Most importantly, the information in this Assessment will be used to assist ADWR in working with the Phoenix community to develop management strategies to assist the AMA in moving even closer to safe-yield by the end of the Fourth Management Plan.

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LIST OF ACRONYMS

ADWR	Arizona Department of Water Resources
ADES	Arizona Department of Economic Security
AMA	Active Management Area
AWBA	Arizona Water Banking Authority
AWS	Assured Water Supply
BMP	best management practices
CAGRD	Central Arizona Groundwater Replenishment District
CAP	Central Arizona Project
CAWCD	Central Arizona Water Conservation District
CAWS	Certificate of Assured Water Supply
Code	Groundwater Code
CRM	Colorado River Management
DAWS	Designation of Assured Water Supply
DCDC	Decision Center for Desert Cities
DWID	Domestic Water Improvement District
GIU	General Industrial Use Permit
GPCD	gallons per capita per day
GSF	Groundwater Savings Facility
IGFR	Irrigation Grandfathered Right
IPCC	International Panel on Climate Change
MAG	Maricopa Association of Governments
M&I	Municipal and Industrial
NOI	Notice of Intention to Drill
SNWA	Southern Nevada Water Authority
Type 1 Right	Type 1 non-irrigation grandfathered right
Type 2 Right	Type 2 non-irrigation grandfathered right
USF	Underground Storage Facility
WWTF	Wastewater Treatment Facility
1MP	First Management Plan
2MP	Second Management Plan
3MP	Third Management Plan
4MP	Fourth Management Plan

PART I INTRODUCTION TO THE ASSESSMENT

1. INTRODUCTION

1.1 Purpose of the Phoenix Active Management Area Assessment

The *Water Demand and Supply Assessment 1985-2025, Phoenix Active Management Area* (Assessment) is a compilation and study of historical water demand and supply characteristics for this groundwater basin from 1985 to 2006. It reviews past conditions and makes projections through the year 2025 using eight scenarios. The Arizona Department of Water Resources (ADWR) conducted this Assessment as preparation for the planning and public interaction that will precede the drafting of the *Fourth Management Plan for Phoenix Active Management Area* (4MP) as required by the *1980 Groundwater Management Code* (Code). For more information regarding the Code, Management Plans, ADWR's mission and the governmental and institutional setting for this Active Management Area (AMA), refer to the *Third Management Plan for Phoenix Active Management Area 2000 – 2010* (3MP)

The Assessment is divided into five parts, as described below:

- The Introduction, which provides a general overview of the Phoenix AMA, the statutory management goal, the Assured Water Supply requirements, the Central Arizona Project, the Central Arizona Groundwater Replenishment District, the Underground Storage Program, and the Arizona Water Bank;
- The Budget Components and Calculation of Overdraft, which defines the major components of the water budget used in this Assessment and how overdraft is calculated;
- The Historical Water Demand and Overdraft for each water use sector (Municipal, Industrial, Agriculture, and Indian Communities);
- The Projected Demand and Overdraft by Sector using assumptions formulated by ADWR based on historical use, population projected by the Department of Economic Security (ADES), the Maricopa Association of Governments (MAG), and others; and
- The Fourth Management Plan process that will follow this Assessment.

1.2 General Overview of the Phoenix AMA

Five AMAs (Phoenix, Pinal, Prescott, Santa Cruz and Tucson) have been designated as requiring specific, mandatory management practices to preserve and protect groundwater supplies for the future (*See* ***Figure 1-1.***). The Phoenix AMA is 5,646 square miles in area and was established in 1980 upon enactment of the Code. Over the past 30 years, water users in the Phoenix AMA have increased the use of renewable supplies, facilitated by the completion of the Central Arizona Project (CAP) canal, allowing use of Colorado River water either directly or indirectly through artificial recharge and recovery projects. The use of reclaimed water has also increased in the Phoenix AMA since the creation of the AMA, further assisting in reducing historical reliance on groundwater supplies. For a detailed overview of the geography, hydrology, climate, and environmental conditions in the Phoenix AMA, refer to the *Draft Arizona Water Atlas, Volume 8, Active Management Area Planning Area* (ADWR, 2010).

1.3 The Management Goal of the Phoenix AMA

The Code established management goals for each of the AMAs, focused primarily on the reduction of groundwater dependence. The statutory management goal of the Phoenix AMA is to achieve safe-yield by 2025 and maintain it thereafter. Safe-yield means that the amount of

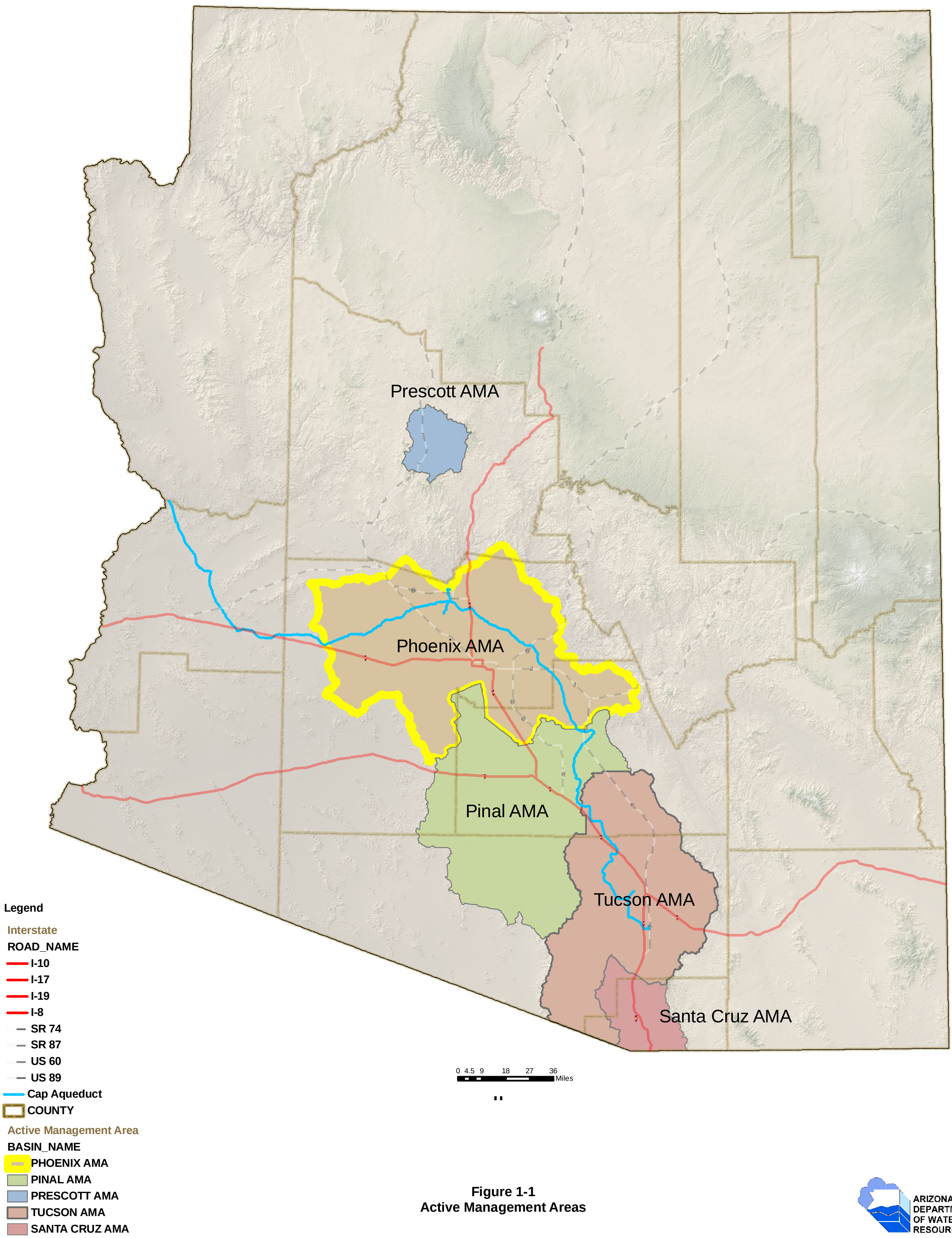


Figure 1-1
Active Management Areas

groundwater pumped from the AMA on an average annual basis does not exceed the amount of water that is naturally or artificially recharged. Safe-yield is a basin-wide balance; water level declines in one portion of the AMA could be offset by reducing groundwater pumping or recharging water in another part of the AMA. The safe-yield goal was established as part of the Code, and is intended to guide the water management strategies to address the long-term implications of groundwater overdraft.

1.4 Groundwater Management in the AMAs

To address groundwater depletion in the state's most populous areas, the state legislature created the Code in 1980 and created ADWR to implement it. The goal of the Code is twofold: 1) to control severe groundwater depletion, and 2) to provide the means for allocating Arizona's limited groundwater resources to most effectively meet the state's changing water needs. This effort to manage Arizona's groundwater resources was so progressive that in 1986 the Code was named one of the ten most innovative programs in state and local government by the Ford Foundation and Harvard University. When granting the award, it was noted that no other state had attempted to manage its water resources so comprehensively. Accordingly, Arizona built consensus around its policy and then followed through to make it work in practice.

Areas where groundwater depletion is most severe are designated as AMAs. There are five AMAs. These areas are subject to regulation pursuant to the Code. Each AMA has a statutory management goal. In the Phoenix, Prescott, and Tucson AMAs, the primary management goal is to achieve safe-yield by the year 2025. In the Pinal AMA, where the economy is primarily agricultural, the management goal is to preserve that economy for as long as feasible, while considering the need to preserve groundwater for future non-irrigation uses. Recognizing that the Santa Cruz AMA is currently at the safe-yield status, the goal of the Santa Cruz AMA is to maintain safe-yield and prevent local water tables from experiencing long-term decline. Each AMA carries out its programs in a manner consistent with these goals while considering and incorporating the unique character of each AMA and its water users.

Since groundwater use in AMAs is regulated, withdrawal of groundwater in these AMAs requires a permit from ADWR. On most of these wells state law assesses withdrawal fees and requires annual groundwater withdrawal and use reports to be filed.

In order to withdraw and use groundwater, an individual must complete the following steps:
1. Obtain a groundwater withdrawal authority;
2. Obtain a well permit and employ a licensed well driller;
3. Measure and report annual groundwater withdrawals; and
4. Meet conservation program requirements under the AMA Management Plans.

The following groundwater withdrawal authorities are used to allocate groundwater resources and to limit demand for groundwater in the AMAs.

1. Irrigation Grandfathered Rights

Within AMAs, anyone who owns land that was legally irrigated with groundwater at anytime from January 1, 1975 to January 1, 1980 and has been issued a Certificate of Irrigation Grandfathered Right (IGFR) by ADWR has the right to use groundwater for the irrigation of that land. The term irrigation is limited to the growing of crops for sale, human consumption or livestock feeding on two or more acres.

2. Type 1 and Type 2 Non-Irrigation Grandfathered Rights

A Type 1 non-irrigation grandfathered right (Type 1 right) is associated with land permanently retired from farming and converted to a non-irrigation use. This right, like an irrigation grandfathered right, may be sold or leased only with the land. The maximum amount of groundwater that may be pumped each year using a Type 1 right is three acre-feet per acre. Groundwater withdrawn pursuant to a Type 2 non-irrigation grandfathered right (Type 2 right) can generally be used for any non-irrigation purpose. The right is based on historical pumping of groundwater for a non-irrigation use from a non-exempt well (pumping capacity of greater than 35 gallons per minute) and equals the maximum amount pumped in any one year between 1975 and 1980. Type 2 rights can be sold separately from the land or well. These rights are most often used for industrial purposes such as sand and gravel facilities, golf courses and dairies. Type 1 and Type 2 right holders are generally required to comply with the conservation requirements associated with the Industrial Conservation Programs in the Management Plans.

3. Service Area Rights

Service area rights allow cities, towns, private water companies and irrigation districts to withdraw and transport groundwater to serve their customers. Most persons within an AMA receive water through service area rights. Entities with service area rights must comply with the Municipal Conservation Program requirements in the Management Plans.

4. Groundwater Withdrawal Permits

Groundwater withdrawal permits allow new withdrawals of groundwater for non-irrigation uses. Currently, seven types of withdrawal permits are allowed under the Code. A General Industrial Use Permit (GIU), the most commonly used type of permit, allows the withdrawal of groundwater for industrial uses outside the service area of a city, town or private water company. Generally, users of these permits are required to comply with the Industrial Conservation Program requirements in the Management Plans.

Wells

Two types of applications for well drilling authority exist. A Notice of Intent (NOI) to Drill is required to be filed with ADWR for all wells which are to be drilled outside the AMAs and exempt wells which will be located inside an AMA. Exempt wells are typically small domestic wells, pumping not more than 35 gallons per minute. Under the Code, exempt wells are not required to meter or report water use and are not regulated by ADWR, other than being required to file an NOI. For non-exempt wells within an AMA an application for a Drilling Permit is required.

Water Measurement, Groundwater Withdrawal Fees and Reporting Requirements

Groundwater withdrawn from non-exempt wells must be measured using an approved measuring device or method. In addition, all groundwater withdrawn from non-exempt wells is subjected to an annual groundwater withdrawal fee. Fees collected for augmentation, conservation assistance, and monitoring and assessing water availability are used to finance the augmentation and conservation assistance programs that are part of the Management Plans for AMAs, plus funding the Arizona Water Banking Authority (discussed below).
Annual water withdrawal and use reports are required to be filed for most groundwater withdrawn within an AMA. Accurate records of the right holder’s withdrawals, transportation, delivery and use of groundwater must be kept by the right holder and reported to ADWR on a yearly basis.

Management Plans and Conservation Requirements

Management Plans reflect the evolution of the Code, assisting in moving Arizona toward its long-term water management goals. Management Plans are required from each AMA for five sequential management periods extending from 1980 through 2025. The First Management Plan (1MP) applied from 1985-1990. The Second Management Plan (2MP) was in effect until 2000, and the Third Management Plan (3MP) from 2001 until 2010. ADWR is in the initial stages of formulating the Fourth Management Plan (4MP), through the development of this Assessment, scheduled for release in 2011. The provisions of the 4MP will be in effect from 2010 through 2020. A Fifth Management Plan (5MP) will be developed for the years 2020 through 2025.

Most entities withdrawing groundwater from a non-exempt well are required, pursuant to the Management Plan, to participate in one of the following: the Agricultural Conservation Program, the Municipal Conservation Program or the Industrial Conservation Program. Holders of an IGFR who withdraw water from a non-exempt well or receive groundwater from another source are subject to the Agricultural Conservation Program, which determines conservation requirements based on water duties and maximum annual groundwater allotments or through Best Management Practices (BMP). A key component of the Code prohibits the establishment of new IGFRs – eliminating new acres from being put into agricultural production.

Under the Municipal Conservation Program, municipal water providers are required to meet conservation requirements based on reductions in total per capita use or through implementation of BMPs. Additionally, municipal providers are required to limit the amount of lost and unaccounted for water in their delivery system.

All Type 1 and Type 2 right holders and some GIU permit holders are subject to the Industrial Conservation Program. Conservation requirements are based on the best available technology for the end use and range, based on the permit or right type, from BMPs to specific groundwater allotments for water users such as turf-facilities.

Compliance and Enforcement Program

ADWR developed a compliance and enforcement program to ensure that conservation requirements are being met. The annual water withdrawal and use reports previously mentioned are one part of this program. Additionally, ADWR conducts audits to determine if water users comply with conservation requirements. If a water user is out of compliance, ADWR sends out a notice of non-compliance, conducts post audit meetings with the water user, and attempts to negotiate a settlement for the excess groundwater used.

Conservation and Augmentation Assistance Programs

In 1991, the 2MP was modified to include a program for conservation assistance to water users within an AMA. The goal of the Conservation Assistance Program is to assist water users in achieving the Management Plan requirements, leading ultimately to a realization of the management goal of the AMA.

The 2MP and the 3MP also include an Augmentation Assistance Program designed to provide augmentation grants for construction and pilot recharge projects designed to directly increase water supplies or water storage, planning, and research and feasibility studies. The Conservation Assistance and Augmentation Assistance Program grants are funded by groundwater withdrawal fees collected from those who pump groundwater in each AMA.

1.5 The Assured Water Supply Program

The Assured Water Supply (AWS) program, created as part of the Code, is designed to preserve groundwater resources and to promote long-term water supply planning in the AMAs. This is accomplished by regulations that limit the use of groundwater by new subdivisions. Every person proposing to subdivide land within an AMA must demonstrate the availability of a 100-year AWS.

In 1995, ADWR adopted AWS Rules to implement the AWS program. Under the AWS Rules, developers can demonstrate a 100-year supply by either satisfying the criteria described below and obtaining a Certificate of Assured Water Supply (CAWS) from ADWR or by obtaining a written commitment of service from a water provider that has a Designation of Assured Water Supply (DAWS).

An AWS demonstration must include proof that the proposed subdivision will meet the following criteria, that the water supply or supplies: 1) will be of adequate quality; 2) will be physically, legally, and continuously available for the next 100 years; 3) will be consistent with the management goal for the AMA; 4) will be consistent with the Management Plan for the AMA; and 5) financial capability will be demonstrated to construct the necessary water storage, treatment, and delivery systems. The Arizona Department of Real Estate will not issue a public report that allows the developer to sell lots without a demonstration of an AWS within an AMA. For more information on the AWS Program, please visit the ADWR website at **www.azwater.gov/azdwr.**

The AWS requirement is only one important tool to help attain the management goal of the AMA. Because the AWS requirements only apply to new subdivisions (existing uses and other non-subdivision new uses are exempt from the assured water supply requirement under the Code), the ability of this program by itself bring the AMA into safe-yield is limited.

1.6 Central Arizona Project

The Central Arizona Project (CAP) is designed to bring about 1.5 million acre-feet of Colorado River water per year to its three-county service area (Maricopa, Pima and Pinal counties). The CAP carries water from Lake Havasu near Parker, Arizona to the southern boundary of the San Xavier Indian Reservation southwest of the City of Tucson. It is a 336-mile long system of aqueducts, tunnels, pumping plants and pipelines and is the largest single resource of renewable water supplies in the state of Arizona. The Central Arizona Water Conservation District (CAWCD) manages and operates the CAP.

For more information on the CAP, please visit www.cap-az.com.

1.7 The Central Arizona Groundwater Replenishment District

One of the most important criteria for demonstrating an AWS is the consistency with management goal. The consistency with management goal section of the AWS Rules limits the quantity of mined groundwater that an applicant may use to demonstrate an AWS – ultimately decreasing the ability to mine groundwater to zero acre-feet – which assists in meeting the statutory goal of safe-yield. In 1993, the legislature created a groundwater replenishment authority to be operated by CAWCD throughout its three-county service area. This replenishment authority of CAWCD is referred to as the Central Arizona Groundwater Replenishment District (CAGRD). In 1999, the legislature expanded CAWCD's replenishment authorities and responsibilities by passing the Water Sufficiency and Availability Act. Membership in the CAGRD provides a means by which an AWS applicant can satisfy the requirement that the proposed water use be consistent with the water management goals of the AMA.

The effect of the consistency with management criteria is to prevent new development from relying solely on mined groundwater to serve its water demands. Development, however, is not eliminated for those landowners and water providers who have no direct access to CAP water or other renewable supplies. If a water provider or a landowner has access to groundwater and desires to rely exclusively on groundwater to demonstrate a 100-year water supply, it may do so, provided it joins the CAGRD. As a member of the CAGRD, the landowner or provider must pay the CAGRD to replenish any groundwater pumped by the member, which exceeds the pumping limitations imposed by the AWS Rules. For more information on the CAGRD, please visit the CAGRD website at www.cagrd.com .

1.8 The Underground Storage & Recovery Program

For decades, more groundwater has been pumped from Arizona's aquifers than has naturally recharged back into the aquifers. This imbalance has left some aquifers significantly depleted. Using renewable supplies and recharging water underground reduces this imbalance. Artificial recharge is a means of storing excess water supplies so that they may be used in the future. Artificial recharge is an increasingly important tool in the management of Arizona's water supplies, particularly in meeting the goals of the Code. Storing water underground to ensure an adequate supply for the purpose of satisfying current and future needs is both a practical and cost-effective alternative to direct use of renewable supplies.

In 1986, the Arizona Legislature established the Underground Water Storage and Recovery program to allow persons with surplus supplies of water to store that water underground and recover it at a later time. In 1994, the Legislature enacted the Underground Water Storage, Savings, and Replenishment Act, which further refined the recharge program.

A person who wishes to store, save, replenish, or recover water through the recharge program must apply for permits through ADWR. Depending on what the applicant intends to accomplish, different types of permits may be required.

An Underground Storage Facility (USF) Permit allows the permit holder to operate a facility that stores water in the aquifer. A Constructed USF Permit allows for water to be stored in an aquifer by using some type of constructed device, such as an injection well or percolation basin.

A Managed USF Permit allows for water to be discharged to a naturally water-transmissive area such as a streambed that allows the water to percolate into the aquifer without the assistance of a constructed device.

A Groundwater Savings Facility (GSF) Permit allows renewable water supplies, owned by the water storer, to be delivered to a separate recipient who agrees to curtail groundwater pumping on a gallon-for-gallon basis, thus creating a groundwater savings.

A Water Storage Permit allows the permit holder to store water at a USF or GSF. In order to store water, the applicant must provide to ADWR evidence of its legal right to the source water proposed for recharge. Water storage must occur at a permitted facility, as described above.

A Recovery Well Permit allows the permit holder to recover long-term storage credits or to recover stored water annually. Recovery can occur inside the area of impact of the stored water (the area where the water artificially recharged into the aquifer actually occurs) or outside the impact area of the stored water; however, recovery must occur in the same AMA where the water was stored. For more information on the Underground Storage and Program, please visit the ADWR website at www.azwater.gov.

1.9 The Arizona Water Banking Authority

The Arizona Water Banking Authority (AWBA) was established in 1996 to increase utilization of the state's Colorado River entitlement and develop long-term storage credits for the state. The AWBA stores or "banks" unused Colorado River water to be used in times of shortage to firm (or secure) water supplies for Arizona. These water supplies help to benefit municipal and industrial users and communities along the Colorado River, fulfill the water management objectives of the state, store water for use as part of water rights settlement agreements among Indian communities, and assist Nevada and California through interstate water banking. Through these mechanisms, the AWBA aids in ensuring long-term water supplies for Arizona.
Each year, the AWBA pays the delivery and storage costs to bring Colorado River water into central and southern Arizona through the CAP canal. The water is stored underground in existing aquifers (direct recharge) or is used by irrigation districts in lieu of pumping groundwater (indirect or in-lieu recharge). For each acre-foot stored, the AWBA accrues credits that are redeemable in the future when Arizona's communities or neighboring states need this backup water supply.

PART II BASIC BUDGET COMPONENTS AND CALCULATION OF OVERDRAFT

2. BUDGET DATA OVERVIEW

The historical data contained in this Assessment were compiled from Annual Water Withdrawal and Use Reports (annual reports) filed by water users since 1984; other components required to estimate both historical and projected overdraft came from the *ADWR Salt River Valley Regional Model*. The detailed dataset compiled during this effort is stored in the *Phoenix Master Data Template* (Template)(ADWR, 2010). The Template is an inventory of the demand and supply for the AMA. The data housed in the Template has been summarized in a budget format, referred to as the Summary Budget. Both the Template and Summary Budget are available online at www.azwater.gov/AzDWR/WaterManagement/Assessments.

In order to be consistent across the years and sectors, staff took extensive efforts to re-evaluate demand and supply data from the individual annual reports submitted by water providers, irrigation districts, industrial facilities, farms and recharge facilities to populate the Template and Summary Budget, rather than relying on previously compiled totals. The years considered as the historical period for this Assessment are 1985 to 2006. During those 21 years, the data required by annual reports has become more complicated as the statutes, rules and Management Plans have changed, and as water management itself has become more complex. Meanwhile, the methods used to store, retrieve and compile the data have become more sophisticated. This evolution of data development and retrieval may cause the more recently compiled totals for demand or supply to be slightly inconsistent with previously published numbers in previous Management Plans. While data reporting details and data retrieval have changed over the years, annual water use data have been reported in a relatively consistent manner for over 21 years. This long period of consecutive annual reporting provides the opportunity for ADWR to analyze past use and project future water demand using the longest period of record yet available. The data regarding future potential demand and supply were projected using various methods, as explained in detail beginning in Part III. Appendices 1-8 contain additional information regarding how these numbers were developed.

3. THE BASIC BUDGET COMPONENTS

The basic components of the Summary Budget are demand, supply, artificial recharge, and offsets to overdraft. Each of these components, necessary for calculating overdraft, is discussed in detail in the following sections.

3.1 Demand

Demand consists of the beneficial use of water for cultural purposes by the Municipal, Industrial, and Agricultural sectors and use on Indian reservations. Demand also includes natural system uses such as riparian demand.

3.1.1 Municipal Demand

Municipal water use includes water delivered for non-irrigation uses by a city, town, private water company or irrigation district. Municipal demand is composed of the Large Provider, Small Provider, Institutional Provider, and Domestic Exempt subsectors. The demand of Individual Users, such as turf-related facilities, is also included in the Municipal demand since municipal providers often serve them. These subsectors are listed and defined below in the order of magnitude of use.

Large Provider Demand: Large provider demand is the sum of residential, non-residential, and lost and unaccounted for water delivered by a large provider. A large provider is a municipal provider serving more than 250 acre-feet of water for non-irrigation use per year.

The components of Large Provider Demand are:

Large Provider Residential Deliveries: A non-irrigation use of water, delivered by a large provider, related to the activities of single family or multifamily housing units, including interior and exterior water use.

Large Provider Non-residential Deliveries: Water supplied by a large provider for a non-irrigation use other than a residential use. Deliveries to individual users are included in this category. Individual users are facilities that receive water from a municipal provider for non-irrigation uses to which specific Industrial conservation program requirements apply, including turf-related facilities, large-scale cooling facilities, and publicly owned rights-of-way.

Large Provider Lost and Unaccounted for water: The difference between the total water withdrawn, diverted or received for use within the water provider's water service area and the sum of the residential and non-residential metered deliveries to customers.

Small provider demand: Small provider demand consists of deliveries by a municipal provider for non-irrigation use related to the activities of single family or multifamily housing units. Small provider demand may also include deliveries to non-residential customers and individual users. A small provider is a municipal provider that supplies 250 acre-feet or less of water for non-irrigation use per year.

Large untreated Providers: Large untreated water providers are municipal providers that as of January 1, 1990 were serving untreated water to at least 500 persons or that supplied at least 100 acre-feet of untreated water during the calendar year.

Domestic Exempt: Domestic Exempt Water use is non-irrigation water supplied by exempt wells (pumping not more than 35 gallons per minute) for domestic purposes to persons not on a large or small provider distribution system.

Population Numbers: Although not used directly to calculate water use during the historical period, population numbers are included in the Template and are broken out by persons served by large providers, small providers, institutional providers and those who use domestic exempt wells. Population is used directly in the projected scenarios to estimate Municipal use.
Individual Users: means a person receiving water from a municipal provider for non-irrigation uses to which specific conservation requirements apply, including turf-related facilities, large-scale cooling facilities, and publicly-owned rights-of-way.

3.1.2 Industrial Demand

Industrial use is a non-irrigation use of water, not supplied by a city, town, or private water company, including animal industry use and expanded animal industry use. In general, Industrial users withdraw water from their own wells that are associated with Type 1 and Type 2 rights, GIUs or other withdrawal permits. In the Phoenix AMA, Industrial demand is composed of the following subsectors: Large-Scale Power Plants, Turf, Sand and Gravel, Dairy, Feedlot, Drainage and Dewatering, as well as Non-Conservation/Non-Municipal Facilities and Other Industrial users. All of these categories except two (Non-Conservation/Non-Municipal and Drainage & Dewatering) have specific conservation requirements. These subsectors are defined below.

Large Scale Power Plants: Large-scale power plant demand is the water use at large-scale power plants, which are industrial facilities that produce, or are designed to produce, more than 25 megawatts of electricity.

Turf: Turf demand is the water use by cemeteries, golf courses, parks, schools, or common areas within housing developments with a water-intensive landscaped area of 10 or more acres. Turf-related facilities that use any groundwater, regardless of whether they are Industrial users or are served by a municipal provider (individual users) have a maximum annual water allotment based on the size and age of the facility. The use by golf courses is further broken out in the Template, as it is the largest turf user. Golf course demand is water use at turf-related facilities that are used for playing golf that have a minimum of nine holes including any practice areas.

Sand and gravel: Sand and Gravel demand is the water use at a facility that produces sand and gravel and that uses more than 100 acre-feet of water from any source per year.

Dairy: Dairy demand is the water use at facilities that house an average of 100 or more lactating cows per day during a calendar year.

Feedlot: Feedlot demand is the water use at a facility that houses and feeds an average of 100 or more beef cattle per day during a calendar year.

Drainage & Dewatering: Drainage and dewatering demand pertains to entities that must pump groundwater in order to drain or dewater a site for construction or other continued use of a site. The water is not put to a beneficial use and as such is not included in overdraft calculations, although some of the water may return to the aquifer.

Non-Conservation/Non-Municipal Facilities: Non-Conservation/Non-Municipal Facility demand is the use by the few facilities (typically golf courses) that, because they are served entirely by CAP (having their own contract), are exempt from the turf and golf course conservation requirements in the Management Plans.

Other Industrial: Other Industrial demand is the non-irrigation use of water not supplied by a city, town, or private water company, including animal industry use and expanded animal industry use that are not included in any of the specific Industrial subsectors described above.

3.1.3 Agricultural Demand

Agricultural demand is composed of the use of water by IGFRs for agricultural uses not on Indian reservations, and its associated lost and unaccounted for water. Agricultural use is the application of water to two or more acres of land to produce plants or parts of plants for sale or human consumption, or for use as feed for livestock, range livestock or poultry. In the Phoenix AMA, and the other AMAs, only land associated with a certificate of IGFR can legally be irrigated with groundwater. During the early 1980s, ADWR issued these certificates based on the types of crops and the number of acres planted from 1975 to 1980. Land not irrigated during this period may not be irrigated, except under certain circumstances. The sub-categories of Agricultural demand and lost and unaccounted for water are explained below:

Non-Exempt IGFRs: Non-exempt IGFR use is the water use on land to which an IGFR is appurtenant and is greater than ten acres in size, or greater than two acres in size and part of an integrated farming operation. A person using groundwater pursuant to a non-exempt IGFR must comply with conservation requirements established in the Management Plan for each management period. Historically, the Base Conservation Program requirements were allotment-based: the number of IGFR acres was multiplied by the average water duty (the quantity of water reasonably required for crops grown on the IGFR acres between 1975 and 1980); the result was then divided by an assigned irrigation efficiency listed in each Management Plan (ADWR, 1999). Beginning in 2003, an optional BMP program was developed for non-exempt IGFRs as an alternative to allotments in the Base Conservation Program (ADWR, 2003).

Exempt IGFRs: In 1994, IGFRs less than ten acres in size and not part of an integrated farming operation were exempted from conservation requirements and reporting obligations. Water use by these rights located in the Phoenix AMA was not considered in this Assessment, nor was demand projected for them, because it is negligible.

Agricultural Lost and Unaccounted for Water: This lost water is the total amount of water pumped or diverted minus the demand.

3.1.4 Indian Demand

Indian Demand is composed of *Municipal*, *Agricultural* and *Industrial* Demand on Indian reservations, as described below. Indian water use is exempt from state regulation; however, it is included in this Assessment because of the physical impacts on the aquifer.

Municipal Indian Demand: Indian Municipal demand is the residential and non-residential water use on reservations.

Industrial Indian Demand: Indian Industrial demand is the water use associated with uses such as mines and other types of Industrial uses on reservations.

Agricultural Indian Demand: Indian Agricultural demand is the water use required to grow crops on reservations.

3.1.5 Riparian Demand

A natural demand on the Phoenix AMA's regional water supply is riparian demand primarily from growth along the Salt and Gila Rivers and downstream of wastewater treatment plants. Most riparian growth in the Phoenix AMA is located downstream from the 91st Avenue Wastewater Treatment Plant in Phoenix. Groundwater flow models are used to estimate the volume of water used by riparian growth in the Phoenix AMA.

3.2 Supply

Historically, water users in the Phoenix AMA have relied heavily on groundwater. Over the past 30 years, utilization of renewable supplies has increased significantly. The following is a list of water supplies used during the period of 1985 to 2006 to meet the demands of the sectors in the Phoenix AMA.

Groundwater: Groundwater is water from below the earth's surface.

Direct Use CAP: Direct use CAP is water distributed via the CAP canal and put to direct beneficial use.

Recovered CAP: Recovered CAP is water originally distributed via the CAP canal, then stored in either an USF or a GSF, then recovered under the authority of a recovery well permit. When recovered, this water legally counts as CAP water. In graphs in this Assessment that depict water use by source, recovered CAP is included with direct use CAP in the category "CAP".

Reclaimed Water: Reclaimed water is water that has been collected in a sanitary sewer for subsequent treatment in a facility that is regulated as a sewage system, disposal plant or wastewater treatment facility. Such water remains reclaimed water until it acquires the characteristics of groundwater or surface water.

Recovered Reclaimed Water: Recovered reclaimed water is water that was stored in either an USF or a GSF, and then recovered under the authority of a recovery well permit. When recovered, this water legally counts as reclaimed water. In graphs in this Assessment that depict water use by source, recovered reclaimed water is included with reclaimed water in the category "reclaimed water".

Surface water: Surface water is the waters of all sources, flowing in streams, canyons, ravines or other natural channels, or in definite underground channels, whether perennial or intermittent, floodwater, wastewater or surplus water, and of lakes, ponds and springs on the surface.

Spillwater: Spillwater is a category of surface water that has a unique legal characteristic. It is surface water that is released by the storing entity from storage, diversion, or distribution facilities for beneficial use to avoid spilling. The source of Spill water in the Phoenix AMA is the surface water made available by Salt River Project (SRP) when water is spilling at Granite Reef Diversion Dam or when inflows below the dam exceed water orders. Spill water is offered free to water users, does not count against the user's SRP surface water allotment and may be used on non-member, non-SRP lands.

Recovered Surface Water: Recovered surface water is water that was stored in either an USF or a GSF, and then recovered under the authority of a recovery well permit pursuant to state statute. When recovered, this water legally counts as surface water. In graphs in this Assessment that depict water use by source, recovered surface water is included with surface water in the category "surface water". Surface water must be recovered in the same year it is stored and cannot be used to accrue Long-term storage credits.

Poor quality groundwater: Poor quality groundwater is water withdrawn pursuant to a poor quality groundwater withdrawal permit. Poor quality groundwater withdrawal permits are issued to non-irrigation users to withdraw poor quality groundwater if the groundwater withdrawn, because of its quality, has no other beneficial use at the present time. One exception is poor quality groundwater used pursuant to an approved remedial action, which is recognized in the AWS program as a supply that can be utilized in place of mined groundwater without affecting the allowable groundwater volume allotted to a DAWS.

In-lieu groundwater: In-lieu groundwater is water used in-lieu of groundwater pumped or delivered at a GSF. The entities that provide the alternative supplies to the GSF are permitted to pump an equivalent volume of water at some time in the future, via a recovery well permit. Because this recovered water retains the legal characteristics of the water originally used at the GSF (such as reclaimed water or CAP), the initial use by the recipients at the GSF (usually irrigation districts or individual farmers) is groundwater and as such is depicted as In-lieu groundwater in the Summary Budget.

Other: Other water is any water that does not meet the previously defined sources. Examples of other water are tailwater and Phoenix gatewater. Tailwater is water from any source that runs off of agricultural fields back into canals. Phoenix gatewater is surface water that was created when the city entered into a contract with SRP and the federal government to construct and install spillway gates at Horseshoe Dam. Installation of these gates increased the storage capacity of Horseshoe Dam by approximately 75,000 acre-feet.

Table 3-1 lists the water supplies that are in use, or have been used by each sector, at some point from 1985 through 2006. These water supplies used historically in the Phoenix AMA are anticipated to be used in the future, however, the various sectors may utilize these supplies in different volumes than in the past.

Table 3-1 Historical Sector Use of Water Supplies Through 2006
Phoenix Active Management Area

Source	Municipal	Industrial	Agriculture	Indian
Groundwater	√	√	√	√
Direct Use Surface Water	√	√	√	√
Direct Use CAP	√	√	√	√
Recovered CAP	√	√		
Reclaimed Water	√	√	√	
Recovered Reclaimed Water	√	√		
In-lieu groundwater			√	
Recovered Surface Water	√			
Poor Quality Groundwater		√		
Spill water	√		√	
Other	√		√	

3.3 Artificial Recharge

Artificial Recharge is a means of *artificially* adding water to the aquifer. In the Phoenix AMA, artificial recharge is accomplished through the use of USFs and GSFs (described in Section 1.8). Water stored at these sites becomes long-term storage credits for the storers, which can be recovered at a later date. At the time these long-term storage credits are used (recovered), the recovered water retains the legal characteristic of the water supply stored at the recharge facility (such as reclaimed water or CAP). Water may also be stored at USFs on an annual basis so that it is stored and recovered during the same calendar year and does not accrue a long-term storage credit.

Underground Storage Facilities (USFs): An USF is a facility that stores water in the aquifer. There are two types: *Constructed* and *Managed.* A Constructed USF is one in which water is stored in an aquifer by using some type of constructed device, such as an injection well or percolation basin. A Managed USF is a facility at which water is discharged to a naturally water-transmissive area such as a streambed that allows the water to percolate into the aquifer without the assistance of a constructed device. Historically, USFs in Phoenix have stored CAP, reclaimed water, and surface water.

Groundwater Savings Facilities (GSFs): A GSF is a facility, such as an irrigation district or specific farm, to which a renewable supply is delivered to a recipient who agrees to curtail groundwater pumping and use the water in-lieu of that groundwater. Typically, a separate entity holds the Water Storage Permit (and has the legal right to the renewable supply) and accrues long-term storage credits for each acre-foot of water used in-lieu of the groundwater. Historically, GSFs in the Phoenix AMA have stored CAP.

Artificial recharge plays an important role in meeting the safe-yield management goal. Pursuant to the AWS requirements, development associated with CAWS and DAWS must prove 100-year water supplies that are consistent with the Phoenix AMA safe-yield management goal. This dictates that most or all of these supplies must come from renewable sources. For example, using CAP water can meet or offset a provider's obligation to use renewable supplies. However, there are some factors that affect a water user's ability to utilize CAP water directly, including having a CAP allocation and/or access to excess or leased CAP supplies, proximity to the main CAP distribution system, and access to treatment facilities and distribution systems to directly treat and deliver CAP water to customers.

Many municipal providers may not have physical or legal access to CAP water. For these providers, membership in, and replenishment by, the CAGRD is an option for meeting consistency with the management goal. Entities who are seeking to demonstrate an AWS can voluntarily join the CAGRD to meet the consistency with management goal requirement. The CAGRD must replenish any groundwater used in excess of the allowable groundwater volume (excess groundwater) used by its members within three years after the amount of excess groundwater use is reported, and does so through replenishment (storage) at an USF or GSF.

Some of the water stored at a USF or GSF is also debited to assist the AMA in achieving the statutory management goal. CAP water stored for long-term storage credits is debited a five percent cut to the aquifer, unless it is stored directly into specific CAGRD accounts that do not incur the debit. Annual or long-term reclaimed water storage at a Constructed USF or a GSF does not have a cut to the aquifer; however, reclaimed water stored at a Managed USF is debited 50 percent. These cuts to the aquifer help the AMA reach safe-yield and are included in the Summary Budget as an offset to overdraft.

Another mechanism that can be used to assist the AMA in achieving its management goal is unrecoverable recharge (or groundwater augmentation). Although this is rarely, if ever, used, an entity could recharge water for the benefit off the AMA, without accruing long-term storage credits. The stored water does not retain its original legal characteristic but would simply become part of the available groundwater supply for the benefit of all water users in the AMA.

Underground storage and recovery is an important water management tool, but it does not always directly offset overdraft. Although CAGRD replenishment is factored into the Summary Budget, and cuts to the aquifer assist in reaching safe-yield, many of the recharge activities (such as accrual of long-term storage credits) are not factored into the Summary Budget. Even though local water levels may rise in the areas of hydrologic impact of artificial recharge, that water is in effect already spoken for – it has been stored with the intent of recovering it at a later date.

3.4 Offsets to Overdraft

Offsets to overdraft are quantities of water that recharge the aquifer, either as a result of the natural system or cultural activity, and therefore "offset", at least in part, groundwater pumping.

These include net natural recharge, incidental recharge, cuts to the aquifer, supplies identified in the AWS Rules, CAGRD replenishment, reclaimed water discharge, and conservation.

3.4.1 Net Natural Recharge

The natural components that affect groundwater overdraft include mountain front recharge, streambed infiltration of runoff, and underflow (subsurface migration of water) into and out of the Phoenix AMA. These components are described in more detail below.

Mountain Front Recharge: Mountain front recharge is natural recharge that occurs in channels at the margins of mountain ranges, mainly the Superstition and McDowell Mountain ranges.

Streambed infiltration: Streambed recharge occurs when precipitation creates intermittent but occasionally large surface water flows from the Salt, Gila and Agua Fria River drainages and to a lesser extent by intermittent, smaller flows from Cave Creek, Skunk Creek, New River, and Queen Creek. Stream channel recharge on the Salt/Verde and Gila River systems, although potentially very large, is highly irregular and not reliable, occurring only when there is insufficient capacity to store water upstream.

Groundwater Inflow: Groundwater Inflow is water that flows into the Phoenix AMA as groundwater flows north out of the Pinal AMA near Florence and Sacaton.

Groundwater Outflow: Groundwater outflow occurs when groundwater exits the Phoenix AMA from the Rainbow Valley Subbasin near Waterman Wash and the area that abuts Maricopa-Stanfield area and flows into the Pinal AMA.

The sum of mountain front recharge, streambed infiltration, and groundwater inflow minus groundwater outflow gives the total *Net Natural Recharge (See Table 3-2)*. The amount of Net Natural Recharge can vary from year to year with the amount of precipitation and the timing and magnitude of storm events. As such, the rate of streambed infiltration used in the historical period varies from year to year based on actual flows but is held constant at an average of 84,400 acre-feet per in the projections. The rate for mountain front recharge is held constant in the historical and projected years. The amounts of groundwater inflow and groundwater outflow are also held constant for the historical and projected period and were based on the Regional Groundwater Flow Model of the Salt River Valley.

Table 3-2 Components of Net Natural Recharge
1985, 1995 and 2006

Element of Net Natural Recharge	1985	1995	2006
Mountain Front Recharge	21,500	21,500	21,500
Streambed Infiltration	304,400	240,822	34,600
Groundwater Inflow	24,000	24,000	24,000
Groundwater Outflow	28,000	28,000	28,000
Reclaimed Water Discharge	0	27,684	19,775
Total Net Natural Recharge	**321,900**	**286,006**	**71,875**

All volumes are in acre feet.

3.4.2 Incidental Recharge

Another offset to groundwater overdraft is incidental recharge. Incidental recharge is a by-product of water used for human activities; one example is percolation of irrigation water below the root zone of irrigated crops. ADWR assigns incidental recharge rates for Municipal, Industrial and Agricultural demands (both on and off Indian reservations) and for canal seepage

(See Table 3-3). For purposes of this Assessment, incidental recharge for the Municipal and Industrial sectors is assumed to occur in the year the water is applied. However, for the Agricultural sector, the incidental recharge is assumed to gradually reach the water table over a 20-year period, based on information from the ADWR Regional Groundwater Flow Model of the Salt River Valley (Freihoefer, Mason, Jahnke, Dubas, & Hutchinson, 2009).

The final component of incidental recharge is Canal Seepage, which is the water that seeps annually into the aquifer from canals. Canal seepage amounts for this Assessment are consistent with the information contained in the ADWR Regional Groundwater Flow Model of the Salt River Valley.

Table 3-3 Incidental Recharge Rates Used in the Summary Budget
1985, 1995, and 2006
Phoenix Active Management Area

Source of Incidental Recharge	**Percent of Total Demands or Volume Applied to Source of Recharge**		
	1985	1995	2006
Municipal Demand			
Municipal Demand	4% of Muni Demand 24% of Urban Irrigation		
Agricultural Demand[1]			
Agriculture	427,981	361,177	193,285
Indian Agriculture[1]			
Industrial Demand			
Turf-related Facilities, Sand and Gravel Operations	12%		
Other Industrial Facilities	4%		
Dairies, Feedlots and Power Plants	0%		
Canal Seepage	120,199	116,930	129,975

Note: [1]Agricultural incidental recharge is calculated in the ADWR Regional Groundwater Flow Model of the Salt River on a cell-by-cell basis and is in acre-feet. Indian Agricultural recharge is combined with Agricultural incidental recharge through 2006. Volumes are in acre-feet.

3.4.3 Cuts to the Aquifer

Pursuant to the Underground Storage and Recovery Program, permitted artificial recharge, in many cases, requires that a certain percentage of the recharged volume be deemed non-recoverable to benefit the aquifer. These required non-recoverable volumes are called *cuts to the aquifer* and help offset groundwater overdraft. CAP water stored at constructed facilities carries a five percent cut to the aquifer; reclaimed water stored at Constructed USFs carries no cut to the aquifer; and reclaimed water stored at Managed USF carries a 50 percent cut to the aquifer. In addition to the 50 percent cut to the aquifer, reclaimed water delivered to a Managed USF can also offset a portion of the riparian demand in the wash or river where the project is located. The amount of reclaimed water used by the riparian vegetation is calculated and then subtracted from the total amount delivered before the 50 percent cut is calculated for the facility.

3.4.4 Assured Water Supply and CAGRD Replenishment

The AWS Rules require use of primarily renewable supplies, such as CAP water and reclaimed water by DAWS and CAWS issued after 1995. However, pursuant to the AWS Rules, a certain volume of groundwater is allowed to be used. These groundwater allowances are intended to help municipal providers transition from groundwater to renewable supplies. Groundwater use by a DAWS or CAWS can be classified into two categories: allowable groundwater or excess groundwater.

When a CAWS or DAWS is issued, a groundwater allowance account is established. ADWR credits additional allowable groundwater to these accounts based on a number of factors. The AWS Rules allow for a limited volume of groundwater to be pumped based on formulas for each AMA in the AWS Rules. The volume of this allowable groundwater use is reduced over time to zero in 2025 in the Phoenix AMA. The AWS Rules also allow for a limited volume of poor quality groundwater, used pursuant to an approved remedial action plan, to be added each year to the groundwater allowance through the year 2025. Additionally, groundwater withdrawn in areas that have been identified by ADWR as “waterlogged” and are exempt from the conservation requirements, may be deemed by ADWR to be consistent with the management goal. The AWS Rules also allow for a DAWS or CAWS to add to the groundwater allowance by extinguishing grandfathered rights (IGFRs, Type 1 and Type 2 rights) within the same AMA. The calculation of these extinguishment credits are contained in the AWS Rules and are calculated differently for each AMA. Finally, a DAWS, regardless of date issued, is annually allocated an incidental recharge volume (four percent of the water provider’s total demand in the previous calendar year), which is credited to their groundwater allowance account. Groundwater use reported pursuant to the provider’s or subdivision’s allowable groundwater volume is considered consistent with the management goal of the AMA.

In contrast, excess groundwater is not considered consistent with the management goal, and must be replaced by a renewable supply. A provider may choose to utilize their own renewable supplies or can voluntarily join the CAGRD. The CAGRD has the obligation to replenish the amount of excess groundwater reported by member service areas (providers with a DAWS) or member lands (subdivisions issued CAWS) with renewable supplies. CAGRD replenishment must take place within three years after excess groundwater is reported. Excess groundwater must be replenished within the AMA where it was withdrawn, but is not required to be replenished in the same *location* within the same AMA as where it was withdrawn. Excess groundwater is debited in the year it is utilized; however, while the CAGRD has three years to replenish the excess groundwater, for purposes of this Assessment, replenishment by the CAGRD is an offset to overdraft in the same year the groundwater is debited.

3.4.5 Reclaimed Water Discharge

Historically, reclaimed water has been discharged into the Salt and Gila Rivers from the 91st Avenue WWTF and the 23rd Avenue WWTF. The values of this discharge are 9,200 acre feet from the 91st Avenue WWTF and 60 percent of the 23rd Avenue WWTF.

3.4.6 Contribution of Conservation and Renewable Supplies

Conservation of water supplies, including groundwater, is not explicitly accounted for in the Summary Budget. However, because less groundwater is withdrawn, conservation intuitively provides a clear benefit toward reaching safe-yield. Each water use sector (Municipal, Agricultural and Industrial) has associated conservation requirements that are described in the *Third Management Plan for Phoenix Active Management Area, 2000-2010*.

Direct use of renewable supplies also offsets the amount of groundwater that would otherwise be used, and assists in reaching safe-yield. Management Plan provisions provide incentives for use of renewable supplies including surface water, CAP water, and reclaimed water to meet conservation requirements.

4. CALCULATING OVERDRAFT IN THE SUMMARY BUDGET

The management goal of the Phoenix AMA is safe-yield by 2025; therefore, monitoring the effects of the cumulative impacts of demand on the aquifer is critical. The components listed in Section 3 above are included in the Summary Budget and are critical in identifying the AMA's success toward achieving the statutory management goal of safe-yield. If the AMA has not achieved safe-yield, it is in an overdraft condition and the ADWR uses this information to evaluate what additional tools are necessary to assist the AMA in achieving its goal.

Table 4-1 lists the various inputs to and withdrawals from the aquifer that are used to estimate groundwater overdraft. Inputs, which are considered additions to the aquifer, include incidental recharge contributed by the various sectors, net natural recharge, cuts to the aquifer as required by the Underground Storage and Recovery statutes, and replenishment by the CAGRD as required by the AWS Rules (*See* Section 3.4 for a discussion on these components).

Withdrawals from the aquifer include withdrawals of groundwater by various water use sectors, riparian demand, and groundwater outflow. In addition, when a farmer uses CAP or reclaimed water in-lieu of groundwater pumping at a GSF, that use is considered a withdrawal because at some unknown point in the future, the storer, such as a municipal provider, will withdraw water from the aquifer.

Annual groundwater overdraft is calculated by subtracting withdrawals from the inputs, or recharge. If groundwater withdrawals exceed the offsets or inflows, there is overdraft. Part III describes and quantifies the historical water use and overdraft for the Phoenix AMA for the historical period of 1985 to 2006.

Table 4-1 Overdraft Inputs and Withdrawals
Phoenix Active Management Area

Inputs	Withdrawals
Sector Incidental Recharge	Sector Pumpage
Municipal	*Municipal*
Industrial	*Industrial*
Agriculture	*Agriculture*
Indian Agriculture	*Indian Agriculture, Municipal and Industrial*
Canal Seepage	Riparian Demand
Net Natural Recharge	
Reclaimed Water Discharge	
CAGRD Replenishment	
Artificial Recharge Cut to the Aquifer	

Note: Estimated Overdraft (with and without the Groundwater Allowance) = Inputs – Withdrawals

PART III HISTORICAL WATER DEMANDS AND OVERDRAFT

5. HISTORICAL WATER DEMANDS BY SECTOR

The proportion of water demand among the sectors has changed, primarily in the Agricultural and Municipal sectors, since 1985. However, the overall demand remained relatively unchanged. In 1985, Agricultural demand accounted for 57 percent of the total AMA demand, Municipal demand accounted for an additional 28 percent, Indian demand accounted for 11 percent and the remaining 4 percent was for Industrial demand. In 2006, Municipal demand had increased to 50 percent of the total AMA demand, Agricultural demand had decreased to 33 percent of the total AMA demand, Indian demand remained relatively unchanged at 11 percent and Industrial demand had increased to account for the remaining 7 percent of total demand (ADWR, 2010).

Historically, water users in the Phoenix AMA have relied on both surface water and groundwater; in 1985 surface water accounted for 51 percent of supply and groundwater for 47 percent of supply. By 2006, a larger variety of water supplies were utilized, however, surface water and groundwater still accounted for the largest source of supply at 38 and 31 percent, respectively. The use of reclaimed water and CAP had increased by 2006 with CAP water accounting for 18 percent of supply. Agricultural and Industrial water users are also increasingly taking advantage of indirect utilization of CAP water and/or reclaimed water. Historical demand and supplies for each sector are discussed in more detail below.

5.1 Municipal Sector Demands and Supplies

The Municipal sector in the Phoenix AMA includes four categories of water users: large providers, small providers, domestic exempt well users and individual users. The Arizona Corporation Commission (ACC) regulates 22 of the 42 large providers and 19 of the 56 small providers in the Phoenix AMA as private water companies. The other providers are cities, towns, domestic water improvement districts, cooperatives, mobile home parks, and providers serving specific locations such as schools, colleges and correctional facilities.

5.1.1 Municipal Demands

Total Municipal water demand in the Phoenix AMA was 484,652 acre-feet greater in 2006 than in 1985, an increase of almost 77 percent (*See Table 5-1*). In the Phoenix AMA most of the growth was in the large provider category of municipal use. In contrast, small provider demand had decreased since 1985. This was due to several factors. Several small providers transitioned into the large provider category. Between 1985 and 2006, eight small providers began using more than 250 acre-feet of water per year and became regulated by ADWR as large providers. Other small providers were absorbed into existing large provider service areas. Finally, several small providers served primarily or exclusively water for exterior landscape purposes and discontinued service or lost customers. *Figure 5-1* shows the locations of the large and small provider service areas. There are no institutional providers in the Phoenix AMA. Luke Air Force Base is regulated as a large municipal provider. Williams Air Force Base was closed between 1994 and 1995. Between 1985 and 2006, the number of exempt domestic wells in the Phoenix AMA increased by over 175 percent.

The Phoenix AMA is the only AMA besides the Pinal AMA with large untreated water providers that deliver water for urban irrigation (*flood irrigation*) of residential and commercial landscaping. There are 20 large untreated water providers in the Phoenix AMA. In addition, some small providers only serve water for urban irrigation and do not provide potable water service; however, they are counted in the small provider category of use. Large untreated providers in the Phoenix AMA serve mostly surface water, but sources of supply also include groundwater, CAP water, and some reclaimed water.

There are 415 individual users in Phoenix AMA - 121 facilities are schools, 95 are golf courses, and the others are lake facilities, cemeteries, parks, homeowners associations, and other general turf and landscaping. Groundwater accounts for approximately 13 percent of individual user demand and non-groundwater supplies such as reclaimed surface water and CAP meet the remaining 87 percent of demand.

Table 5-1 Municipal Water Demand
1985, 1995 and 2006
Phoenix Active Management Area

Municipal Use Category	1985	1995	2006
Large Providers			
Number	33	33	42
Total Use	492,087	677,231	961,925
Groundwater Use	191,947	191,728	204,878
Small Providers			
Number	87	75	56
Total Use	9,177	4,630	3,911
Groundwater Use	9,177	4,630	3,878
Urban Irrigation			
Number	20	20	20
Total Use	128,889	135,478	147,178
Groundwater Use	20,622	59,610	37,922
Domestic Well Use			
Number	5,168	7,260	14,315
Total Use	3,605	4,372	5,395
Groundwater Use	3,605	4,372	5,395
Total Use	**633,757**	**821,711**	**1,118,409**
Total Groundwater Use	**225,350**	**260,340**	**252,072**

Note: All water values are in acre-feet. Thunderbird Adventist is included as a Large Untreated Provider in the Third Management Plan but uses less than 100 acre-feet on untreated water in some years and so was included in the small provider category.

5.1.2 Municipal Supply

Surface water is still the largest source of supply in the Municipal sector, however, the use of CAP water has steadily increased since it was first used in 1986. In 1985, surface water accounted for 64 percent of the supply and groundwater accounted for 36 percent. By 2006, surface water accounted for only 43 percent of the supply while CAP water accounted for 30 percent and groundwater for 23 percent. The use of reclaimed water has also increased from 1,713 acre-feet in 1986 to 33,421 acre-feet in 2006; the highest use was in 2002. The use of recovered water (from all sources) also increased between 1995 and 2006. Supplies utilized by municipal providers are illustrated in *Figure* 5-2.

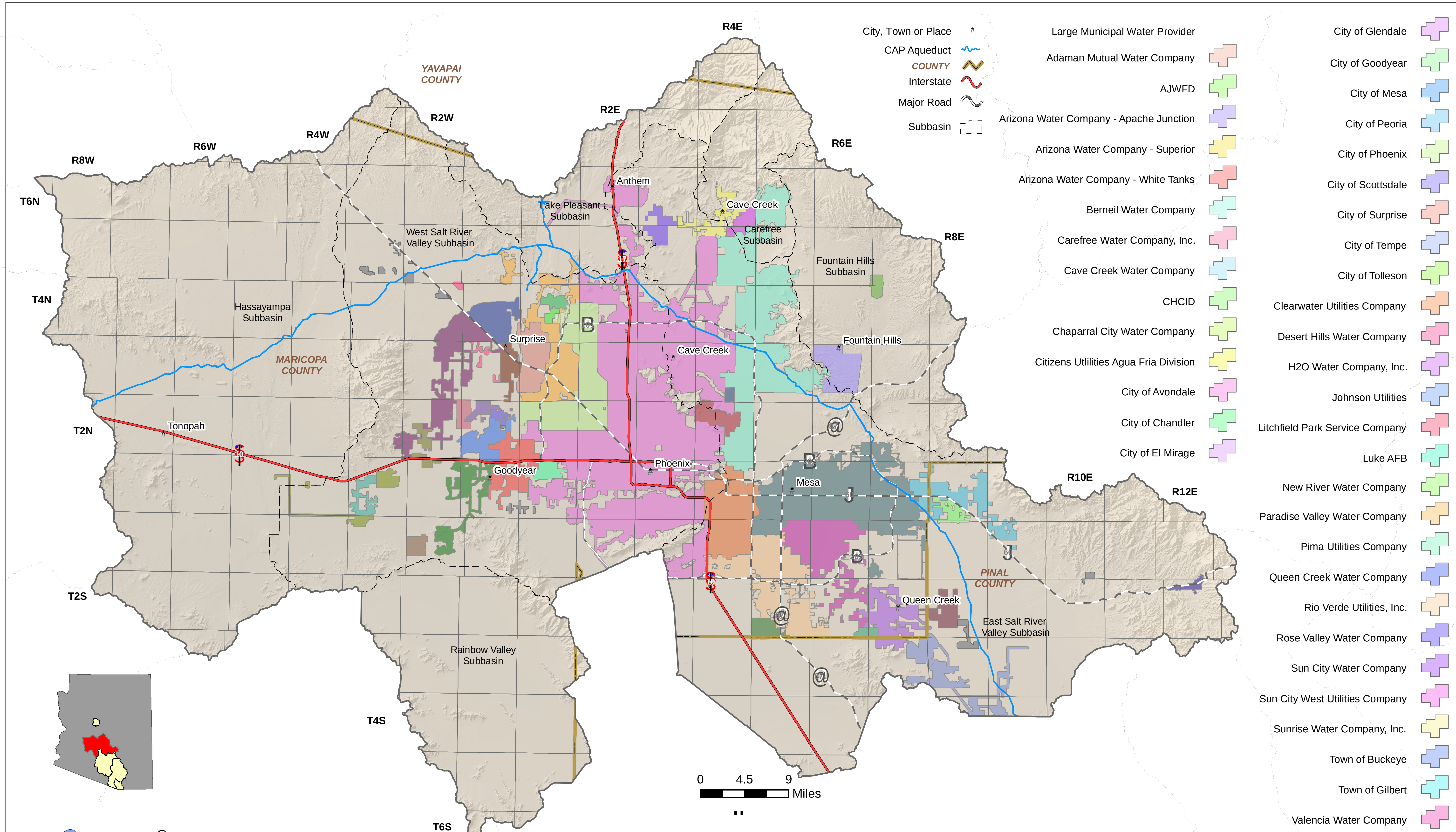
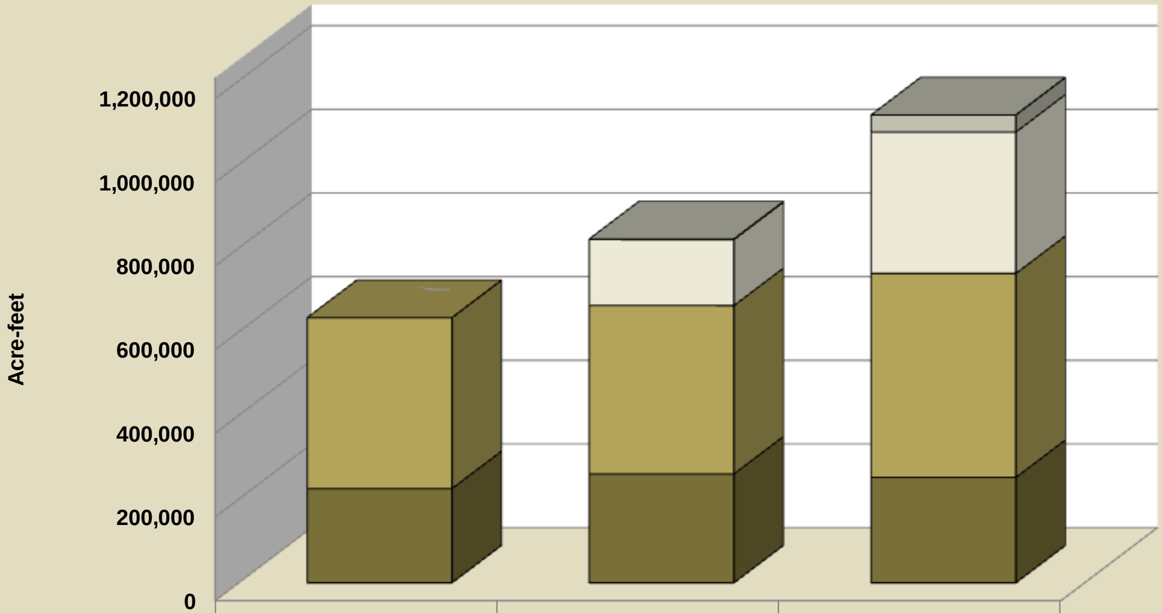


Figure 5-1
Phoenix AMA
Municipal Water Providers

Figure 5-2 Historical Municipal Supplies, 1985, 1995 and 2006
Phoenix Active Management Area



	1985	1995	2006
TOTAL	633,757	821,711	1,118,409
Reclaimed Water	0	1,068	40,639
CAP	0	157,685	338,101
Surface Water	408,407	402,618	487,598
Groundwater	225,350	260,340	252,072

5.1.3 Large Municipal Providers

Large Provider Water Use Characteristics

There are currently 42 large municipal providers in the Phoenix AMA (*See Figure 5-1*). These include 16 municipally owned and/or operated systems, 23 private water companies, Luke Air Force Base and 2 districts. As shown on *Table* 5-1*,* large municipal providers have historically met most of their demand with surface water delivered by SRP from the Salt and Verde Rivers. Groundwater, CAP water, and reclaimed water make up the remaining portion of demand. Luke Air Force Base is included in the large provider category of municipal use.

Large Provider Demand and Supply

Large provider demand has increased since 1985, increasing more than 95 percent between 1985 and 2006. In 1985, municipalities accounted for almost 92 percent of large provider demand. By 2006, municipalities accounted for 86 percent of large provider demand. Demand served by private water companies increased more than 250 percent from 1985 to 2006, while demand served by cities and towns increased 81 percent. However, the volume of demand served by municipalities increased more than the volume of demand served by private water companies. Municipal demand rose by over 360,000 acre-feet from 1985 to 2006, while private water company demand rose about 106,000 acre-feet.

Surface water is the primary source of supply used in the municipal sector (*See Figure 5-2*). Total groundwater demand in the municipal sector has remained fairly constant. In 2006 groundwater use was split nearly equally between municipalities and private water companies. In contrast, in 1985, large municipalities used more than three times the volume of groundwater used by private water companies. While groundwater use by municipalities has decreased since 1985 as a proportion of total municipal demand, groundwater use by private water companies has more than doubled.

Factors Affecting Large Provider Water Use

Population growth is the greatest factor affecting water demand. The location where growth occurs affects the supplies used to meet the new demand. Generally, municipalities serve the central areas of the Phoenix AMA and private water companies serve the fringe. A large portion of the demand from in-fill within municipalities' service areas is met with surface water and CAP water, but demand from new subdivisions constructed on the fringes within private water companies' service areas is met primarily with groundwater. Growth in private water company service areas increased groundwater use; nonetheless, the volume of groundwater demand in the municipal sector has remained fairly constant since 1985 because municipalities have gradually increased their use of non-groundwater supplies while decreasing their use of groundwater.

The availability of surface water from the Salt and Verde Rivers, provided by SRP, fluctuates from year to year. In years when surface water supplies have been lower, CAP water use has been higher. Over time, renewable supplies have made up a larger portion of supplies.

Most water providers in the Phoenix AMA that are designated as having an assured water supply have not historically relied to a significant extent of the CAGRD (*See Table 5-2*). The CAGRD recharges water to offset groundwater pumping. Phoenix AMA DAWS providers generally meet the consistency with the management goal criteria of the AWS rules for the AMA through use of renewable supplies, either directly treated and delivered or artificially recharged and recovered. Of the fifteen DAWS providers in the Phoenix AMA, ten are CAGRD members although reliance on the CAGRD has not been significant.

As long as sufficient underground storage capacity is available and to the extent that distribution infrastructure continues to expand, the limiting factor on the use of renewable supplies by Phoenix AMA large providers will be availability of the supplies: the allocations and excess CAP water available, surface water, and reclaimed water that can be stored underground or directly used.

Table 5-2 Designated Water Providers
Phoenix Active Management Area

Municipal Provider	Date Designation Issued or Modified	Projected Estimated Demand	Year of Projected Estimated Demand
City of Avondale	9/29/10	26,056	2025
City of Chandler	6/04/09	130,642	2025
Chaparral City WC	4/7/2004	8,000	2014
City of El Mirage	9/29/10	8,086	2020
Town of Gilbert	9/29/10	93,198	2025
City of Glendale	9/29/10	87,510	2025
City of Goodyear[1]	Pending	16,743	2018
Johnson Utilities	1/2/2009	18,154	2028
City of Mesa	9/29/10	187,845	2025
City of Peoria	9/29/10	64,241	2025
City of Phoenix	9/29/10	482,836	2025
City of Scottsdale	9/29/10	129,072	2025
City of Surprise	9/29/10	16,718	2020
City of Tempe	9/29/10	73,685	2025
WUCFD (Apache Junction)	9/29/10	3,562	2025

Note: Volumes are in acre-feet.

5.1.4 Small Municipal Providers

Small Provider Water Use Characteristics

The number of, and demand by, small providers has decreased since 1985 as small providers have transitioned to large provider status, been absorbed by existing large municipal providers, or been identified as untreated providers (*See Table* 5-1). Small providers rely primarily on groundwater, although some small providers use surface water, CAP water, or reclaimed water.

Small Provider Demand and Supply

Evaluating characteristics and trends in demand and supply in the small provider subsector in the Phoenix AMA is difficult because small provider water use is not as homogenous as it is in the other AMAs. The populations served by small providers are diverse and include homeowner associations, mobile home parks, entities that share small non-exempt wells through well sharing agreements, and others. Additionally, the supply can also be diverse and vary by year, specifically with respect to the use of untreated water. In general, the number of small municipal providers has decreased in the Phoenix AMA since 1985. As their service areas have grown, several have transitioned to large provider status (*See Table 5-1*). Small provider population has increased from approximately 9,542 people in 1985 to approximately 14,280 people in 2006.

Small provider GPCD rates have varied considerably. Data on small provider population served is historically inconsistent and incomplete. Given the available data, rates of use have varied from a high of 1,055 GPCD to a low of 170 GPCD. The small provider GPCD in 2006 is estimated to have been 240 GPCD.

Factors Affecting Small Provider Water Use

Small providers have little incentive to initiate use of renewable supplies. New subdivisions, served by small providers that have not obtained a DAWS, must obtain a CAWS. If the CAWS is issued, the subdivision can meet the consistency with the management goal requirement through a combination of using their groundwater allowance, extinguishment credits, and/or by joining the CAGRD as a member land.

5.1.5 Exempt Well Demand and Supply

The number of exempt wells in the Phoenix AMA has increased steadily from 5,168 in 1985 to 14,315 in 2006. Exempt well demand is estimated to have been almost 5,400 acre-feet in 2006.

Exempt Well Demand and Supply

Exempt well owners are not required to report volume used or number of people relying on the exempt well. Because of this, exempt well demand and population were estimated for the historical period. The exempt well population in the year 2000 was calculated by subtracting the known populations of the large providers and small providers based on data from the 2000 US Census population for the AMA. The Maricopa County "balance of county" historical growth rate was used to regress from the year 2000 exempt well population to an estimate of the 1985 exempt well population. The same growth rate was used to estimate exempt well population from 2001 through 2006. This method yielded exempt well populations of 26,023 people in 1985 and 38,943 people in 2006.

The exempt well water demand can only be estimated because the statutes do not require reporting by exempt wells. In previously published documents, ADWR had used an assumption of between 0.5 and 1.0 acre-feet per well per year. For this Assessment, ADWR used a different approach. The interior and exterior demand models for new single family development (ADWR, 1999) and the 2000 US Census average persons per household for Maricopa County were used to estimate exempt well demand. As a result, a demand of 124 gallons per person per day was applied to the population number.

Exempt wells are assumed to use 100 percent groundwater.

Factors Affecting Exempt Well Use

Because exempt wells are unregulated, there is no requirement or incentive to use renewable water supplies. Under the AWS Rules, dry lot subdivisions of 20 or fewer lots are not required to meet the consistency with management goal requirement. A dry lot subdivision is a development where each lot purchaser is responsible for drilling and maintaining their own private domestic exempt well. Consequently, new exempt wells added to the AMA in small subdivisions or through un-subdivided lot splits do not join the CAGRD and their withdrawals of groundwater are not replenished.

5.1.6 Individual User Water Use Characteristics

Water demands for individual users are included in the demands for large and small providers, although they have their own conservation requirements under the Industrial Conservation Program in the Management Plans. There are 415 individual users in Phoenix AMA - 121 facilities are schools, 95 are golf courses, and the others are lake facilities, cemeteries, parks, homeowners associations, and other general turf and landscaping. Groundwater accounts for approximately 13 percent of individual user demand and non-groundwater supplies such as reclaimed, surface water and CAP meet the remaining 87 percent of the demand.

5.1.7 Urban Irrigation

The number of large untreated water providers has not increased, nor will it increase because to qualify as a large untreated water provider the provider must have been delivering untreated water prior to January 1, 1990. Large untreated water providers are limited to delivering four acre-feet per acre per year.

Urban Irrigation Demand and Supply

Large untreated water provider demand was approximately 129,000 acre-feet in 1985; it had increased to approximately 136,000 acre-feet by 1995. Demand fluctuated from year to year between 1996 and 2006. The highest demand, approximately 164,000 acre-feet, occurred in 2003; the lowest demand, slightly less than 101,000 acre-feet, occurred in 2004.

Surface water is the primary supply for urban irrigation, but its availability varies. Groundwater is the second most common supply. A small amount of CAP water has also been used, but this is atypical for this municipal subsector. In years when surface water supply has been less than average, groundwater has been the second most used source of supply; CAP water use has also been higher in low surface water supply years.

Factors Affecting Urban Irrigation Use

Surface water supply has the greatest effect on water use in the urban irrigation sector. Also, the limitations on adding no more large untreated water providers to the AMA will limit the use in this subsector.

5.2 Industrial Sector Demands and Supplies

The Code defines industrial use as a non-irrigation use of water not supplied by a city, town, or private water company, including animal industry use and expanded animal industry use. In general, industrial users withdraw water from their own wells that are associated with grandfathered groundwater water rights (Type 1 and Type 2 rights) or withdrawal permits (*See* Figure 5-3). Although industrial users are primarily dependant on groundwater, some use renewable supplies such as CAP water or reclaimed water. Historically, industrial uses in the Phoenix AMA have included turf related facilities, electric power generation, dairies, feedlots, and sand and gravel operations. For more information regarding Industrial users, refer to Section 3.1.1.

5.2.1 Overview of Industrial Rights and Authorities

Type 1 and Type 2 rights are the predominant withdrawal authority used by Industrial users. Industrial users can also withdraw water pursuant to groundwater withdrawal permits such as GIU permits or Mineral Extraction permits (permits used for mining operations or sand and gravel operations). All of these rights and permits have an allotment associated with them that limits the amount of water that can be withdrawn on an annual basis. In addition to these associated right and permit allotments, certain types of Industrial facilities are subject to conservation requirements that may impose additional restrictions on the amount of water that can be used at a facility.

Industrial use is primarily dependent on population growth and the economy. In some cases, the difference between the actual water use and the total allotment is substantial (See Table 5-3), and is generally explained as a result of the allocation process used to establish Type 2 rights. This process assigned users allotments based on the highest annual groundwater withdrawal between the years 1975 and 1980. On average, approximately 36 percent of the Phoenix AMA's industrial groundwater rights and permit volumes are used.

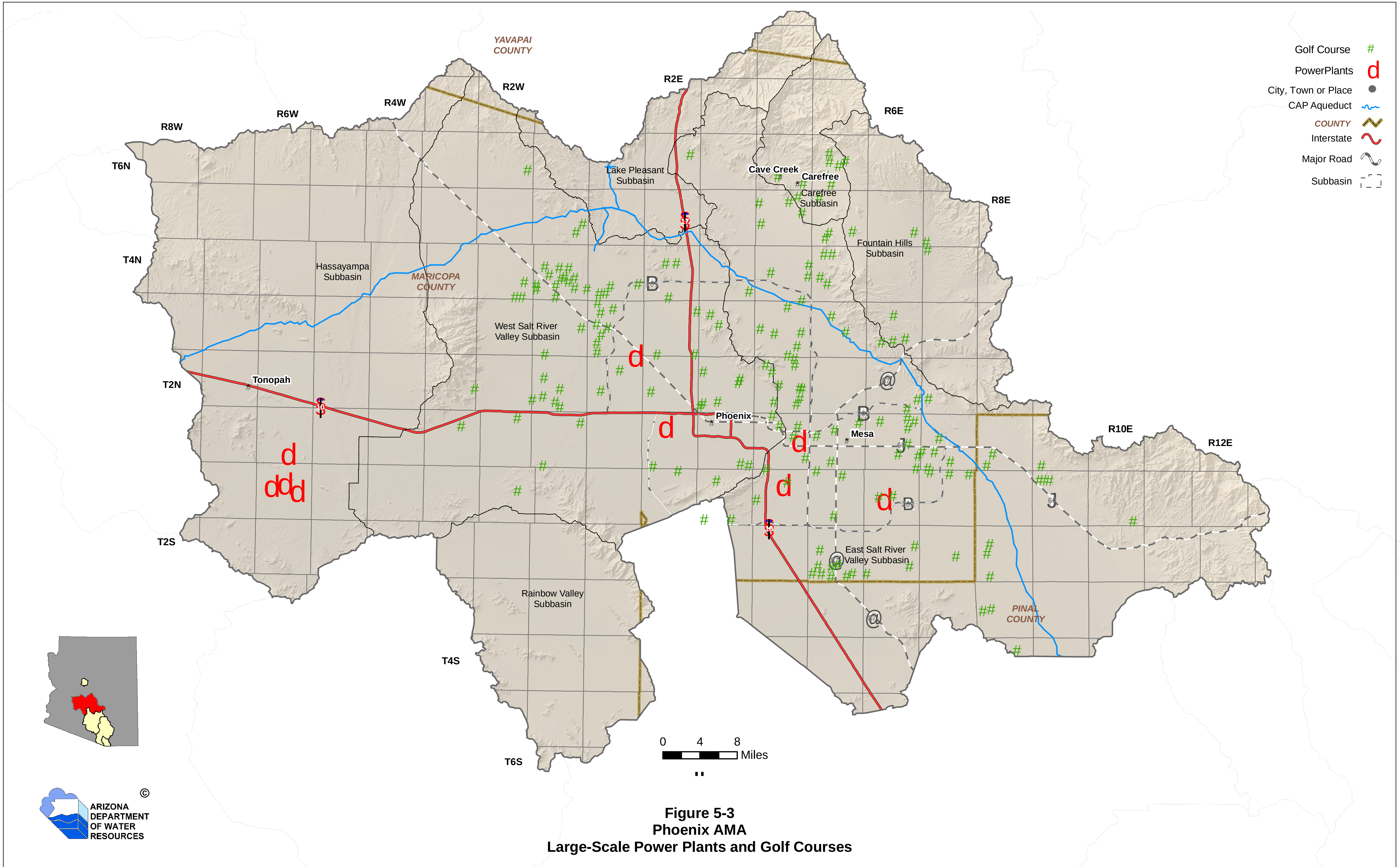


Figure 5-3
Phoenix AMA
Large-Scale Power Plants and Golf Courses

Table 5-3 Industrial Groundwater Rights and Withdrawal Summary
2006

User Category	Right or Permits	Number of Facilities	Right or Permit Volume	Groundwater Use	Total Water Use
Large-Scale Power Plants	Type 1 & Type 2 Power Generation	9	21,791	14,042	69,585
Turf-Related Facilities[1]	Type 1 & Type 2; GIU Permit	138	76,308	43,143	60,632
Sand and Gravel Facilities	Type 2 – Mineral Extraction; Mineral Extraction Permit	49	40,763	10,401	10,401
Dairies	Type 1 & Type 2; GIU (General Industrial User) Permit	81	20,787	10,080	10,080
Feedlots	Type 1 & Type 2; GIU (General Industrial User) Permit	8	2,060	58	58
Other Industrial Facilities	Type 1 & Type 2; GIU Permit	404[2,3]	84,056	10,574	10,625
Total		**689**	**245,765**	**88,298**	**161,381**

Note: All water values are in acre-feet. [1]Includes Industrial turf-related facilities only. In the Phoenix AMA there are 426 turf-related facilities that receive water from a municipal provider. [2] Number of rights and permits, not facilities. [3]Does not include drainage, temporary dewatering and hydrologic testing permits.

5.2.2 Industrial Demand and Supply by Subsector

The Industrial sector in the Phoenix AMA has steadily increased since 1985, showing more than an 80 percent increase between 1985 and 2006. Total industrial water use in the Phoenix AMA was 88,668 acre-feet in 1985, 138,008 acre-feet in 1995, and 161,381 acre-feet in 2006 (*See Table 5-4*). Turf-related facilities accounted for approximately half of the industrial groundwater demand in 1985. The remaining demand was divided among large-scale power plants, sand and gravel operations, dairies, feedlots, and other uses such as cooling and manufacturing (*See Figure* 5-4). By 2006, large-scale power plant use had increased to approximately 43 percent and turf water use decreased to 38 percent of total industrial sector water use (*See Figure 5-5*).

Table 5-4 Industrial Water Demand by Subsector
1985, 1995 and 2006

Type of Facility	1985	1995	2006
Large Scale Power Plants	15,568	52,731	69,585
Turf-Related Facility	44,697	50,534	60,632
Sand and Gravel Operations	9,895	11,792	10,401
Dairies	5,858	7,990	10,080
Feedlots	2,887	584	58
Other Industrial Users	9,763	14,377	10,625
Total	**88,668**	**138,008**	**161,381**

Note: Volumes are in acre-feet.

Figure 5-4 Proportion of Industrial Demand by Subsectors 1985
Phoenix Active Management Area

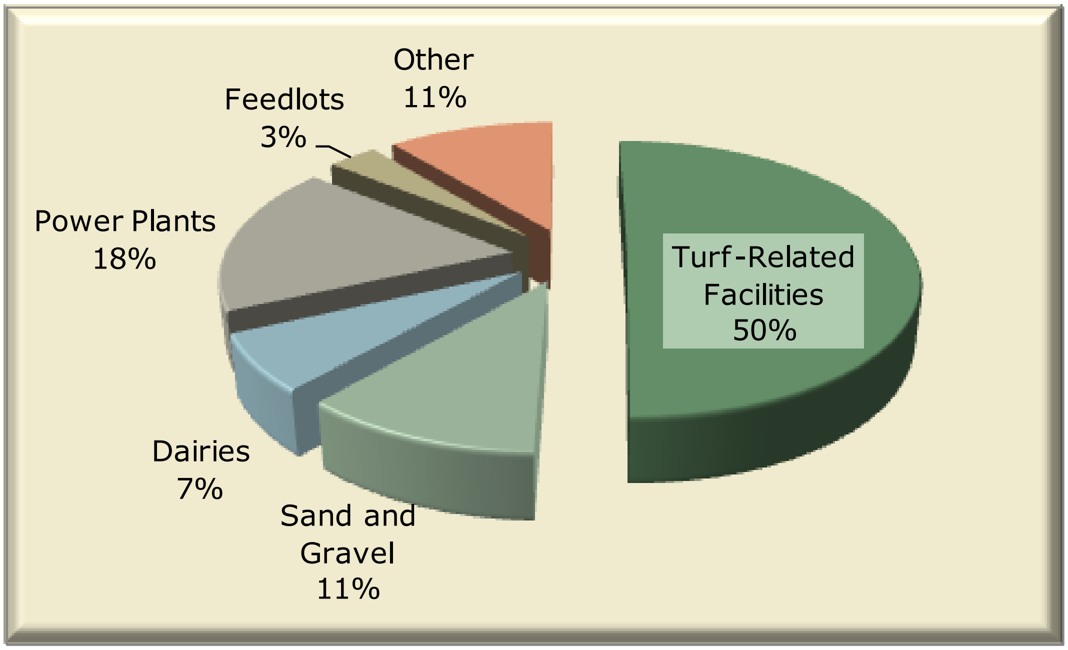
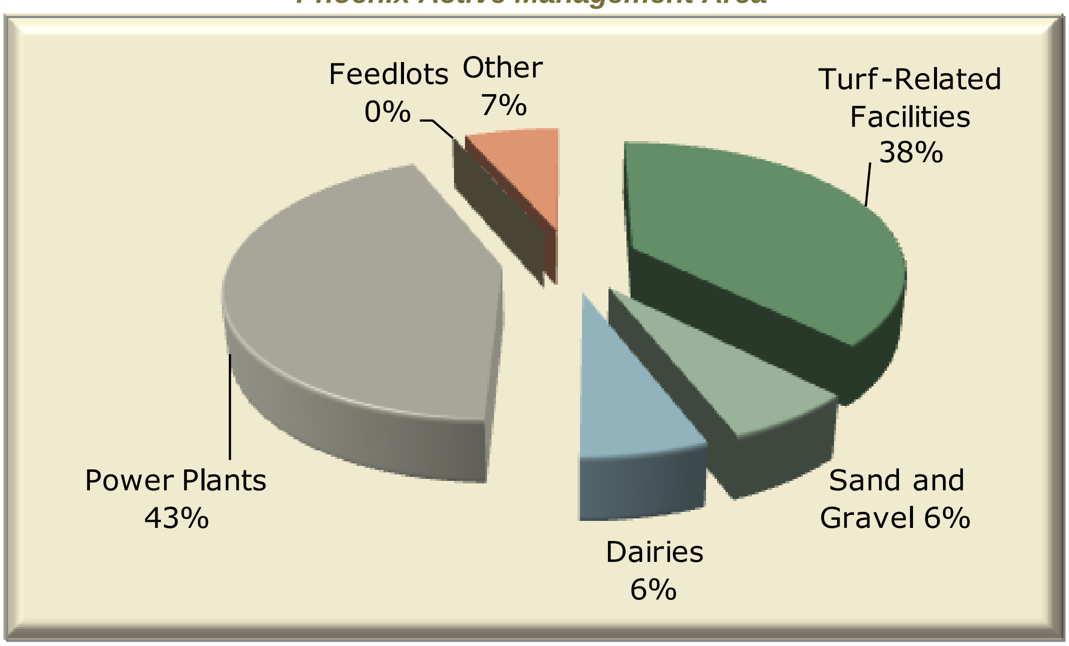
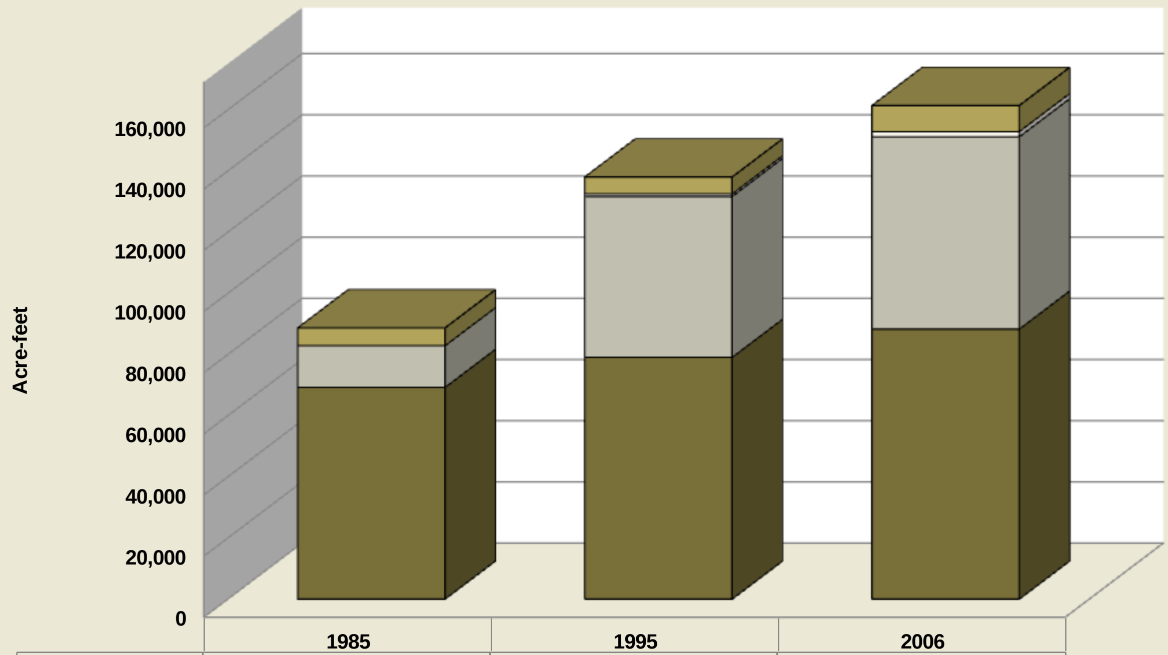


Figure 5-5 Proportion of Industrial Demand by Subsectors 2006
Phoenix Active Management Area



In 1985, groundwater was the primary source of Industrial water supply in the Phoenix AMA (*See Figure 5-6)*. By 2006, reclaimed water became another important source of supply and accounted for over 38 percent of the demand. The use of reclaimed water to meet Industrial sector demand increased over 350 percent between 1985 and 2006. This was primarily due to use at the Palo Verde Nuclear Generating Station and increased use on turf-related facilities. Each sub-sector of Industrial demand and supply is discussed below.

Figure 5-6 Historical Industrial Supplies, 1985, 1995 and 2006
Phoenix Active Management Area



	1985	1995	2006
TOTAL	88,667	138,007	161,380
Surface Water	5,810	5,504	8,513
CAP	0	828	1,698
Reclaimed Water	13,628	52,606	62,872
Groundwater	69,229	79,069	88,298

Large-Scale Power Generation

There are nine large-scale power plants located in the Phoenix AMA *(See Figure 5-3)*. Their names and megawatts of total power generating capacity are as follows: Kyrene (SRP) – 521; Ocotillo Generating Station (APS) – 340; Mesquite Power (SEMPRA) – 1,250; Duke Energy – 600; Agua Fria (SRP) – 630; San Tan (SRP) – 1,225; West Phoenix Generating Station (APS) – 1,000; Redhawk Power Plant (APS) – 1,060; and the Palo Verde Nuclear Generating Station – 3,872. Total water demand for the large-scale power plant subsector in the Phoenix AMA was 15,568 acre-feet in 1985 and 69,585 acre-feet in 2006. This subsector has grown from approximately 18 percent of the total industrial demand in 1985 to 43 percent in 2006. A large portion of this water, 60,000 acre-feet annually, is used by the Palo Verde Nuclear Generating Station, the nation's largest nuclear power plant. The primary consumptive use of water at a thermal power plant is evaporation in the cooling towers. All large-scale power plants in the Phoenix AMA utilize some volume of groundwater, with the exception of the Redhawk Power Plant, which utilizes reclaimed water as its sole source. The Palo Verde Nuclear Generating Station also utilizes a large volume of reclaimed water. The Kyrene and San Tan plants utilize CAP water in addition to groundwater. In the year 2006, the large-scale power plant sub-category of Industrial users had surpassed turf –related facilities as the subsector with the highest water use.

Turf-Related Facilities

A turf-related facility is defined in the *Third Management Plan for Phoenix Active Management Area, 2000-2010* as a facility with 10 or more acres of water intensive landscaped area. Turf-related facilities are generally parks, schools, cemeteries, golf courses and subdivision common areas. In 2006, there were a total of 564 turf-related facilities in the Phoenix AMA. Total water use by all turf-related facilities in the Phoenix AMA was 139,788 acre-feet in 2006. Four hundred and twenty of these facilities were classified as *individual users*. Their use is included in the water demand for the Municipal sector and is counted as non-residential municipal demand. The remaining 147 turf-related facilities were Industrial users that were either in existence before the Code and use Type 2 rights or were developed after the Code on retired agricultural land using Type 1 rights. This industrial subsector has grown from using approximately 44,700 acre-feet in 1985 to 60,632 acre-feet in 2006. *Table 5-5* illustrates the split of turf-related facilities between the Industrial and Municipal Sectors.

In 2006, the 185 active golf courses in the Phoenix AMA (*See Figure 5-3*) used approximately 100,000 acre-feet of water of which 45 percent was groundwater; the balance was CAP water, reclaimed, and surface water. Other turf-related facilities in the Phoenix AMA included 16 cemeteries, 147 parks, 131 schools, 76 subdivision common areas and 9 miscellaneous turf related facilities. Turf-related facilities that use any groundwater, regardless of their water source, have a maximum annual water allotment based on the size and the age of the facility.

Table 5-5 Turf-Related Facilities Demands in 2006
Phoenix Active Management Area

				Water Source				
	Number of Facilities			Municipal		Industrial		
Type of Facility	Municipal	Industrial	Total	Groundwater	Total Use	Groundwater	Total Use	Total
Golf Courses	95	90	185	6,446	46,544	39,447	53,620	100,164
HOAs	56	20	76	1,210	9,758	2,062	4,389	14,147
Parks	143	4	147	1,091	11,891	33	641	12,532
Schools	121	10	131	1,116	9,564	386	444	10,008
Cemeteries		7	9	16	57	892	1,068	1,100
Other	4	5	9	236	507	147	438	945
	426	**138**	**564**	**10,156**	**79,156**	**43,143**	**60,632**	**139,788**

Note: Volumes are in acre-feet.

Sand and Gravel

Sand and gravel facilities in the Phoenix AMA used 11,792 acre-feet of water in 1995 and 10,401 acre-feet in 2006. In 2006, there were 49 active sand and gravel operations in the AMA. Water in this subsector is primarily used to wash aggregate before sale; a small amount is used to clean trucks and equipment, and for dust abatement. Increases in sand and gravel production and associated water use are closely tied to periods of population growth and urbanization. Historically, sand and gravel operations in the Phoenix AMA have used solely groundwater.

Dairies

Historically, dairies have accounted for approximately seven percent of the Phoenix AMA's total industrial water demand. In 1995, there were 77 dairies in the Phoenix AMA and the number of dairies peaked at nearly 100 in 1999. As the Phoenix area urbanized, a large number of dairy operations relocated into rural areas of the Pinal AMA. In 2006, there were 81 dairies in the Phoenix AMA and water use had decreased to 10,080 acre-feet from a high of 12,569 acre-feet in 2002. The relocation of Phoenix dairies to the Pinal AMA appears to have slowed considerably in recent years. Dairies in the Phoenix AMA have historically relied on groundwater.

Feedlots

In 1985, feedlots accounted for approximately percent of the Phoenix AMA's total industrial water demand. By 2006, the demand had decreased to only 58 acre-feet. Feedlots in the Phoenix AMA have historically relied on groundwater.

Other Industrial

Other Industrial is a water use category that typically includes a variety of commercial and manufacturing uses that do not fit into the subsectors listed above. Other Industrial water use has slightly decreased in the Phoenix AMA over the last decade. Water use in this subsector totaled 14,377 acre-feet in 1995 and 10,625 acre-feet in 2006. Groundwater has historically been used to meet the demands of this subsector, however, small amounts of CAP water, surface water, and reclaimed water have also been used.

5.3 Agricultural Sector Demands and Supplies

5.3.1 Overview of Agricultural Rights and Allotments

As mentioned previously, only land associated with a certificate of IGFR can legally be irrigated with groundwater within an AMA (*See Figure 5-7)*. IGFRs are categorized as either non-exempt or exempt. Non-exempt IGFRs have specific conservation requirements established in the Management Plan for each management period. Exempt IGFRs, which are ten acres or less and not part of an integrated farming operation, are no longer required to comply with specific conservation requirements. For more information of IGFRs, refer to Section 3.1.3.

Since the Code generally prohibits newly irrigated acres the total number of IGFR certified acres has decreased over time as lands have urbanized (*See Table 5-6*). The decrease in allotments was due in part to the reduction in acreage, but it was also due to reductions in assigned irrigation efficiencies, as a result of Management Plan requirements. Historically, use has been substantially lower than allotments; in the future, use may exceed allotments because of flexibility account provisions in the Base Program. For more information on flexibility accounting, refer to the *Third Management Plan for the Phoenix Active Management Area, 2000-2010*.

5.3.2 Agricultural Demands and Supplies

In general, the Agricultural demand sector has decreased over time in the Phoenix AMA although it was the primary demand sector through 1999 when demand was almost 990,000 acre-feet. In 2000, the Municipal demand sector exceeded 1,000,000 acre-feet for the first time and replaced agriculture as the primary demand sector. Most of the decrease in water use can be attributed to urbanization of agricultural lands rather than increases in assigned irrigation efficiencies. Other factors affecting agricultural water use included economic and climate conditions (Needham R. A., 2005; Needham & Wilson, 2005). Additionally, cropping patterns have also changed significantly over the past decade.

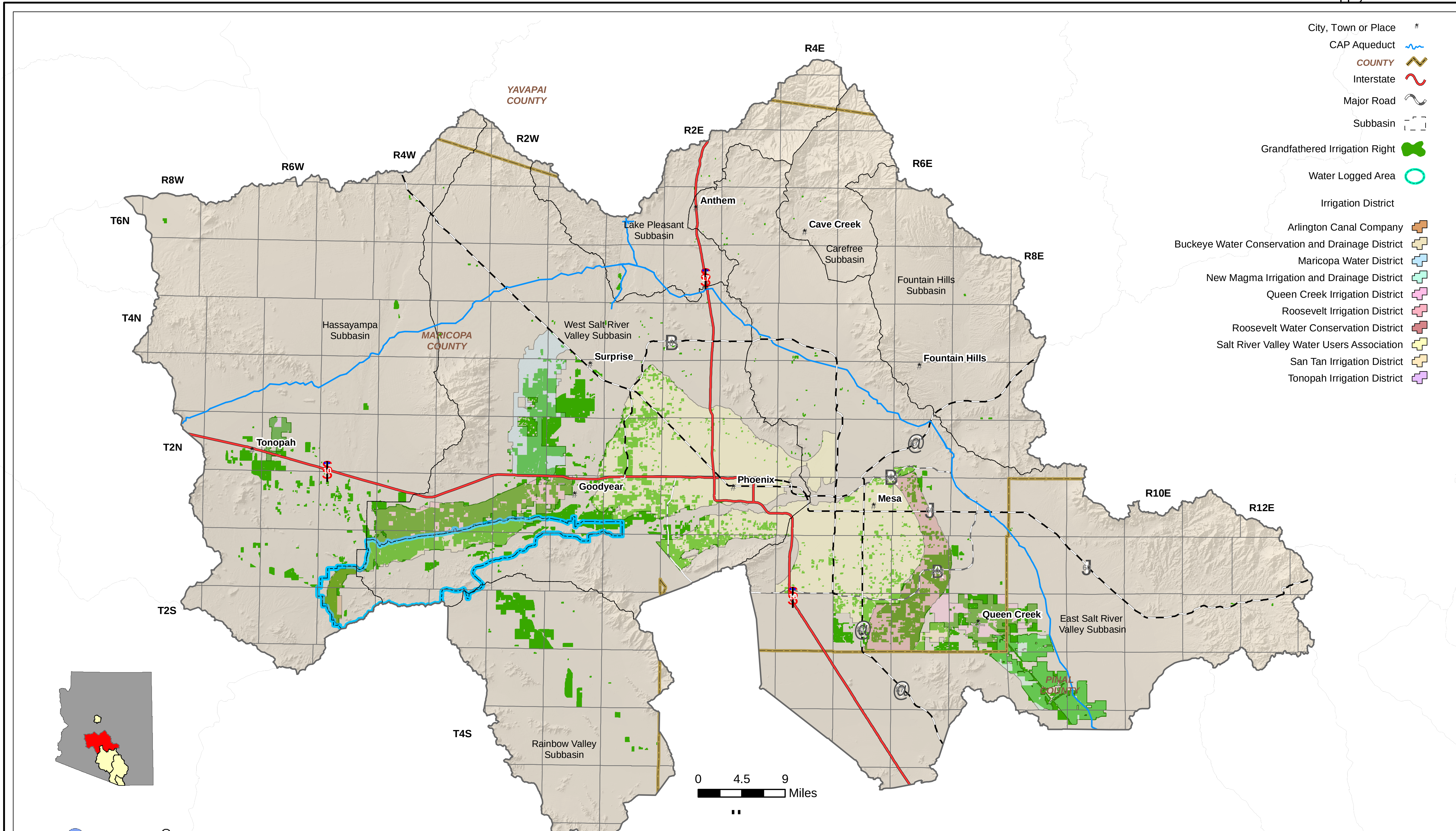


Figure 5-7
Phoenix AMA
Location of IGFRs and Irrigation Districts

Table 5-6 Agricultural Total Demand, Certified Irrigation Acres and Allotments By Irrigation Grandfathered Rights 1985, 1995, and 2006 Phoenix Active Management Area

Year	Total Demand	Certified Irrigation Acres	Allotments
1985	1,201,469	353,851	1,881,962
1995	1,082,342	303,129	1,477,132
2006	682,863	193,950	861,645

Note: Volumes are in acre-feet.

Several exemptions apply to the water duty and conservation requirements of the Management Plans in the Phoenix AMA. Beginning in 1988, A.R.S. § 45-411.01 (A) exempted irrigation districts and IGFR holders in the Buckeye Waterlogged Area from conservation requirements, allotments, and payment of withdrawal fees. This area consists of lands served by the Arlington Canal Company, Buckeye Water Conservation and Drainage District, and the St. John's Irrigation District, as well as several private IGFR holders. This exemption lasts until December 31, 2019, the end of the fourth management period. The Director of ADWR is required by A.R.S. §45-411.01 (F) to review the hydrologic conditions of the Buckeye Waterlogged Area in consultation with representatives of the Arlington Canal Company, Buckeye Water Conservation and Drainage District, and St. John's Irrigation District and submit a recommendation to the governor and legislature no later than December 15, 2015 regarding the extension of the exemption from the water duty and groundwater allotment (ADWR, 1999).

Extinguishment of IGFRs pursuant to the AWS Rules between 1985 and 2006 accounts for 19,064 acres that can no longer be used for agricultural production. Extinguishment of these rights generated 617,899 acre-feet of extinguishment credits, of which 257,455 have been pledged and 360,444 have not been pledged to help meet the consistency with management goal criteria of proving a 100-year AWS.

5.3.3 Non-Exempt IGFR Water Use Characteristics

Demand

Cropping patterns have changed significantly over the past decade. From 1985 until 1995, the crop mix remained relatively unchanged from the historical mix. The primary crops grown in the AMA were, in order of acres planted: cotton; alfalfa; wheat; barley; corn; and citrus (United States Department of Agriculture, 2009; ADWR, 1999). From 1995 through 2006, there was a sharp decrease in cotton and wheat acreage and a steady increase in alfalfa, corn, and sorghum acreage. Based on ADWR crop surveys and United States Department of Agriculture data, in 2006 the crop mix was approximately 50 percent alfalfa, 21 percent cotton, 10 percent corn and sorghum, 10 percent wheat and barley, and 2 percent citrus. Other crops historically and currently grown in the AMA include potatoes, vegetables, pasture, roses, and melons. The acreage of land planted in upland cotton has gradually decreased. Pima cotton production crashed in the early to mid-1990s because of pest problems. With the rise of the dairy industry, alfalfa and other hay production has greatly increased; corn and grain sorghum have also become important feed crops in the area. The number of dairy cattle in Maricopa County averaged 81,500 head between 1985 and 1995; the average rose to 113,600 head between 1996 and 2006.

Urbanization has not only changed overall agricultural demand; it has also changed spatial demand characteristics. In general, the decrease in agricultural water use has been most rapid in the central region of the Phoenix AMA and has followed the path of development. Meanwhile, agricultural water use has increased in the western and southeastern regions to offset reductions in production elsewhere (Hetrick & Roberts, 2004). These increases may also be related to factors such as exemptions in the Buckeye Waterlogged Area in the west, and the availability of CAP water through GSF projects in the southeastern portion of the Phoenix AMA.

Irrigation district canal losses, while not attributed directly to farming operations, can represent a significant portion of demand. In general, canal losses in the Phoenix AMA have fluctuated between 3 percent and 6 percent of total annual agricultural demand. As canals have been lined or use has been discontinued, efficiencies have increased. Between 1985 and 1995, canal losses averaged nearly 5 percent; between 1996 and 2006, canal losses averaged only 4 percent.

Supplies

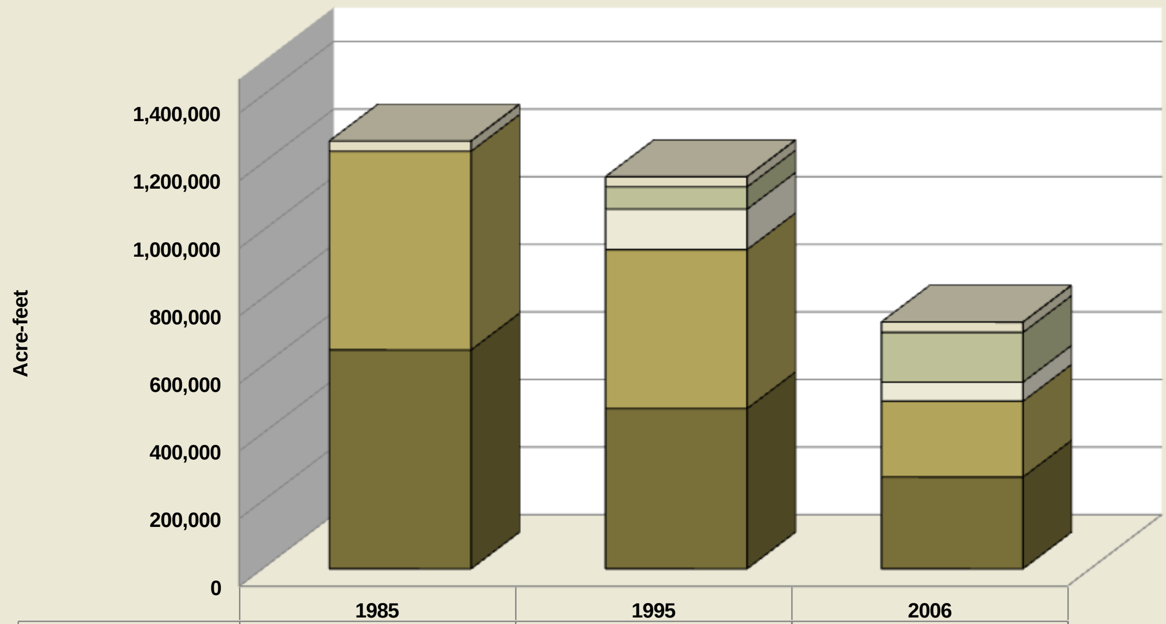
Historically, both surface water and groundwater supplies have been used in the Phoenix AMA. Water from the CAP first became available in 1986; prior to this, surface water from the Salt and Verde Rivers was the largest source of renewable supplies to the region (ADWR, 1999). SRP's series of reservoirs and large distribution system make water from the Salt and Verde Rivers available to all water demand sectors. Use of reclaimed water is not a new concept in the Phoenix AMA; however, widespread use has typically been limited by the location of wastewater treatment facilities, and public health concerns (ADWR, 1999).

Overall groundwater (or in-lieu groundwater) use by agriculture has decreased since 1985 but still is significant, while surface water use has decreased substantially. Much of this change in use can be attributed to the location - primarily in the central, heavily urbanized portion of the AMA - of irrigation districts with surface water supplies. A combination of lower costs because of incentive pricing of CAP agricultural pool water (see Section 5.5.2 from more information) combined with increased pumping costs of groundwater in some districts has led to increased use of CAP water (*See Figure 5-8*).

5.3.4 Exempt IGFR Water Use Characteristics

In 1994, IGFRs less than 10 acres in size and not part of an integrated farming operation were exempted from conservation requirements and reporting obligations; therefore, their demand since 1993 is not accurately known. In the Phoenix AMA irrigation districts that deliver to such rights continue to report water deliveries. These reports indicate that demand by these rights has been stable with an average demand of just under 18,000 acre-feet per year.

Figure 5-8 Historical Agricultural Supplies, 1985, 1995, and 2006
Phoenix Active Management Area



	1985	1995	2006
TOTAL ACRE-FEET	1,265,633	1,159,919	730,025
Reclaimed Water	30,138	30,000	30,550
In-Lieu Groundwater	0	65,690	147,149
CAP	0	119,829	56,305
Surface Water	587,776	470,366	224,523
Groundwater	647,719	474,033	271,498

5.4 Indian Demands and Supplies

5.4.1 Overview and Non-Regulatory Status

The Salt River Pima-Maricopa Indian Community (SRPMIC), the Fort McDowell Yavapai Nation (FMYN), and the northern portion of the Gila River Indian Community (GRIC), which also extends into the Pinal AMA, are located within the boundaries of the Phoenix AMA. Their water use is exempt from regulation by the state. However, the demand characteristics of these communities are included here because they have a hydrologic impact on the safe-yield goal.

5.4.2 Water Rights Settlement

The congressionally authorized settlements for the Indian communities in the Phoenix AMA are described below. For more information regarding these and other settlements, refer to the Arizona Water Atlas, Volume 1, Executive Summary.

Salt River-Pima Maricopa Indian Community

In the Salt River-Pima Maricopa Indian Community (SRPMIC) Water Rights Settlement Act of 1988, Congress approved an agreement which gave the SRPMIC an annual entitlement to 122,400 AF of water plus storage rights behind Bartlett and modified Roosevelt Dams. Sources of water for the SRPMIC under the settlement include the Salt and Verde rivers, groundwater and CAP water. This Community is permitted to pump groundwater, but must achieve safe-yield when the East Salt River sub-basin in the Phoenix Active Management Area does so. SRPMIC has leased its 13,000 AF CAP allocation to the Phoenix valley cities from 2000 to 2099. The Arizona State Legislature appropriated $3 million, which was added to $47 million from the United States for the SRPMIC's trust fund(ADWR, 2010).

Fort McDowell Yavapai Nation

In 1990, Congress ratified an agreement between the Fort McDowell Yavapai Nation (FMYN) and neighboring non-Indian communities, including SRP, Roosevelt Water Conservation District, Chandler, Mesa, Phoenix, Scottsdale, Tempe, Gilbert, CAWCD, the United States and the State of Arizona. FMYN is provided an annual entitlement to 35,950 AF of water from the Verde River and CAP under this agreement,. The 18,233 AF of CAP in the water budget may be leased for 100 years or less off reservation within Pima, Pinal, and Maricopa counties. This settlement also provides for a minimum stream flow on the Lower Verde River of 100 cfs. In accordance with the 1990 Act, a fund for the development of agricultural and other beneficial uses of water on the reservation was created with $23 million from the United States and with a $2 million appropriation by the Arizona State Legislature (ADWR, 2010).

Gila River Indian Community

In December 2004 the President signed into law the Arizona Water Settlements Act. Title II of the Act provided approval of the Gila River Indian Water Settlement Agreement. The settlement awarded the GRIC an annual entitlement to 653,500 AF of water from various sources including CAP allocations, reclaimed (through CAP exchange), groundwater, and surface water from the Gila, Verde and Salt rivers. It also established a funding mechanism for on-reservation development of this Community's farming operations and gave leasing authority to the GRIC for its CAP water as long as the water is leased within Arizona (ADWR, 2010).

5.4.3 Indian Demand, Supply and Factors Affecting Use

Indian Agriculture

All three of the Indian reservations in the Phoenix AMA have agricultural water use. Demand in this subsector has remained relatively constant between 1985 and 2006 (*See Table 5-7*). Surface water has historically been the primary supply used to meet Indian Agricultural demand, however, the use of CAP water has increased in recent years (*See Figure* 5-9).

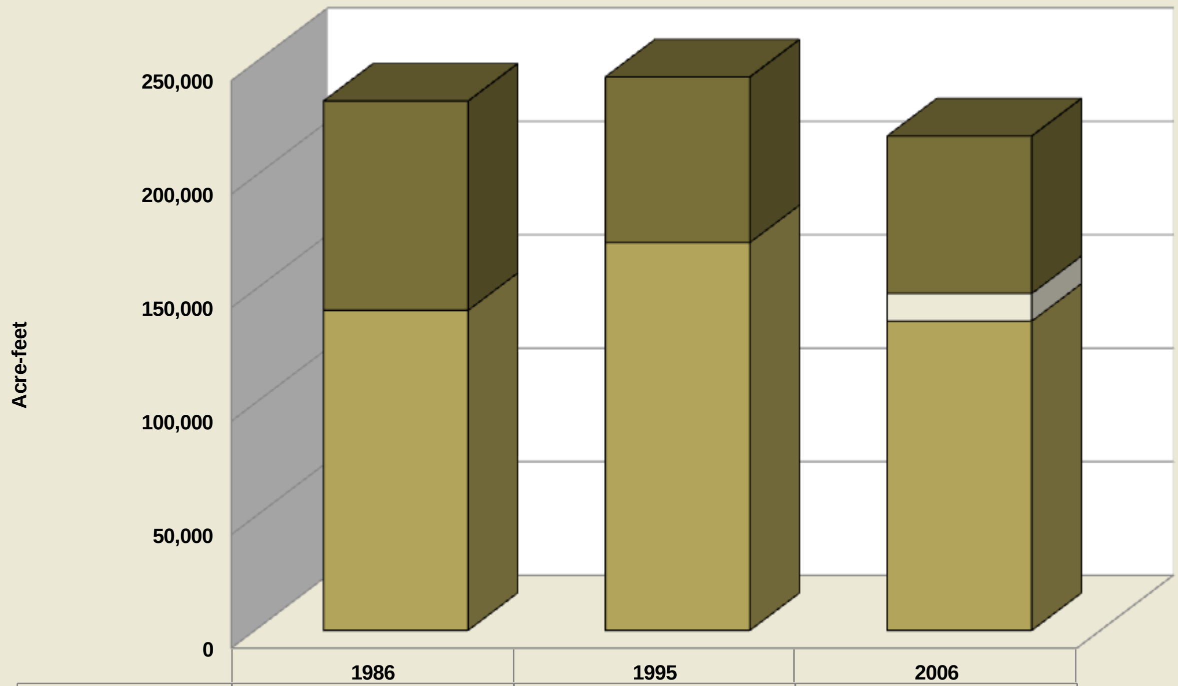
Table 5-7 Indian Agricultural Demand and Groundwater Use
Phoenix Active Management Area

Year	Total Water Use	Groundwater Use
1985	233,163	92,424
1995	243,810	73,161
2006	217,779	69,606

Note: Volumes are in acre-feet.

The 373,000 acre GRIC extends into both the Phoenix and Pinal AMAs along the Gila River. The GRIC currently irrigates approximately 15,000 acres *(See Figure 5-10)* . Independent farming operations irrigate an additional 22,000 acres of GRIC land. The primary crops grown on the reservation are cotton, wheat, millet, alfalfa, barley, melons, pistachios, olives, citrus, and vegetables (ITCA, 2003). An average of 134,000 acre-feet of water per year was used in the Phoenix AMA portion of the reservation between 1985 and 2006. Water demand has remained nearly constant since 1985, but is expected to increase because of several projects underway that resulted from the recently signed water rights settlement. The GRIC have rights to an estimated 653,500 acre-feet of water per year (ADWR, 2006) in 13 categories including CAP water, surface water, reclaimed water, and groundwater (ADWR, 2010).

Figure 5-9 Indian Historical Agricultural Supplies
Phoenix Active Management Area



	1986	1995	2006
TOTAL ACRE-FEET	233,163	243,810	217,779
Indian Groundwater	92,194	72,931	69,373
Indian CAP	0	0	12,149
Indian SW	140,969	170,879	136,257

The 373,000-acre GRIC extends into both the Phoenix and Pinal AMAs along the Gila River. The GRIC currently irrigates approximately 15,000 acres *(See Figure 5-10)*. Independent farming operations irrigate an additional 22,000 acres of GRIC land. The primary crops grown on the reservation are cotton, wheat, millet, alfalfa, barley, melons, pistachios, olives, citrus, and vegetables (ITCA, 2003). An average of 134,000 acre-feet of water per year was used in the Phoenix AMA portion of the reservation between 1985 and 2006. Water demand has remained nearly constant since 1985, but is expected to increase because of several projects underway that resulted from the recently signed water rights settlement. The GRIC have rights to an estimated 653,500 acre-feet of water per year (ADWR, 2006) in 13 categories including CAP water, surface water, reclaimed water, and groundwater (ADWR, 2010).

The SRPMIC currently irrigates approximately 12,000 acres. The primary crops grown on the reservation are cotton, melons, potatoes, onions, broccoli, and carrots (Salt River Pima-Maricopa Indian Community , 2009). An estimated 85,000 acre-feet per year was used between 1996 and 2006. Although water demand did not fluctuate significantly, some shifts occurred because of crop prices and surface water availability. SRPMIC's agricultural water demand has been met by a combination of groundwater and surface water delivered by SRP.

The FMYN currently irrigates approximately 1,945 acres. The primary crops grown on the reservation consist of 620 acres of alfalfa, 1,000 acres of pecans, and 325 acres of citrus (Hotel Internet Marketing by eMax, 2009). An average of 10,200 acre-feet of water per year was used between 1996 and 2006. Water demand has fluctuated only slightly because of the large number of orchards. The FMYN's agricultural water demand has historically been met primarily by surface water delivered by SRP; however, groundwater use has increased in recent years.

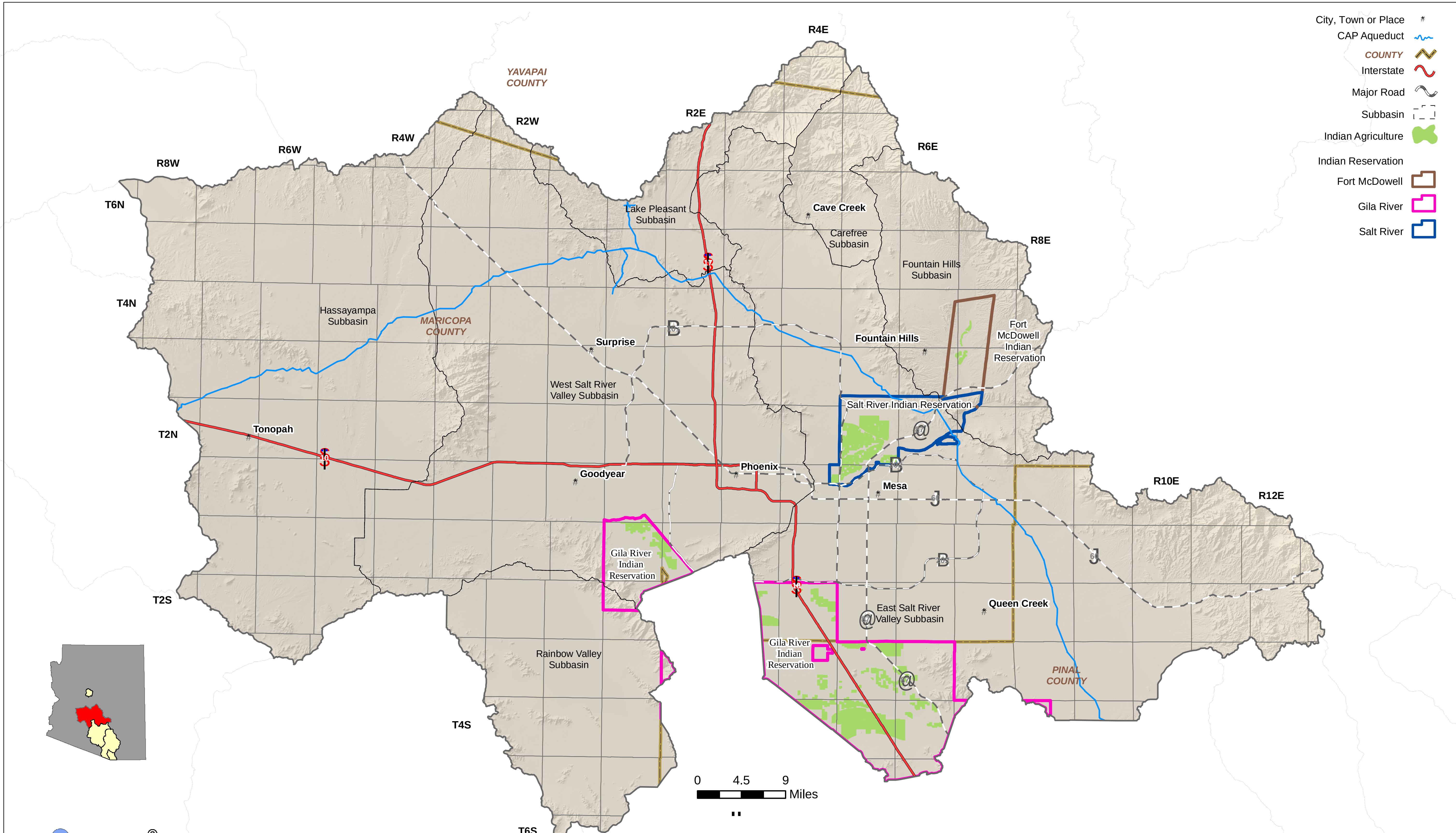


Figure 5-10
Phoenix AMA
Indian Agricultural and Municipal Areas of Use

Indian Municipal

The population on reservation land in the Phoenix AMA has increased slightly. ADWR used an estimate of 12,000 Indians on reservations in the Phoenix AMA in the 3MP. In 2000, the US Census accounted for 15,000 Indians on reservations within the Phoenix AMA. The 3MP assumed a total municipal demand of 6,064 acre-feet for Indians on reservations (*See Table 5-8)*. More recent population estimates using the 2000 Census population and gpcd rates from the 3MP suggest a total municipal demand of 8,087 acre-feet. The supply for Indian municipal demand is assumed primarily groundwater.

Table 5-8 Indian Municipal Demand and Groundwater Use
1985, 1995 and 2006
Phoenix Active Management Area

Year	Total Water Use	Groundwater Use
1985	6,064	6,064
1995	8,087	8,087
2006	8,087	8,087

Note: Volumes are in acre-feet.

5.5 Artificial Recharge

Artificial recharge consists of artificial means of adding water to the aquifer, but it also results in the increased use of renewable water supplies, such as reclaimed water, CAP and surface water, over non-renewable groundwater by allowing for flexible and effective storage and recovery of renewable water supplies. For more information regarding the role of artificial recharge and the types of facilities used, refer to Section 3.3.

5.5.1 Underground Storage Facilities

Artificial recharge in the Phoenix AMA is primarily accomplished at USFs (*See Table 5-9)*. In 1990, the legislature authorized CAWCD to construct State Demonstration Recharge Projects with property tax revenues collected in Pima and Maricopa Counties. Three of these projects were constructed in the Phoenix AMA, began recharging between 2001 and 2006, and have been heavily utilized by CAWCD, the AWBA and municipal and industrial entities. The amount of water stored through 2006, by facility type is shown in *Table 5-9*.

Managed Facilities

There are currently three permitted Managed USFs in the Phoenix AMA. The Hassayampa Recharge Facility, located in the Hassayampa River channel, is operated by Hassayampa Ventures, LLC, a private entity. CAWCD operates the Agua Fria Managed USF in conjunction with the Agua Fria Constructed USF in the Agua Fria river channel. Both of these facilities recharge CAP water. The City of El Mirage operates a relatively small Managed USF on the Agua Fria River to store reclaimed water from their water reclamation facility. Storage at the El Mirage facility is subject to a 50 percent cut to the aquifer, while the facilities recharging CAP water are subject to a five percent cut.

Constructed Facilities

The Phoenix AMA currently has 41 Constructed USFs. The five largest facilities, permitted to either CAWCD or SRP, utilize basin recharge. The three CAWCD facilities currently recharge only CAP water. The two SRP facilities are permitted to store CAP water, reclaimed water, and Salt and Verde River water. The other USFs in the Phoenix AMA are smaller and recharge less than 10,000 acre-feet per year. Recharge methods used at constructed USFs in the Phoenix AMA include infiltration basins, trenches, and vadose zone and direct injection wells. Of these

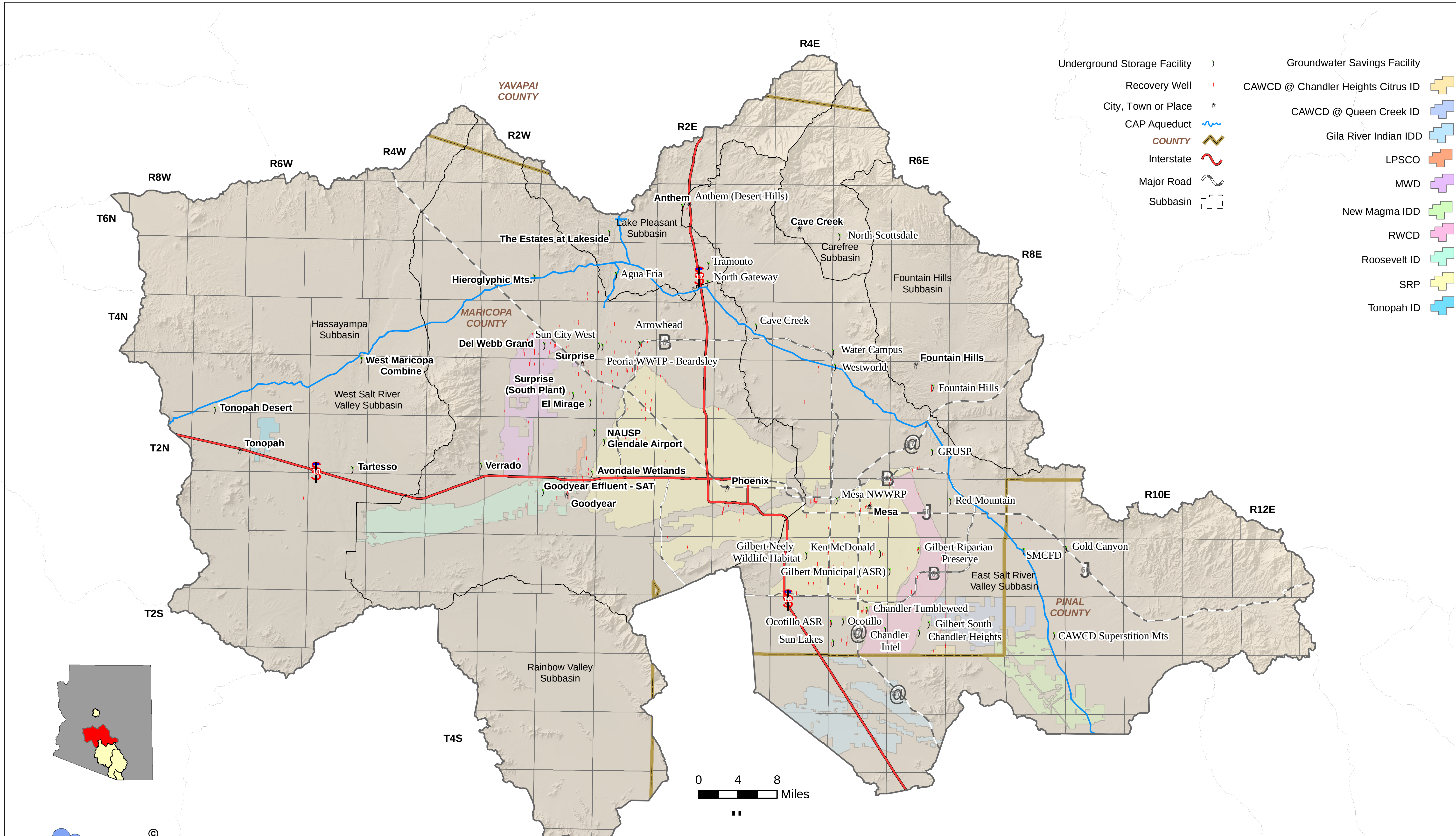


Figure 5-11
Phoenix AMA
Artificial Recharge Facilities

facilities, 25 recharge only reclaimed water, nine recharge only CAP water, two recharge CAP water and

Table 5-9 Artificial Recharge Volumes
1985, 1995 and 2006
Phoenix Active Management Area

Recharge Facilities	1995	2000	2006
Groundwater Savings Facility			
Number of Facilities	8	12	11
CAP Stored	56,573	211,389	93,804
Reclaimed Water Stored	464	110	30,000
Underground Storage Facilities (Constructed)			
Number of Facilities	8	29	41
CAP Stored	63,026	95,315	199,723
Reclaimed Water Stored	8,420	31,325	25,569
Surface Water Stored	7,307	13,200	20,713
Underground Storage Facilities (Managed)			
Number of Facilities	0	2	3
CAP Stored			16,054
Reclaimed Water Stored			1,595
Total Stored	**135,790**	**351,338**	**410,442**

Note: Volumes are in acre-feet.

5.5.2 Groundwater Savings Facilities

The Phoenix AMA has eleven permitted GSFs (*See Figure 5-11*). Of the GSFs in the Phoenix AMA, six are permitted to store only CAP water, two store only reclaimed water, one stores CAP and surface water, and one CAP and surface water in addition to reclaimed water. Their permitted annual volumes range from 840 to 105,000 acre-feet per year. These permits require GSFs to use their non-Indian agriculture (NIA) pool of excess CAP water (CAP NIA settlement pool), before credits may be accrued using GSF CAP water. The CAP NIA settlement pool is a volume of CAP water that the CAWCD Board of Director's identified for use on NIA lands. The policy was adopted in May of 2000. This policy established an NIA pool of 400,000 acre-feet from 2004 through 2016. The pool will decline to 300,000 acre-feet in 2017 and to 225,000 acre-feet beginning in 2024 through 2030. The permits also contain limitations on total water use from all sources (including all CAP sources, surface water, and groundwater) and require proof that there is a direct reduction in groundwater pumping.

The storing entities at GSFs in the Phoenix AMA include municipal providers storing their Municipal and Industrial (M&I) subcontract CAP water, excess CAP water or reclaimed water, industrial storers, private entities, the CAWCD, and the Arizona Water Banking Authority (AWBA).

The Gila River Indian Irrigation and Drainage District (GRIID) has been permitted as a GSF from 2007 to 2010. The AWBA entered into an agreement with GRIID to store CAP water in advance of the GRIC taking additional direct deliveries expected in 2010.

5.5.3 Credits Accrued Through 2006

Long-Term Storage Credits

There are 78 long-term storage (LTS) accounts including the AWBA and two CAGRD replenishment accounts in the Phoenix AMA. Many municipal providers with DAWS store M&I subcontract or excess CAP water and recover that water annually or from long-term storage accounts to meet their AWS consistency with management goal requirements. For many of these providers, recovery occurs outside the area of impact of storage at both USF and GSF facilities, creating potential localized water supply issues related to the continuing decline in water levels where the credits are withdrawn. While most water is stored for municipalities, there are a few other entities that store and recover relatively smaller volumes of either CAP or reclaimed water credits for landscape and golf course irrigation. Recharge credit types and amounts through 2006 are shown in *Table 5-10*.

Table 5-10 Artificial Recharge Credit Types and Amounts Through 2006 Phoenix Active Management Area

Credit Type	Amount (acre-feet)
Long Term Storage Credits	
Underground Storage Facilities	
CAP	1,214,642
Reclaimed	300,040
Surface Water (Plan 6)	6,922
Total	1,521,604
Groundwater Savings Facilities	
CAP	2,062,993
Reclaimed	153,391
TOTAL	**3,737,988**
Arizona Water Bank	
Intrastate	1,213,547
Interstate - Nevada	23,820
Total	1,237,367
Central Arizona Groundwater Replenishment District	
CAWCD	339,881
CAGRD	1,146
Conservation District Account	50,900
Replenishment Reserve Account	16,953
Total	408,880
Recovery	496,802
Credits Remaining in Storage	**3,241,186**

Note: Volumes are in acre-feet. Stored water is water delivered to be stored minus losses and the cut to the aquifer. "Credits Remaining in Storage" is the difference between Total USF/GSF Storage and Total AMA Recovery.

Other long-term storage account holders in the Phoenix AMA include Aqua Capital, a Nebraska based investment firm, and the Tohono O'Odham Nation, which stores CAP water for investment and possible sale of the credits to water users in the AMA. Resolution Copper Mining LLC is also accruing CAP credits in anticipation of future recovery for a mining project near Superior, AZ.

AWBA Credits

The AWBA has been storing CAP water at USFs and GSFs in the Phoenix AMA since 1997. Using a variety of funding sources, the AWBA has utilized these facilities to meet goals and obligations for the Phoenix AMA CAP M&I subcontractors as well as firming Colorado River on-river M&I supplies, and, through interstate agreements such as storage for the Southern Nevada Water Authority (SNWA).

CAGRD Storage and Replenishment

CAWCD, on behalf of the CAGRD, began storing CAP water at GSFs in 1993 and at USFs in 1995 in the Phoenix AMA (*See* Section 3.4.4). CAWCD stored substantial volumes of water in early years, but their storage activity declined significantly when the AWBA was created and began storing in 1997.

The CAGRD began storing CAP water in the Phoenix AMA in 2004. It has steadily increased storage activity to meet the growing replenishment obligation of their members and to accrue credits in the CAGRD's replenishment reserve account. Long-term storage credits in the Conservation District or Replenishment Reserve accounts are for the purpose of replenishing the aquifer from groundwater mining and may not be recovered.

6. HISTORICAL DEMANDS AND OVERDRAFT

6.1 Summary Budget

The following discussion considers historical total demands for three years water use years (1985, 1995, and 2006) and groundwater overdraft in the Phoenix AMA from 1985 to 2006. The Historical Summary Budget for the three years is shown in *Table 6-1*. The basic budget components, and how they relate to the overdraft calculation, were discussed in further detail in Sections 3 and 4. Detailed water use figures for all years between 1985 and 2006 may be found at www.azwater.gov/AzDWR/WaterManagement/Assessments/default.htm.

Overdraft, depicted in *Table 6-1*, is the sum of the groundwater use (including in-lieu groundwater) for all four sectors, plus the riparian demand, minus the sum of the incidental recharge values for the four sectors, plus the additional offsets to overdraft (including net natural recharge, reclaimed water discharges, canal seepage, cuts to the aquifer, and CAGRD replenishment). Groundwater withdrawn pursuant to poor quality groundwater permits and pursuant to approved remedial actions is also subtracted from the overdraft value. For purposes of this Assessment, overdraft is depicted in two values: 1) including the groundwater allowance volume in overdraft, to identify the physical impact of these withdrawals on the aquifer and 2) excluding groundwater allowance volumes, in recognition that this volume of groundwater is considered to be consistent with the management goal under the AWS Rules.

6.1.1 Demand

In 1985, total demand for the water using sectors (Municipal, Industrial, Agriculture, and Indian) in the Phoenix AMA was 2,227,284 acre-feet. Agricultural uses accounted for approximately 57 percent of total demand in the Phoenix AMA; while Municipal uses accounted for approximately 28 percent. From 1985 to 2006, demand in the Agriculture sector varied, but generally decreased. By 2006, it had decreased to 33 percent of total sector demand (730,025 acre-feet);

this decrease was accompanied by a 45 percent decrease in the amount of legally irrigable acreage as farmland was retired for development. During this same period, Municipal demand increased to 50 percent of the total Phoenix AMA demand. This increase corresponded to a more than 100 percent increase in population, from approximately 1,856,000 people in 1985 to almost 3,796,000 people in 2006. Most of the Indian water demand, and therefore increase in that demand, has been for agricultural irrigation purposes. A small amount has been used for Municipal and Industrial purposes on reservations. Total Indian demands are only 10 percent of the total AMA demands. During this time, Industrial use has increased from 4 percent to slightly over 7 percent of the total demand.

Table 6-1 Historical Summary Budget and Overdraft
1985, 1995 and 2006
Phoenix Active Management Area

SECTOR	CATEGORY	1985	1995	2006
Municipal				
Demand		633,757	821,711	1,118,409
Supply	*Groundwater*	225,350	260,340	252,072
	Surface water	408,407	402,618	487,598
	CAP (direct use & credits recovered)	0	157,685	338,101
	Reclaimed water	0	1,068	40,639
Incidental Recharge		50,984	59,789	73,956
Industrial				
Demand		88,667	138,007	161,380
Supply	*Groundwater*	69,229	79,069	88,298
	Surface water	5,810	5,504	8,513
	CAP (direct use & credits recovered)	0	828	1,698
	Reclaimed water	13,628	52,606	62,872
	Incidental Recharge	6,942	8,054	8,949
Agricultural				
Demand		1,265,633	1,159,919	730,025
Supply	*Groundwater*	647,719	474,033	271,498
	In-Lieu Groundwater	0	65,690	147,149
	Surface water	587,776	470,366	224,523
	CAP (direct use, no In-Lieu Groundwater)	0	119,829	56,305
	Reclaimed water	30,138	30,000	30,550
Incidental Recharge[1]		705,200	508,400	425,700
Indian				
Demand		239,227	249,874	225,866
Supply	*Groundwater*	98,258	78,995	77,460
	Surface Water	140,969	170,879	136,257
	CAP		0	12,149
	Reclaimed water		0	0
Other				
Demand	*Riparian*	48,000	48,000	48,000
Supply	*Cuts to the aquifer*	0	5,946	15,917
	CAGRD Replenishment	0	0	17,472
	Net Natural Recharge	321,900	258,322	52,100
	Reclaimed water discharge		27,684	19,775
	Canal Seepage	120,199	116,930	129,975
Groundwater Use not	*GW Allowance*	0	0	128,214

SECTOR	CATEGORY	1985	1995	2006
counted towards overdraft	*Excess Groundwater*	0	0	29,226
	Poor Quality Groundwater	0	1,857	1,742
Overdraft	***Subtracting GW Allowance***	**-116,669**	**19,145**	**10,676**
	Without Subtracting GW allowance	**-116,669**	**19,145**	**138,890**

Note: All values are in acre-feet. [1]Agricultural incidental recharge includes Indian Agricultural Incidental Recharge.

6.1.2 Supply

In 1985, surface water was the primary supply used to meet demands in the Phoenix AMA. The use of CAP water has increased from zero in 1985 to over 408,253 acre-feet in 2006 – approximately 18 percent of total use. The use of reclaimed water has increased from almost 44,000 acre-feet in 1985 to over 134,000 acre-feet in 2006, approximately six percent of total use. Renewable supplies, including CAP, reclaimed water, and surface water, were 63 percent of total AMA supply in 2006; renewable supplies were 53 percent of total AMA water supply in 1985.

6.1.3 Offsets to Overdraft

The various offsets to overdraft for the historical period, as explained in more detail in Section 3.4, are listed in *Table 6-2* below.

Table 6-2 Offsets to Overdraft
1985, 1995, and 2006
Phoenix Active Management Area

Type of Offset	1985	1995	2006
Incidental Recharge			
Municipal	50,984	59,789	73,956
Industrial	6,942	8,054	8,949
Agricultural	705,200	508,400	425,700
Net Natural Recharge	321,900	286,006	71,875
CAGRD Replenishment	0	0	17,472
Canal Seepage	120,199	116,930	129,975
Cuts to the Aquifer	0	5,946	15,917
Total	**1,205,225**	**985,125**	**743,844**

Note: Agricultural includes Indian and Agricultural incidental recharge. Net natural recharge includes reclaimed discharge.

The Net Natural recharge value, which consists of mountain front recharge, streambed infiltration, groundwater inflow, and groundwater outflow and reclaimed water discharge, varies, sometimes greatly, from year to year. However, only the streambed infiltration and reclaimed water discharge values actually vary from year to year; the other sub-components are constant and total 4,700 acre-feet each year. The range of values used for reclaimed water discharge varies from zero in the early years to 33,193 acre-feet, but after 1995, it stays between about 19,000 and 33,000 acre-feet. It is really streambed infiltration that displays extreme variations, ranging from nothing in a few years to an estimated 832,700 acre-feet in 1993. The year 1993 was not typical as the rain in January of that year was unusually intense and prolonged, and caused the most widespread flooding in Arizona since the turn of the 20th century. The entire state received precipitation in excess of 300%, while the greatest rainfall occurred in the area north and east of Phoenix. Run-off from the snowpack was projected to be 342% of normal, since the National Weather Service reported in 1993 the snowpack was 154% of normal in the Salt-Verde River Watershed (Doeing, Williams, & Bradley, 1997). Other years with noticeably higher streambed infiltration values during the historic period were 1985, 1992, 1993, 1995 and 2005.

The streambed infiltration values, and therefore net natural recharge values, used in this Assessment are significantly different than what was used in the 3MP because for this Assessment, *annual* streambed infiltration was used rather than the *median* annual streambed infiltration. In the 3MP, net natural recharge was 24,100 acre-feet each year, whereas in this Assessment, it varies from a low of 26,700 acre-feet to a high of 859,000 acre-feet in 1993. The decision to use actual annual streambed infiltration values rather than the median values was done in recognition of refinements to, and calibrations of, groundwater flow models.

Artificial recharge cuts to the aquifer are shown in greater detail in *Table 6-3*. In the Phoenix AMA, no recharge projects were permitted and operational in 1985; therefore the years listed begin with 1995.

Table 6-3 Artificial Recharge Cuts to the Aquifer
1995, 2000 and 2006
Phoenix Active Management Area

Recharge Facilities	1995	2000	2006
Underground Storage Facilities (Managed)			
CAP	0	0	394
Reclaimed water	0	0	798
Underground Storage Facilities (Constructed)			
CAP	3,151	4,752	10,818
Reclaimed water	0	0	0
Salt/Verde			6
Groundwater Savings Facilities			
CAP	2,795	10,017	3,901
Reclaimed water	0	0	0
TOTAL	**5,946**	**14,769**	**15,917**

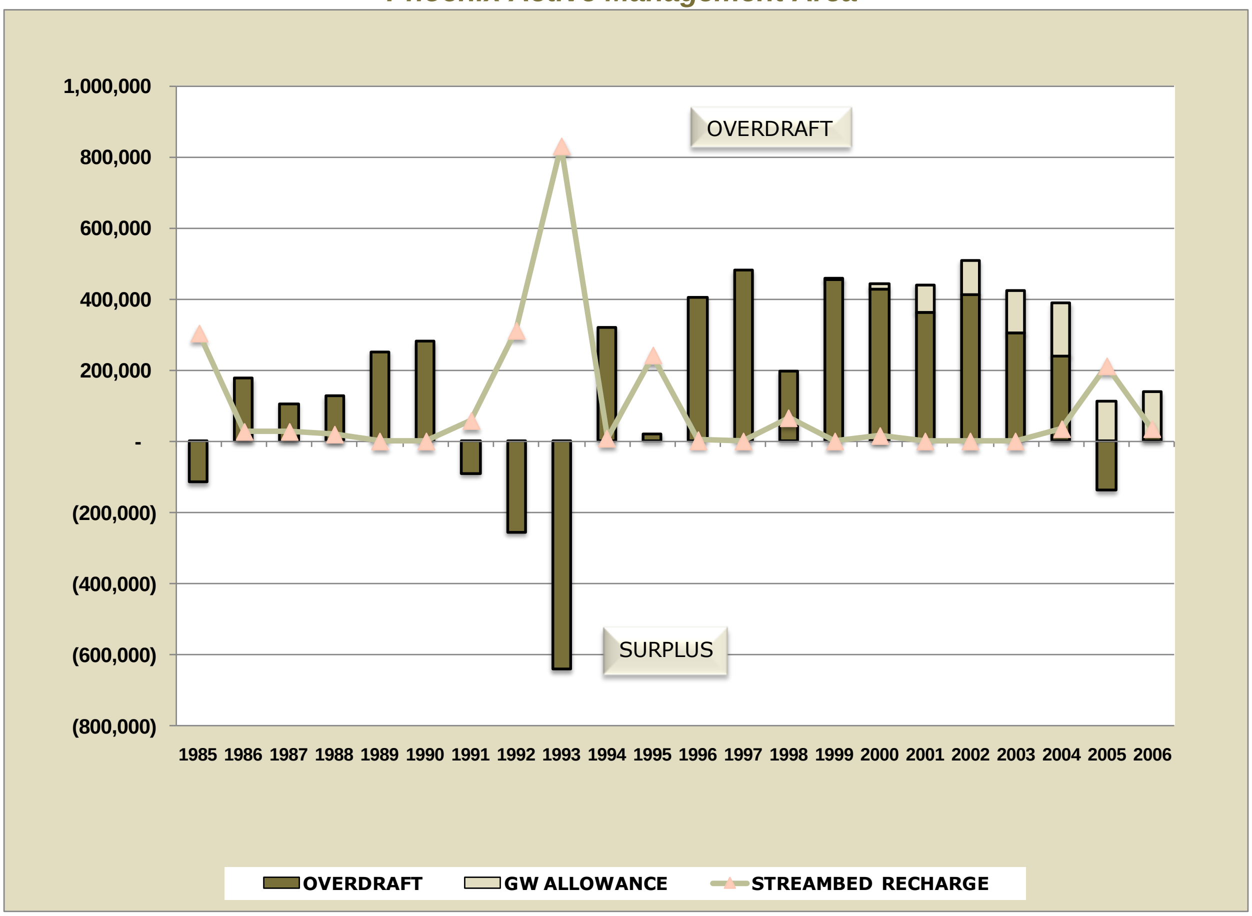
Note: Volumes are in acre-feet.

6.2 Historical Overdraft

Figure 6-1 displays historical overdraft, and streambed infiltration, in the years from 1985 to 2006. The overdraft for 2000 on is displayed with and without the groundwater allowance pumping included. Although groundwater allowance pumping is indeed groundwater that is not being replenished, it is allowable pumping under the AWS Rules. As described in Section 3.4.4, the groundwater allowance component to the AWS Rules illustrates a policy decision that was made to allow for growth, flexibility, and transition to the AWS Rule requirements. Most withdrawal authorities do not have a replenishment requirement. These authorities include IGFRs, Type 1 and Type 2 rights, groundwater withdrawal permits, exempt wells, and service area rights operated by undesignated municipal providers who serve customers not covered by a CAWS issued after 1995. Groundwater pumped pursuant to these types of withdrawal authorities applies directly to groundwater overdraft because no replenishment is required.

Based on the total overdraft estimates used in this Assessment, the Phoenix AMA is in a state of surplus, or very near surplus, in five (1985, 1991, 1992, 1993, and 1995) of the 21 years and in overdraft the for the rest of the historic period. This is in contrast to the 3MP budgets, which depicted the AMA to be in overdraft for from 1990 through 1995. There are two primary reasons for the difference in estimates of overdraft between the two publications: 1) the difference in values used for streambed infiltration, discussed in detail in Section 6.1.3; and 2) the difference in values used for Agricultural Incidental Recharge. In the 3MP, the Agricultural Incidental Recharge was based on the amount of water applied to cropped land in the specific year in question. In this Assessment, and as explained in Section 3.4.2, Agricultural Incidental Recharge is lagged by 20 years. "Lagged" means that water applied for agricultural purposes, which is not used by the crop or evaporated, is considered to reach the aquifer twenty years after it was applied. The high recharge amounts in 1990 through 1995 are a result of the water applied in the years 1960 through 1965, when more acres were in production, cotton was the predominant crop and laser-leveling was not yet in use. The major factors that affected historical overdraft as determined in this Assessment are discussed below.

Figure 6-1 Historical Estimated Overdraft and Streambed Infiltration 1985 to 2006 Phoenix Active Management Area



6.3 Major Factors that Affected Historical Overdraft

During the historical period examined in this Assessment, the following several factors, to varying degrees in different years, have affected overdraft in the Phoenix AMA: 1) The shift of water demand between the sectors; 2) the change in use of supplies; 3) pumpage by undesignated providers and the groundwater allowance; 4) streambed infiltration and canal seepage; and 5) artificial recharge.

Shift of Demand between Water Demand Sectors

In 1985, the dominant use sector in the Phoenix AMA was the Agricultural sector, which used 57 percent of the water, while the Municipal, Industrial and Indian sectors used 28 percent, 4 percent and 11 percent respectively (*See* Figure 6-2 *below*). By 2006, the population had more than doubled, and as a result, in part, of urbanization related to that growth, agricultural use had decreased by 42 percent and represented 33 percent of the total demand *(See Figure 6-3)*.

Figure 6-2 1985 Demand by Sector
Phoenix Active Management Area

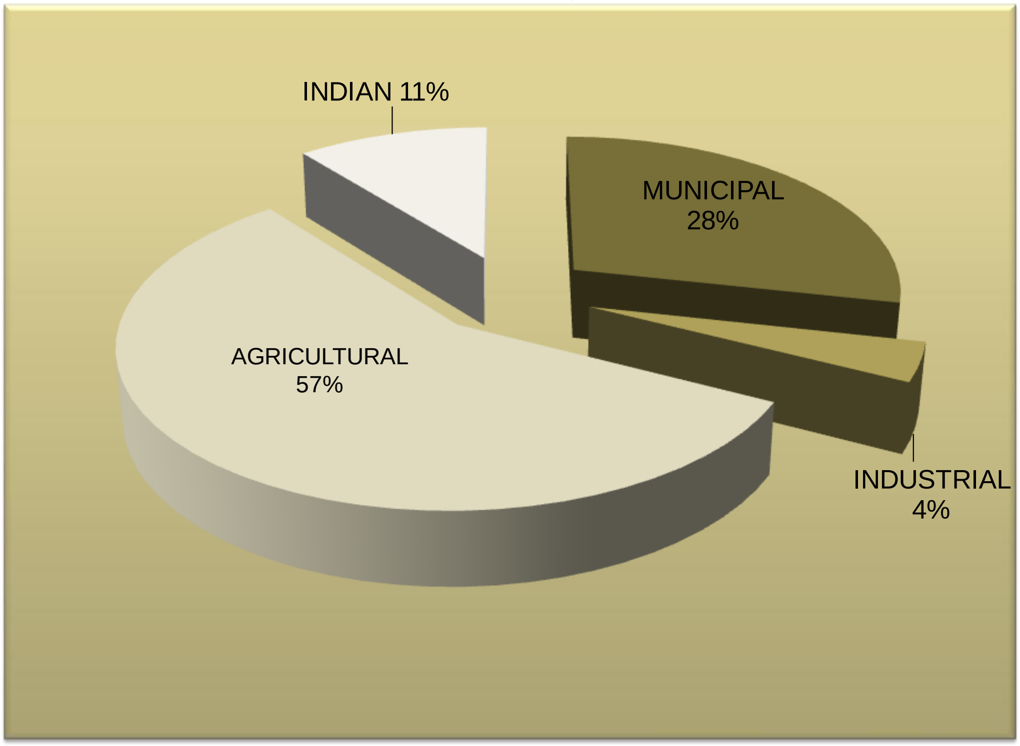
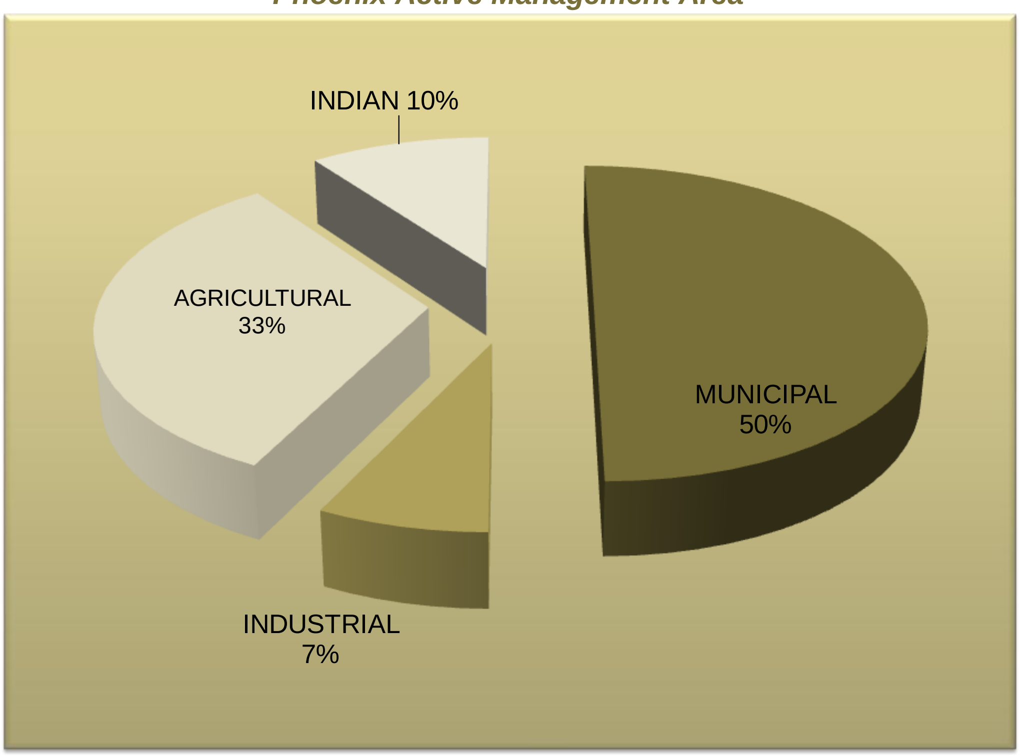


Figure 6-3 2006 Demand by Sector
Phoenix Active Management Area



One way that the switch from agricultural to municipal use affects overdraft is that generally, more incidental recharge results from agricultural use than occurs with municipal use, due to the nature of the uses. Agricultural incidental recharge was, according to model estimates, approximately 705,000 acre-feet in 1985. As explained in Section 3.4.2, agricultural incidental recharge is lagged by 20 years. By 2006, agricultural incidental recharge is estimated to have been lower, but still relatively high, at 508,400 acre-feet. This amount of incidental recharge can overcome, or at least mask, a great deal of groundwater pumping. However, as each year passes, the AMA will experience less of a benefit from the agricultural incidental recharge as we move further away in time from the high agricultural use years, and as more irrigation acres are urbanized. In the future, agricultural incidental recharge will not have the positive impact on the aquifers of the AMA that it had in the past, which means overdraft will increase.

Another example of how the change from agricultural use to municipal use can affect overdraft is the ability to extinguish lands with irrigation grandfathered rights. IGFRs, Type 1 rights and Type 2 rights can be extinguished for credits pursuant to the AWS rules. These credits can be used to help meet the consistency with management goal criterion in proving a 100 year AWS. As of 2006, 321 grandfathered rights, including 26,197 acres of IGFRs (and to a much lesser extent, Type 1 rights) had been extinguished for AWS extinguishment credits in the Phoenix AMA. A total of 846,000 acre-feet of extinguishment credits had been issued as of that date; of those credits, 308,000 acre-feet of credits had been pledged toward CAWS or DAWS. A total of 538,000 acre-feet of credits remain unpledged. For purposes of this Assessment, extinguishment credits pledged to DAWS and CAWS are included in the groundwater allowance component of the Summary Budget.

Another instance of how the shift or change in use by sectors affects overdraft is the increase in Industrial demand. As municipal use grew, so did the Industrial sector's use, since in many subsectors there is a direct relationship between population and industrial use. Industrial use grew from 4 percent of the total use, or about 89,000 acre-feet (including reclaimed water use at Palo Verde Nuclear Generating Station) in 1985 to 161,000 acre feet, or 7 percent of the total. If the approximately 63,000 acre-feet of reclaimed water used by the Industrial sector (primarily by the Palo Verde Nuclear Generating Station) is subtracted from its demand, the industrial sector uses the highest percentage (77 percent) of groundwater of any water use sector in the Phoenix AMA. This equates to nearly 88,000 acre-feet of groundwater in 2006. There is no replenishment obligation for Industrial groundwater users.

The Change in Use of Supplies

In 1985, the CAP canal extension was not yet providing water to the Phoenix AMA, although CAP use began the very next year in 1986. Even so, the volume of other surface water used within the Phoenix AMA had always been very high in comparison with the other AMAs. Reclaimed water use, however, in 1985 was relatively low, largely because of the lack of infrastructure, but was in use by the agricultural sector. The primary supplies used in 1985 in the Phoenix AMA were surface water (1,142,961 acre-feet, or 51 percent of the total) and groundwater (1,040,557 acre-feet or 47 percent).

Since 1985, the use of renewable sources has grown considerably. CAP made up 18 percent of water use in 2006, and the use of reclaimed water increased significantly as well, in large part due to the use of that source by Palo Verde Nuclear Generating Station. In-lieu groundwater was not in existence in 1985, but accounted for 7 percent of the total use in the Phoenix AMA by 2006. In-lieu groundwater (described in Section 3.2) is water that is physically CAP or reclaimed water that would have otherwise not been put to a beneficial use. Groundwater use in 1985 was 47 percent of the total, but in 2006, it was only 31 percent of the total; over a million acre-feet of groundwater was used in 1985, but in 2006, less than 700,000 acre-feet was used.

Figure 6-4 1985 Water Supply Used to Meet Demands

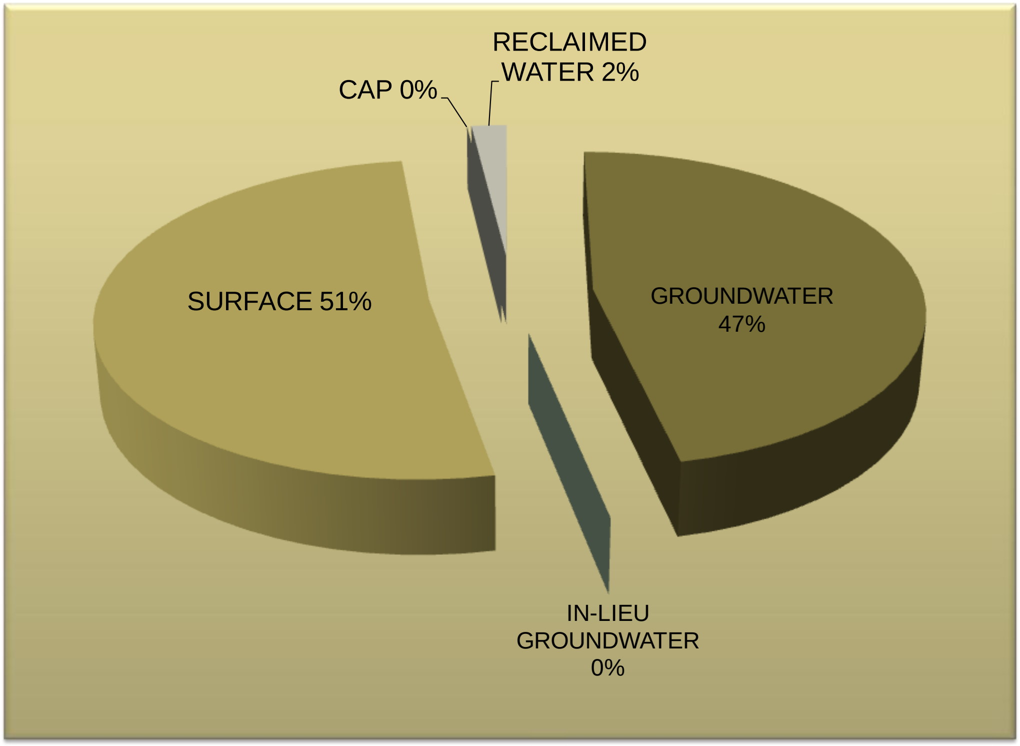
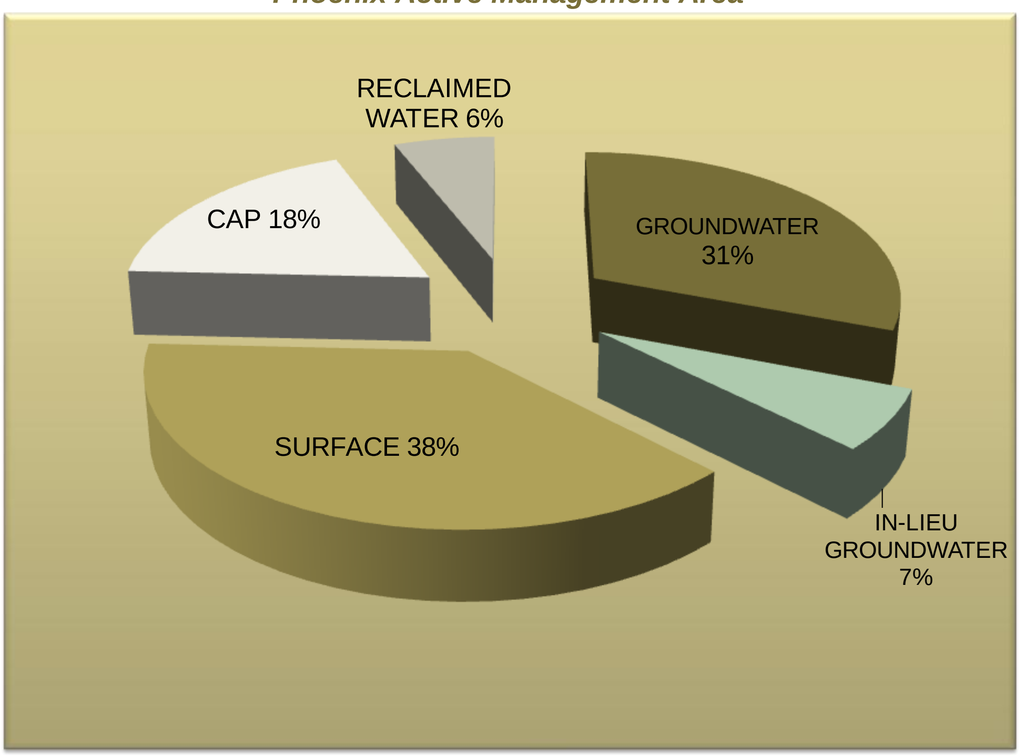


Figure 6-5 2006 Water Supply Used to Meet Demands
Phoenix Active Management Area



Unreplenished Groundwater and Allowable Groundwater

Even though the majority of the municipal sector uses renewable supplies for over half of their demands and most of the groundwater that is used is subject to replenishment, there is still a small amount of groundwater that is not required to be replenished. In 2006, this un-replenished groundwater was approximately 94,632 acre-feet in 2006 and is associated with subdivisions platted before 1995 and commercial uses in undesignated provider service areas.

The amount of groundwater a municipal provider can serve is based on conservation requirements set forth in the management plans, but that volume can generally increase as population increases. Although the Code contained provisions for the AWS program, the AWS Rules were not adopted until 1995. The AWS Rules include the requirement that most groundwater pumping be made consistent with the water management goal of the AMA for DAWS and CAWS. However, the AWS Rules also allocate a small volume of groundwater that is allowable.

Allowable groundwater use, groundwater reported pursuant to the provider's or subdivision's groundwater allowance, is considered consistent with the management goal of the AMA. This allowable groundwater use is not replenished and therefore contributes physically to groundwater overdraft. CAWS are allocated a specific volume of allowable groundwater based on the date the CAWS is issued. DAWS providers who served water to customers prior to the adoption of the AWS rules in 1995 were assigned a volume of allowable groundwater to allow them to transition to renewable supplies over time. DAWS providers who did not serve customers prior to the date of adoption of the AWS rules receive zero groundwater allowance. Allowable groundwater used in the Phoenix AMA pursuant to a DAWS or CAWS totaled 128,214 acre-feet in 2006. The cumulative groundwater allowance volume for the DAWS totaled 4,214,707 acre-feet. (*See Table 6-4*).

Table 6-4 Groundwater Allowance for DAWS Providers through 2006 Phoenix Active Management Area

Provider Name	Groundwater Allowance Balance 2006 (acre-feet)
City of Avondale	42,990
City of Chandler	229,737
Chaparral City WC	36,512
City of El Mirage	9,483
Town of Gilbert	129,658
City of Glendale	302,304
City of Goodyear	73,419
Johnson Utilities	10,780
City of Mesa	543,149
City of Peoria	114,977
City of Phoenix	1,941,503
City of Scottsdale	368,107
City of Surprise	44,748
City of Tempe	366,680
WUCFD	659
Total	**4,214,707**

Note: Volumes are in acre-feet.

Streambed Infiltration and Canal Seepage

Although over one million acre-feet of groundwater was used in 1985, the AMA was, based on this assessment, in surplus in 1985 by about 116,000 acre-feet. This surplus was primarily due to the role of three types of offsets: lagged agricultural incidental recharge, streambed infiltration, and to a lesser extent, canal seepage. The median annual streambed infiltration, or infiltration (explained in more detail in Section 3.4.1) is about 23,000 acre-feet per year but can vary greatly from almost nothing in some years to, based on modeling data, to almost 833,000 acre-feet in 1993. The effect of streambed infiltration, or the lack thereof, on overdraft can be seen in Figure 6-1. In 1992 and especially 1993, streambed infiltration was much higher than normal and actually helped put the AMA in surplus. However, in 1994, streambed infiltration is estimated to have been only 7,500 acre-feet; the AMA was in overdraft that year. While streambed infiltration can be a great help in offsetting overdraft, it is highly unpredictable and cannot be consistently relied upon year to year.

Canal seepage is more constant, since it is a function of the amount of water delivered via canals in the AMA. It is estimated to average about 115,000 acre-feet per year.

Artificial Recharge

Artificial recharge is another offset to overdraft and plays an important role in meeting the safe-yield management goal. Pursuant to the AWS Rules, development associated with CAWS and DAWS must prove water supplies for 100 years, most or all of which must come from renewable sources, including CAP or other renewable water supplies. Some factors affecting providers' ability to use renewable water supplies include having a CAP allocation and/or access to excess or leased CAP supplies, proximity to the main CAP distribution system, and owning treatment facilities and distribution systems to directly deliver CAP water to customers. Many municipal providers may not have physical or legal access to CAP water; replenishment by the CAGRD is an option for meeting this goal. CAGRD must replenish within three years after the amount of excess groundwater used is reported, and does so through storage and credit accrual at USFs and GSFs.

Renewable water supplies may be stored at USFs on an annual basis so that it is stored and recovered during the same calendar year, or it may be stored to accrue long-term storage credits. CAP water stored for long-term storage credits is debited a 5 percent cut to the aquifer, unless it is stored directly into specific CAGRD accounts that do not incur the debit. Annual or long-term reclaimed storage at constructed USFs or GSFs is not debited. Reclaimed water stored at managed USFs is debited 50 percent. These cuts to the aquifer help the AMA reach safe-yield.

Renewable water supplies can also be stored at a GSF. The Indirect Storage and Recovery Program was created to provide flexibility to increase use of CAP supplies. Typically a farmer receives CAP and curtails groundwater pumpage, reporting the CAP water as in-lieu groundwater. When the CAP credits are later recovered, the recovering entity reports CAP use. Underground storage and recovery is an important water management tool, but it does not always directly offset overdraft. Although CAGRD replenishment is factored into the water budget, and cuts to the aquifer assist in reaching safe-yield, there are many other recharge-related activities occurring that are not factored into the water budget. Even though local water levels may rise in the areas of hydrologic impact of artificial recharge, that water is in effect already spoken for – it has been stored with the intent of recovering it later.

It is important to note that although the factors that sometimes have the most dramatic effect on reducing overdraft in a given year during the historical period were either the result of water use in the past (agricultural incidental recharge) or a product of nature (streambed infiltration), the

Phoenix AMA has taken tremendous strides in achieving safe-yield. During 2006, approximately 60 percent of renewable supplies were used within the AMA. Use of renewable supplies directly offsets groundwater that would otherwise have been withdrawn. The increased use of renewable supplies, in addition to conservation, has been a factor in minimizing overdraft in the Phoenix AMA from 1985 to 2006 despite the fact that the population more than doubled from 1.8 million to nearly 3.8 million people. Also, water that could not have been put to a beneficial use in the AMA because providers had not yet grown into their CAP allocations has been artificially recharged for use in the future, and reclaimed water that in the past was discharged is also being stored for future use.

PART IV PROJECTED DEMANDS AND OVEDRAFT

7. INTRODUCTION TO THE PROJECTIONS

7.1 Purpose and Approach for Projecting Demands

Part III, Historical Water Demand and Overdraft, describes the status of the current imbalance or groundwater overdraft, that occurs in most of the historic period. In order to determine if the Phoenix AMA will achieve the statutory goal of safe-yield by 2025, future demand, supply utilization and groundwater overdraft must be projected. ADWR recognizes for this Assessment that planners and decision makers need to move away from expectations of perfect or near-perfect forecasts (Arizona State University, 2009). Instead, ADWR, in consultation with outside entities, has developed eight different scenarios, each with slightly different assumptions. This Assessment contains three baseline scenarios, three additional shortage scenarios incorporating possible climate change impacts, and two scenarios that increases the use of reclaimed water in the AMA. As defined by the Intergovernmental Panel on Climate Change, "*A scenario is a coherent, internally consistent and plausible description of a possible future state of the world. It is not a forecast; rather, each scenario is one alternative image of how the future can unfold*." The Sustainability of semi-Arid Hydrology and Riparian Areas (SAHRA) website for Scenario Development further explains scenarios as

> "*Descriptions of possible alternatives of the future that take into account the interaction of many different components of a complex system. Although scenarios are not forecasts or even predictions of the most-likely alternatives, they provide a dynamic view of the future by exploring various trajectories of change that lead to a number of possible alternative futures. Because unique and unanticipated conditions have more chances to occur over a long period of time, long-term scenarios have more uncertainty than short-term scenarios*" (Sustainability of semi-Arid Hydrology and Riparian Areas, 2009).

Recognizing that it is impossible to predict accurately what future demand will be, staff developed a plausible range of demand and overdraft scenarios up to and including the year 2025. Baseline Scenario One represents the lowest reasonable water demand, Baseline Scenario Three the highest reasonable water demand, while Scenario Two is a mid-level projection. None of the baseline scenarios incorporate changes in surface water supply as a result of climate change.

Debate continues over climate change; will it occur, and if so, to what extent? Several climate change models exist for the southwestern region of the United States, but at this time, are not localized enough to be useful for the purposes of this Assessment. However, ADWR could not ignore the potential effects of climate change, so an effort was made to incorporate a period of reduced surface water availability based on a similar historical occurrence in the three climate change scenarios. Assumptions behind these additional scenarios, and the impact on groundwater overdraft, are described in Section 14.1.

The seventh scenario developed for this Assessment is the Maximized Reclaimed Water Use Scenario. This scenario recognizes that with population growth, there will be an ever larger volume of reclaimed water that could be re-used, and that such re-use might move the AMA closer to achieving the goal of safe-yield by 2025 (*See* Section 14.2). Use of reclaimed water is ramped up even further in an eighth scenario with, surprisingly, less promising results.

The scenarios developed by ADWR for this Assessment are one set of potential results in terms of projecting future demand and groundwater overdraft. Part of the work that went into the compilation of this Assessment was the creation of a centralized data repository for the historical supply and demand information. This central repository was designed with the intent to provide ADWR with a flexible and readily updateable database that is directly connected to multiple future demand and supply scenarios. This will allow ADWR to quickly update annual report information on the demand side along with continual updates of supplies and future assumptions as conditions change. ADWR's goal is to continue modifying the assumptions each year to incorporate actual data as 2025 approaches, and to incorporate more sophisticated models, such as those currently in use or in development by the Decision Center for Desert Cities (DCDC). DCDC's research on water management decisions in central Arizona incorporates factors such as the area's rapid population growth and urbanization, complex political and economic systems, variable desert climate, and the potential of global climate change. ADWR hopes to collaborate with DCDC staff and regional water managers and other decision makers to use WaterSim, its complex integrative model, to examine the interactive effects of climate conditions, rapid growth, and policy decisions on future water supply and demand conditions. Although originally developed for the Phoenix area, it is hoped that WaterSim could be adapted for use in the Tucson and Pinal AMAs as well.

7.1.1 Water Demand Projection Techniques

For the purposes of this Assessment, staff used three methods to project demands; the per capita or per unit water use approach, the time-series approach (a sequence of data points, measured at successive times spaced at uniform time intervals in order to forecast events based on known past events), and the regression analysis approach (a statistical tool for investigation of the relationship between variables – also sometimes referred to as the econometric approach). For Municipal demand estimates, the Gallons Per Capita Per Day (GPCD) rate was multiplied by the population projection. The time-series approach was employed to statistically analyze the historical water use trend line to project future demand trends based on historical trends. The Industrial and Agricultural projected demands generally resulted from this technique. Finally, the regression analysis approach utilized the Coefficient of Determination (the square of the sample correlation coefficient between the outcomes and their predicted values, varying from 0 to 1) to analyze water use related to influencing factors such as demographic changes, climate changes, and socio-economic changes. This allowed staff to estimate parameters that measure the historical relationship between water use (dependent variable) and different factors (explanatory variable or independent variables), assuming that those parameters will continue into the future.

7.1.2 User Interviews and Settlement Documents

During the development of the scenarios, staff conducted user interviews of academic, government and private sector experts. Staff also reviewed public documents such as intergovernmental agreements and Indian Water Settlements. These interviews and reviews were done in order to gain more insight regarding population growth, the potential for new water users (such as mines, power plants and golf courses), the potential for a change in how current sources are used, the addition of new sources, and changes in urbanization.

8. PROJECTED DEMANDS AND OVERDRAFT

8.1 Projected Summary Budget

The three baseline scenarios correspond generally to low, medium, and high AMA projected demands, according to sets of assumptions assembled for each water use sector. In some cases, the assumptions used to project supplies also varied among the three baseline scenarios. The methodology and assumptions used in projecting the future water use of the Municipal, Industrial, Agricultural, and Indian water use sectors under these three baseline scenarios are described in detail in Sections 8 through 10.

Incidental recharge is calculated as a percentage of the demand for each water use sector. Incidental recharge rates are based on the water use sector and nature of the water use (*See Table 3-3*). Additionally, the amount of groundwater that satisfies riparian demand within the AMA is displayed in the Projected Summary Budget and assumes the projected demand is the same as the historical demand. The Projected Summary Budget includes supply figures for the amount of water added to the aquifer pursuant to Underground Storage and Recovery projects (cuts to the aquifer); CAGRD replenishment of excess groundwater in order to satisfy the consistency with management goal requirement under the Phoenix AMA AWS Rules; net natural recharge on an AMA-wide basis; reclaimed water discharges; and canal seepage.

ADWR has assigned certain volumes of groundwater for use by water providers with a DAWS and for subdivisions with a CAWS. The groundwater allowance is discussed further in Section 3.4, *Offsets to Overdraft*, in the Historical portion of the Assessment. In the Projected Summary Budget, projected overdraft in year 2025 is displayed in two ways: with groundwater allowance pumping subtracted from the overdraft calculation and with it included in the overdraft calculation (*See Table 8-1*). The amount of allowable groundwater pumped, which is the difference between the two sets of overdraft figures, ranges from 120,408 acre-feet in Baseline Scenario One, to 149,300 acre-feet in Baseline Scenario Three.

8.1.1 Demand Range

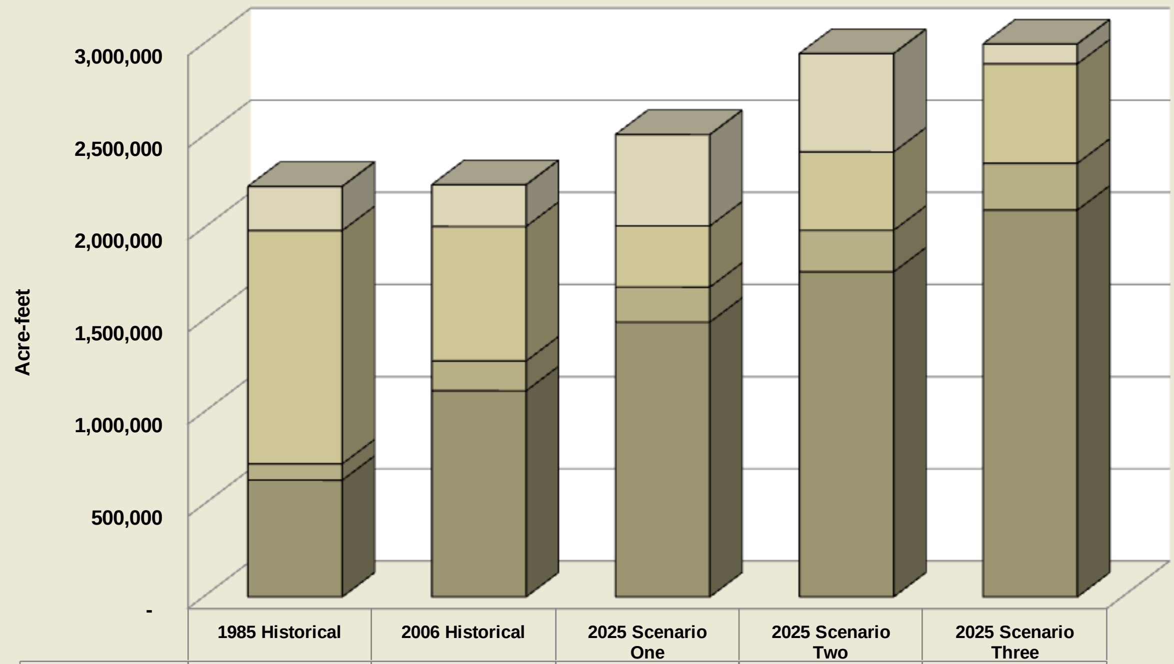
Total projected 2025 demand ranges from 2,507,920 acre-feet in Baseline Scenario One to 3,434,942 acre-feet for Baseline Scenario Three (*See Figure 8-1*). Generally, the difference in Municipal demand between the three baseline scenarios is due to a combination of assumptions regarding future population growth and corresponding water use. The difference in Agricultural demand in the three baseline scenarios involves different assumptions concerning whether irrigable lands will be fully farmed, and whether certain irrigated lands will be taken out of production for residential development. For Indian Agricultural demand, it was assumed that by 2025, the amount of irrigation on-reservation would increase, with different assumptions on the rate of increase in each scenario. The primary difference in Industrial demand figures concerns assumptions regarding population growth and electrical power generation. The assumptions and methodology used for water demand projections are detailed in Sections 9 through 13.

Table 8-1 2025 Projected Summary Budget - Baseline Scenarios
Phoenix Active Management Area

SECTOR	CATEGORY	SCENARIO ONE	SCENARIO TWO	SCENARIO THREE
Municipal				
Demand		1,490,773	1,763,467	2,099,210
Supply	*Groundwater*	438,311	475,294	536,968
	Surface water	653,334	734,862	747,174
	CAP (direct use & credits recovered)	301,189	449,798	526,493
	Reclaimed water	97,940	103,514	288,576
	Incidental Recharge	85,024	97,066	110,704
Industrial				
Demand		190,163	225,666	253,896
Supply	*Groundwater*	104,590	113,116	128,643
	Surface water	9,508	10,283	11,695
	CAP (direct use & credits recovered)	1,902	22,057	22,339
	Reclaimed water	74,164	80,210	91,219
	Incidental Recharge	12,077	14,521	15,224
Agricultural				
Demand		331,836	424,836	539,356
Supply	*Groundwater*	214,491	275,391	371,499
	In-Lieu Groundwater	42,281	59,530	47,181
	Surface water	31,034	43,253	69,470
	CAP (direct use, no In-Lieu Groundwater)	14,030	16,663	21,206
	Reclaimed water	30,000	30,000	30,000
	Incidental Recharge[1]	284,943	284,943	284,943
Indian				
Demand		495,148	533,315	567,393
Supply	*Groundwater*	23,605	61,772	95,850
	Surface Water	218,487	218,487	218,487
	CAP	218,556	248,556	248,556
	Reclaimed water	4,500	4,500	4,500
Other				
Demand	*Riparian*	48,000	48,000	48,000
Supply	*Cuts to the aquifer*	12,482	4,945	966
	CAGRD Replenishment	29,478	18,673	5,569
	Net Natural Recharge	101,900	101,900	101,900
	Reclaimed water discharge	62,295	59,003	82,864
	Canal Seepage	123,338	123,338	123,338
Groundwater Use not counted towards overdraft	*GW Allowance*	120,408	133,852	149,300
	Excess Groundwater	162,475	170,503	214,484
	Poor Quality Groundwater	5,110	5,110	5,110
Overdraft	***Subtracting GW Allowance***	**34,221**	**189,751**	**348,222**
	Without Subtracting GW allowance	**154,629**	**323,603**	**497,522**

Note: All values are in acre-feet. [1]Agricultural incidental recharge includes Indian Agricultural Incidental Recharge.

Figure 8-1 Historical and 2025 Projected Demand by Sector
Phoenix Active Management Area



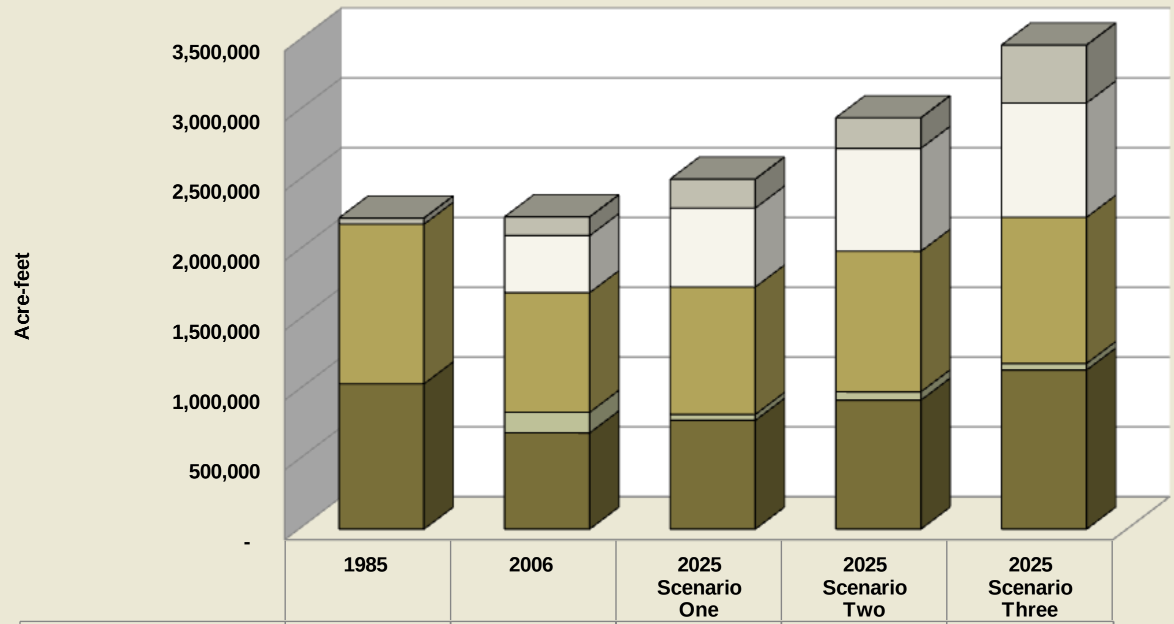
	1985 Historical	2006 Historical	2025 Scenario One	2025 Scenario Two	2025 Scenario Three
TOTAL	2,227,285	2,235,680	2,507,920	2,947,284	3,459,855
INDIAN	239,227	225,866	495,148	533,315	567,393
AGRICULTURAL	1,265,633	730,025	331,836	424,836	539,356
INDUSTRIAL	88,667	161,380	190,163	225,666	253,896
MUNICIPAL	633,757	1,118,409	1,490,773	1,763,467	2,099,210

8.1.2 Supply Range

The total projected supplies used to meet demand are shown in Figure 8-2. The amount of surface water projected to be used in the Baseline Scenarios does not vary much from historical use. GSF Water (CAP or reclaimed) use goes down dramatically as more water is put to direct use instead of being stored. Reclaimed water use increases over the 2006 amount, and varies from about 206,000 acre –feet in Scenario One to more than twice that (414,295 acre-feet) in Scenario Three. CAP use increases as well, as a result of the increase in on-reservation Indian Agriculture, as well as full utilization of municipal providers' CAP allocations.

The largest difference in projected supply among the three baseline scenarios is in groundwater use. Generally, it was assumed that if Municipal and Industrial demand increases, and the available renewable supplies are maximized, groundwater will be a large portion of the supply needed to meet that increased demand. This additional groundwater use directly affects overdraft.

Figure 8-2 Historical and 2025 Projected Supplies
Phoenix Active Management Area



	1985	2006	2025 Scenario One	2025 Scenario Two	2025 Scenario Three
TOTAL ACRE FEET	2,227,285	2,235,680	2,505,920	2,945,284	3,465,942
RECLAIMED WATER	43,766	134,060	206,603	218,223	414,295
CAP	-	408,252	565,676	737,073	818,594
SURFACE	1,142,961	856,890	912,364	1,006,885	1,046,825
IN-LIEU GROUNDWATER	-	147,149	42,281	59,530	47,181
GROUNDWATER	1,040,557	689,328	778,996	923,574	1,139,047

Note: 1985 does not include Indian use as those numbers were not available to the public.

8.1.3 Offsets to Overdraft

A number of factors, as shown in *Table 8-2,* offset groundwater pumping. As mentioned previously, incidental recharge results from sector water use activities, such as water applied to fields in excess of crop consumptive use and evaporation demands within the Agricultural sector, or a similar application of water to Municipal or Industrial turf-related facilities. Incidental recharge rates are assumed to be consistent with historical rates, depending on the water use sector and nature of the water use.

Agricultural incidental recharge in the Phoenix AMA continues to be significant even in year 2025 because although agricultural water use continues to decrease as agricultural land is urbanized, the incidental recharge is lagged by twenty years. Therefore, the amount considered to reach the aquifer in 2025 is the result of water used in 2005. As more time passes from the period during which the highest rates of water was used for Agriculture (the 1960s, 70s and 80s), the impact of that incidental recharge decreases.

Canal recharge is not lagged, and because of the large volume of water that will be continue to be transported in the canals in the Phoenix AMA, it will continue to be a significant offset to overdraft in the future.

Table 8-2 2025 Projected Offsets to Overdraft
Phoenix Active Management Area

TYPE OF OFFSET	Scenario One 2025	Scenario Two 2025	Scenario Three 2025
Incidental Recharge			
Municipal	85,024	97,066	110,704
Industrial	12,077	14,521	15,224
Agriculture[1]	191,054	191,054	191,054
Net Natural Recharge[2]	164,195	160,903	184,764
CAGRD Replenishment	29,478	18,673	5,569
Canal Recharge	123,338	123,338	123,338
Cuts to the Aquifer	12,482	4,945	966
TOTAL	**617,648**	**610,500**	**631,619**

Notes: [1]Includes both Indian and Agricultural lagged incidental recharge. [2] Net Natural Recharge includes reclaimed water discharge.

The next significant offset to overdraft is net natural recharge. The components that make up net natural recharge (mountain front recharge, streambed infiltration, groundwater inflow and outflow and reclaimed water discharge) stay constant in the baseline scenarios, with the exception of reclaimed water discharge. This component varies as reclaimed water generated and re-used varies among the scenarios.

Incidental recharge amounts in year 2025 by the Municipal and Industrial sectors vary since overall use by each sector varies. Municipal incidental recharge increases from the 2006 value by 12,000 acre-feet in Scenario One, and is highest in Scenario Three at 73,956 acre-feet as overall water use increases.

Pursuant to recharge statutes, in many cases permitted artificial recharge activities require that a certain percentage of the recharged volume be made non-recoverable to benefit the aquifer. These required non-recoverable volumes are called *cuts to the aquifer*, and have been discussed in Section 3.4.3. The amount of water accounted for as cuts to the aquifer varies slightly under the three baseline scenarios based on different assumptions regarding amounts of projected recharge, type of water, and type of facility.

8.2 Overdraft Range

In 2006, the estimated total overdraft for the Phoenix AMA was approximately 138,890 acre-feet, of which 128,214 acre-feet was the groundwater allowance portion. The projected 2025 total overdraft figures vary from 154,629 acre-feet in Baseline Scenario One to 497,522 acre-feet, including the groundwater allowance, in Baseline Scenario Three (*See Figure 8-4*).

As detailed earlier in this Assessment, a portion of this overdraft is groundwater allowance under the AWS Program, and is deemed consistent with the management goal of the Phoenix AMA. Even without counting for these groundwater allowance volumes, there remains a projected overdraft in the range of 34,221 to 348,222 acre-feet for 2025.

It should be noted again that in addition to the AWS Program groundwater allowance, certain users are legally permitted to withdraw groundwater pursuant to groundwater rights and withdrawal authorities that do not have a replenishment requirement. These withdrawal authorities include IGFRs, Type 1 and Type 2 rights, groundwater withdrawal permits, exempt wells, and service area rights operated by undesignated municipal providers who serve customers not covered by a CAWS. Groundwater pumped pursuant to these types of withdrawal authorities is included as overdraft and continues to be an impediment to reaching safe-yield because no replenishment is required.

8.3 Factors Affecting Projected Overdraft

Shift of Demand between Water Demand Sectors

The share of total demand by the Municipal sector in 2006 was 50%. In the Baseline Scenarios, the total demand for that sector is in the narrow range of 59% for Baseline Scenario One, 60% for Baseline Scenario Two, and 61% for Baseline Scenario Three. Industrial demand is projected to grow from 7% in 2006 to 16%, 18% or 20%. As discussed in Section 6.3, the incidental recharge rates for the Municipal and Industrial sectors is generally less than the incidental recharge resulting from Agricultural uses. Thus, as demand shifts from the Agricultural sector to the Municipal and Industrial, less water is incidentally recharged, less of the annual groundwater pumpage is offset, and overdraft will likely increase.

The Change in Use of Supplies

The primary supplies in use in 2006 were surface water at 38 percent, groundwater at 31 percent, and CAP at 18 percent. Surface water is still the predominant supply in Baseline Scenarios One and Two, but is edged out slightly by groundwater in Baseline Scenario Three, which has a total demand of 3.45 million acre-feet. In all three Baseline Scenarios, CAP and reclaimed water use increases, while in-lieu of groundwater decreases. In all three Baseline Scenarios, groundwater use increases over the 2006 amount (689,328 acre-feet) to 780,960 acre-feet in Baseline Scenario One, 925,574 acre-feet in Baseline Scenario Two and 1,132,960 acre-feet in Baseline Scenario Three. If the total groundwater pumped increases in the future, projected overdraft will, absent changes in offset factors, grow as well in the amount of the increase that does not have to be replenished.

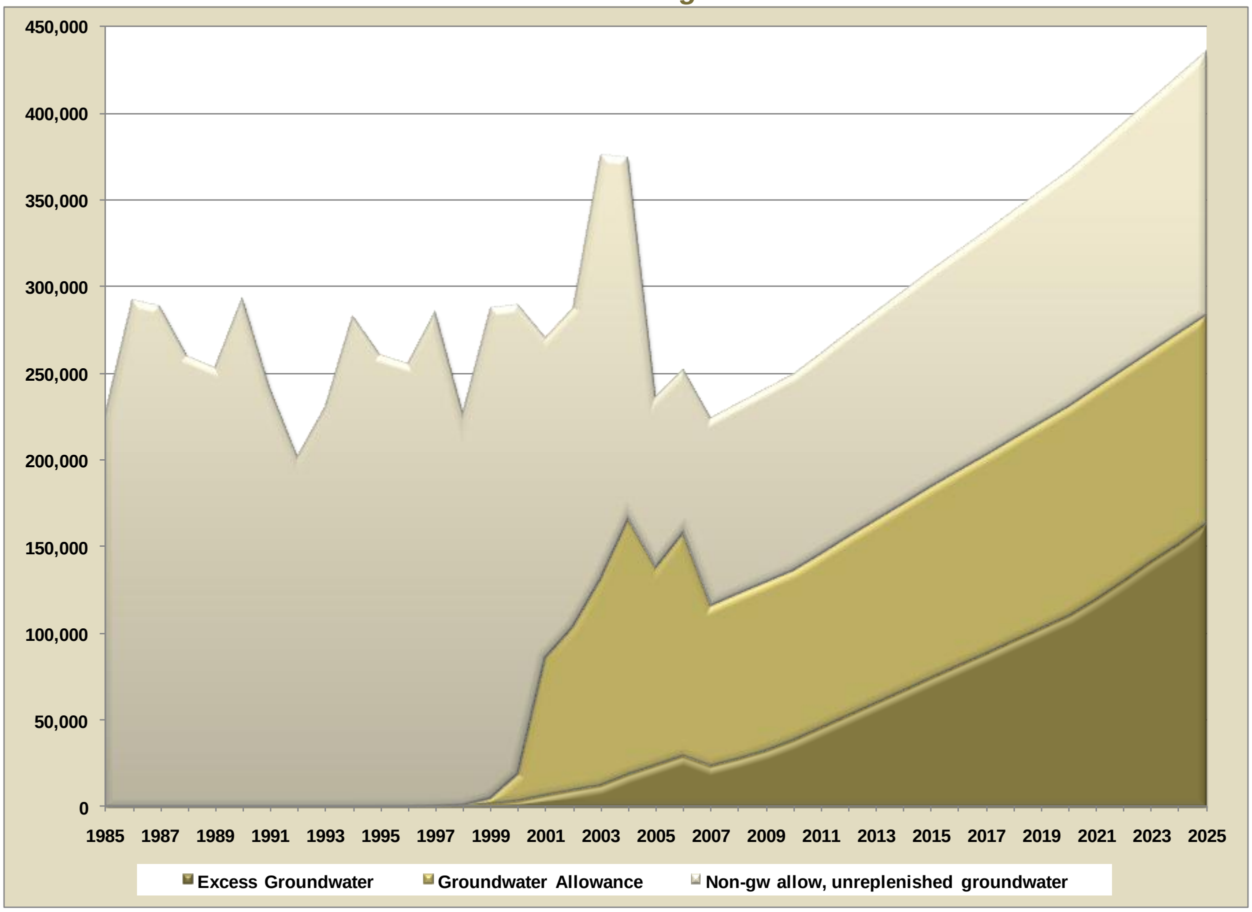
Unreplenished Groundwater and Allowable Groundwater

Unreplenished groundwater in 2006 was 94,632 acre-feet. In the Baseline Scenario projections, unreplenished groundwater is in the narrow range of 152,318 to 170,074 acre-feet. This amount is associated with subdivisions platted before 1995 and commercial uses in undesignated provider service areas. The portion of that amount that can potentially grow and contribute increasingly to overdraft is the amount related to unsubdivided land uses in undesignated provider service areas

Groundwater allowance related pumpage in 2006 was 128,214 acre-feet. In the Baseline Scenarios, this value ranges from an amount less than 2006, 120,408 acre-feet, to over 149,000 acre feet. The volume of allowable groundwater is fixed, so over time the proportion of allowable groundwater to excess will go down and eventually reach zero, although not in the projected period. At that point, only the incidental recharge volume (4 percent) will be considered allowable groundwater.

Finally, the excess groundwater, or the portion that must be replenished by the CAGRD, will continue to grow as development continues and groundwater allowances deplete, since after 2025 there is zero groundwater allowance allocated to new subdivisions after 2025. Figure 8-3 shows the proportion of excess to groundwater allowance and non-groundwater allowance, unreplenished groundwater.

Figure 8-3 Excess, Groundwater Allowance and Non Groundwater Allowance, Unreplenished Groundwater in Baseline Scenario One Phoenix Active Management Area



Note: Volumes are in acre-feet.

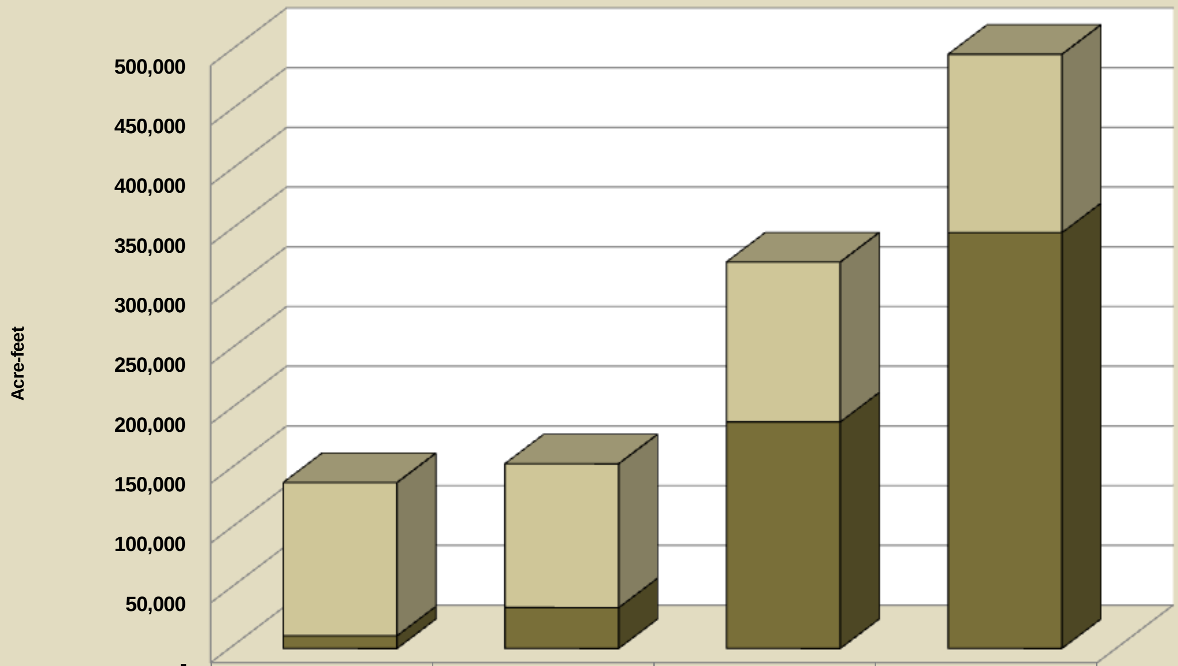
Streambed Infiltration

Streambed infiltration used in the historic period was the actual amount estimated to have occurred in a given year, which for 2006 was 34,600 acre-feet. Because streambed infiltration is quite variable, a constant amount of 84,400 acre-feet based on the median historic streambed infiltration values is used in all the Baseline Scenarios. If streambed infiltration is more than that in a given year, projected overdraft will, absent changes in other overdraft factors, be less. If streambed infiltration is less than 84,000 acre-feet, overdraft will be higher than projected.

Artificial Recharge

Artificial recharge will continue to play a role in reducing overdraft in the projected period. Renewable supplies that would have otherwise gone unused will be stored for future use, thus reducing the amount of groundwater that would have been pumped in the future absent storage. The cut to the aquifer also continues to slightly reduce overdraft in the projected period, anywhere from about 12,500 acre-feet in Scenario One to about 1,000 acre-feet in Scenario Three. Over time, though, less water is anticipated to stored as more CAP and reclaimed water is put to direct use, so the cut to the aquifer will likely have less of a beneficial impact on overdraft in the future.

Figure 8-4 2025 Projected Overdraft
Phoenix Active Management Area



	2006 HISTORIC	Scenario One 2025	Scenario Two 2025	Scenario Three 2025
TOTAL	138,890	154,629	323,603	497,522
GW ALLOWANCE	128,214	120,408	133,852	149,300
OVERDRAFT	10,676	34,221	189,751	348,222

The Baseline Scenarios indicate that the positive trends that occurred between 1985, such as the increased use of renewable sources and the practice of artificial recharge, are projected to continue through the projected period. The population is projected to increase from roughly 3.8 million people in 2006 to between 6.15 and 7.2 million people, which on the higher end is almost double the 2006 amount. Groundwater use, however, is only projected to increase from about 690,000 acre-feet in 2006 to between 780,996 acre-feet and 1,132,960 acre-feet. There will be a small amount of water each year related to undesignated providers that will go unreplenished, however, and the excess groundwater that must be replenished by the CAGRD will grow over time as groundwater allowances are depleted. Another beneficial impact to overdraft that will lessen over time is that of Agricultural incidental recharge, since it decreases each year as agricultural acres are urbanized. Streambed infiltration may, in some years, be higher than the projected amount and if high enough, could cause the AMA to be in surplus for a given year. However, when that could occur and how often is uncertain. One thing that seems apparent, though, in all of the Baseline Scenarios, is that overdraft trends up over time.

The following sections describe in more detail the methodology used to create the Baseline Scenarios, the CAP Shortage Scenarios, and two scenarios in which overdraft trend upward is reversed: the 100% Reclaimed Reuse Scenario and the Maximized Reclaimed Scenario.

9. MUNICIPAL PROJECTIONS

Generally, the highest population projection was paired with the highest water demand projection method and the lowest population projection was paired with the lowest demand projection method. This established the end points of the range of projected municipal population and demand. A third scenario fell between the highest and lowest scenarios (*See Figure 9-1*).

9.1 Description of Demand Methodologies and Assumptions

9.1.1 Population

Projecting Municipal demand begins with population. Some Industrial subsector demand is also directly related to population. This is discussed further in the Industrial projection section. Various methods of projecting population that incorporated multiple steps were used for this Assessment. Some of the scenarios used all the steps, and others did not. Methods used include:

- *Population projections prepared by other agencies* were used to develop a total Phoenix AMA population. There are three counties within the Phoenix AMA; Maricopa, Pinal, and a small portion of Yavapai County. The MAG and Central Arizona Association of Governments (CAAG) projections were used in Maricopa and Pinal counties. In the Yavapai County portion of the AMA, ADWR used Arizona Department of Commerce data.

- *A calculated total AMA population* was developed using different methods for large providers, small providers and exempt wells:

  - *Simple statistics* were used to project population for each individual large provider that does not hold a DAWS. (For designated providers, the projected population and demand included in the provider's DAWS was used.) Trend lines with the highest statistical correlation were selected for each undesignated provider. The trend lines used data from 1985 through 2006. In some cases, water providers submitted population projections to ADWR that extended for some years beyond 2006 but did not extend out to 2025. ADWR used the providers' projections for as many years as were given, and extended the projections to 2025 with statistical trend lines.

  - The small provider sub-sector population was projected using either *an average percent growth rate, or by maintaining the small provider population at the same percent of total AMA population that it was in 2006, or by using the MAG projection*. The period used to generate the growth rate varied by scenario, but was either from 1985 to 1999 or from 1990 to 2000.

  - Exempt well population was projected as either *the remainder of the other agency projection for the entire AMA after large provider, small provider and Indian population was subtracted out, or is ramped up using an average historical growth rate*. The period used to generate the growth rate varied by scenario, but was either from 1985 to 1999 or from 1990 to 2000.

  - Using these methods, the projections for large providers, small providers, and exempt wells were summed to develop a *calculated total AMA population*.

- Under Baseline Scenario Three the populations associated with large providers, was projected using the average historical growth rate for each sub-sector from 1985 through 2000. Then the projection for individual large providers was broken out, based on the percentage that the Baseline Scenario Three overall large provider projection was greater than the Baseline Scenario Two overall large provider projection.

The methods were compared and categorized from lowest to highest. Appendices 1 through 4 describe the individual Municipal assumptions for the Phoenix AMA in more detail.

9.1.2 Designations of Assured Water Supply

Water providers who hold a DAWS have provided ADWR with projected water demand, and in some cases, projected population in their applications for DAWS and in their annual reports. ADWR used information provided in the applications for DAWS for designated providers because the determinations of AWS for these providers are based on this information, which is tracked using data provided in the annual reports. If there was insufficient information, ADWR examined past water use and population trends for the provider and used that information to create an inferred projection that reasonably fit the provider's past trends and plans as submitted to ADWR.

9.1.3 Central Arizona Groundwater Replenishment District Plan of Operation

Every ten years, the CAGRD is required to submit a Plan of Operation to ADWR outlining how it will meet its current and future replenishment obligations. In its 2004 Plan of Operation, the CAGRD projected the population, total demand, groundwater demand, and replenishment obligation of enrolled member lands and member service areas (MSA), as well as future member lands not yet enrolled. The CAGRD worked with MAG, the Pima Association of Governments, and ADES to develop population projections using MAG's projection model and geographic boundaries. As previously explained, ADWR uses several population projection methodologies including those of other agencies in this Assessment. ADWR also used demand and supply assumptions in this Assessment that differed from those used by the CAGRD in its Plan of Operation. Because of these differences, ADWR did not adopt the figures included in the CAGRD's Plan of Operation, but instead developed its own estimate of CAGRD replenishment obligation. These figures are for planning purposes only for this Assessment and are not intended to modify or replace the figures the CAGRD has used in its Plan of Operation.

ADWR did not approach the replenishment obligation from the perspective of growth in individual subdivisions (as the CAGRD used in its Plan of Operation). Instead, ADWR began with the population projection for each municipal provider as a whole, then separated out the population growth in each provider's service area since 1995 (the year of the adoption of the AWS Rules). For undesignated providers (providers who do not hold a DAWS) the sum of all post-1995 population was compared to the sum of the population and demand associated with the linear build-out of issued CAWS at the end of 2006. The difference between projected population and 1995 population represents future population that is assumed to be associated with new CAWS (comparable to future member lands projected by the CAGRD). Similarly, the difference between projected demand and 1995 demand represents future demand, however, not all future demand will be associated with a subdivision and a CAWS. To estimate the proportion of new demand that might be associated with a future CAWS, the single family to multi-family ratio for undesignated providers was applied to the future demand. This approach was taken since new subdivisions primarily consist of single family homes. Then an assumption was made in order to estimate the groundwater portion of future demand presumed to be associated with subdivisions. The ratio of the sum of all undesignated provider groundwater demand to the sum of all undesignated provider total demand was used to estimate the groundwater portion of the future CAWS demand.

For each issued CAWS, the volume of replenishment obligation was based on the CAGRD's reporting percentage for each year through 2025. The remainder of the projected annual groundwater demand minus the calculated replenishment obligation was presumed to be groundwater allowance use. When the groundwater allowance for a CAWS was exhausted, all groundwater demand was assumed to be met by the CAGRD as replenishment obligation.

For each MSA, the replenishment obligation was calculated as the difference between the projected groundwater demand and the projected groundwater allowance use rate as submitted in the provider's application for a DAWS up to any cap on maximum replenishment in the provider's MSA Agreement with CAGRD.

9.1.4 Baseline Scenario One Demand Methodology and Assumptions

Baseline Scenario One uses projections prepared by other agencies to develop a total AMA population. The *Third Management Plan for Phoenix Active Management Area 2000 – 2010* conservation requirement calculation methodology was used with the population projection for each large provider to calculate the projected Baseline Scenario One demand for each large provider (*See Figure 9-1* and *Table 9-1*).

The projection for Small providers in Baseline Scenario One were done in lump sum by MAG, except for one small provider located in Pinal County. For Pinal County it was assumed that providers would maintain the same proportion of the population of the school district in which they were located over time. Small provider demand was calculated using the *Third Management Plan for Phoenix Active Management Area 2000 – 2010* interior and exterior water use models for single family housing units, the 2000 US Census average persons per housing unit for Maricopa County and the projected small provider population. This resulted in a GPCD rate for projected small provider demand of 124 GPCD.

Urban irrigation demand for Scenario One is the 1985 through 2006 historical average volume, held constant for each year throughout the projection period.

Baseline Scenario One projects exempt well population as the remainder of the total AMA population after large providers, small providers, and Indian population are subtracted out. Indian population was held constant from the year 2000 Census population for Census blocks within reservation boundaries. Exempt well demand was calculated using the *Third Management Plan for Phoenix Active Management Area 2000 – 2010* interior and exterior water use models for single family housing units, the 2000 US Census average persons per housing unit for Maricopa County and the projected exempt well population for all three scenarios.

9.1.5 Baseline Scenario Two Demand Methodology and Assumptions

Baseline Scenario Two projected population for each large municipal provider who did not hold a DAWS by selecting the best fit statistical trend line using the historical service area population data. For DAWS providers, the projected population included in the providers' DAWS was used, if provided. If the DAWS projections did not extend out to the year 2025, the projections were developed using statistics. For undesignated providers, annual demand was obtained by multiplying the large provider's 2000 to 2006 average GPCD rate by the population. Demand for designated providers was from their DAWS determinations (*See Figure 9-1* and *Table 9-1*).

Population for small providers in Baseline Scenario Two was calculated starting from the 2007 projected small provider population using the 1990 to 2000 average rate of growth for the "balance of County" for Maricopa County and ramping up to the total small provider population in 2025 as projected by MAG (plus one small provider in Pinal County). Demand was calculated using the 2006 average GPCD rate for small providers of 240 GPCD. This use rate is significantly less than the 1985 through 2006 historical small provider average GPCD rate of 581 GPCD. This high historical use rate is due at least in part to a high proportion of historical

***Table 9-1* 2025 Projected Municipal Water Demand**
Phoenix Active Management Area

Municipal Use Category	Scenario One	Scenario Two	Scenario Three
Large Providers			
Total Use	1,314,868	1,576,810	1,917,767
Groundwater Use	340,854	367,085	433,973
Small Providers			
Total Use	19,780	38,309	38,309
Groundwater Use	19,780	38,309	38,209
Urban Irrigation			
Total Use	135,256	135,256	135,256
Groundwater Use	56,807	56,807	56,807
Domestic Well Use			
Total Use	20,869	13,093	7,878
Groundwater Use	20,869	13,093	7,878
Municipal Total Demand	**1,490,773**	**1,763,467**	**2,099,210**
Municipal Total Groundwater Demand	**438,311**	**475,294**	**536,968**

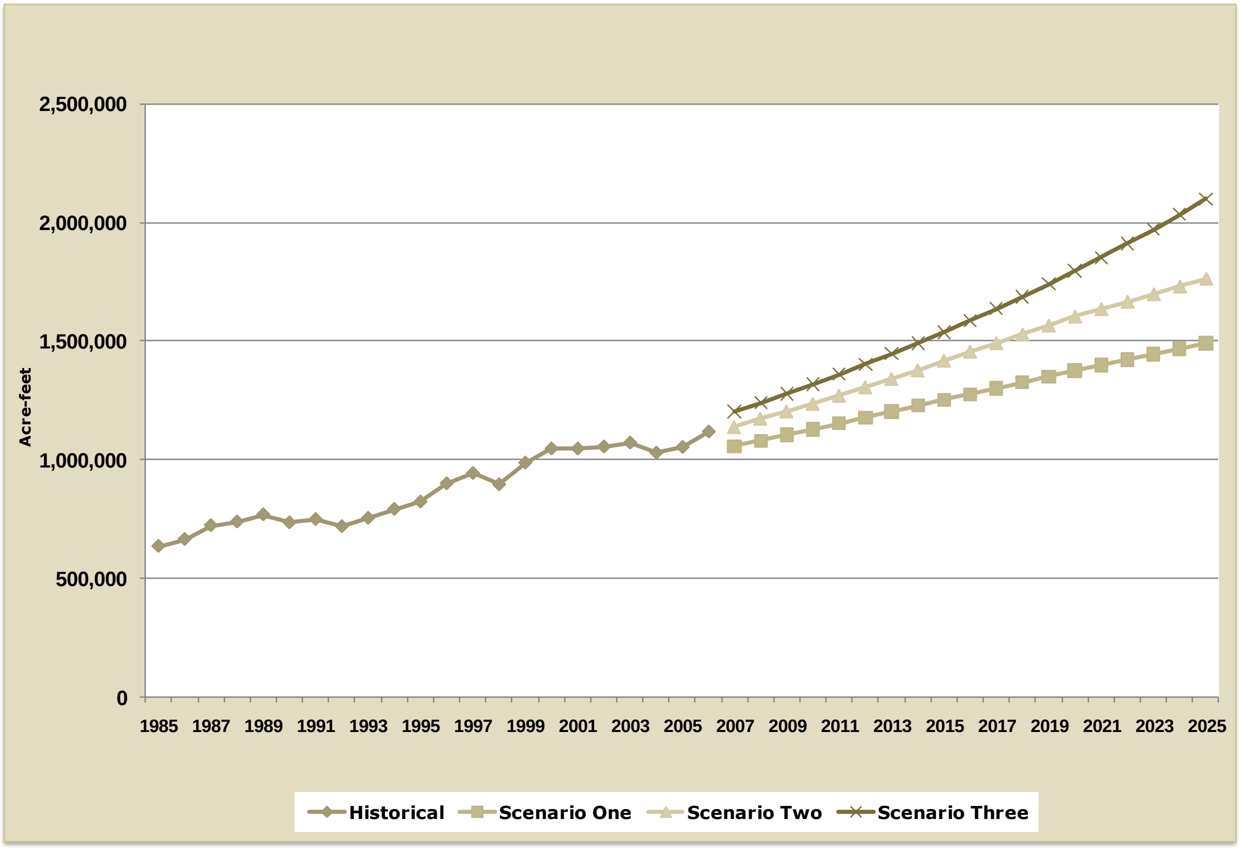
Note: All volumes are in acre-feet.

small provider demand associated with urban irrigation, serving a relatively small population. In recent years, urban irrigation demand in the small provider subsector has been volumetrically lower. Because the management plan provisions do not allow the creation of new large untreated providers, it is not likely that small provider demand will grow at the historical average rate of use. However, since conservation requirements are not as restrictive on small providers, small provider demand may increase at a rate higher than the 3MP model use rates for new residential demand.

Urban irrigation demand in Baseline Scenario Two is the same as for Baseline Scenario One.

Exempt well population for Baseline Scenario Two is the remainder of the total AMA population after large provider, small provider, and Indian population is subtracted from the total AMA projection as determined by other agencies (MAG, CAAG and ADES). Indian population was projected to remain constant from the year 2000 Census figure. The projected demand was calculated the same as for Baseline Scenario One.

Figure 9-1 Historical and Projected Municipal Demand
Phoenix Active Management Area



9.1.6 Baseline Scenario Three Demand Methodology and Assumptions

Baseline Scenario Three used the 1985 to 1999 average rate of growth for large providers to calculate a projection for large providers in sum. This figure was then broken down to each individual large provider by increasing each provider's population by the percent that the Baseline Scenario Three total large provider population projection was greater than the Baseline Scenario Two total large provider population projection. Demand was calculated by multiplying the provider's 2000 to 2006 average GPCD rate by population (*See Figure 9-1* and *Table* 9-1).

Population and demand for small providers in Baseline Scenario Three was calculated the same as Baseline Scenario Two.

Urban irrigation demand in Baseline Scenario Three is the same as for Baseline Scenario One.

Exempt well population for Baseline Scenario Three was projected using the 1985 to 1999 average historical growth rate of exempt well population. The projected demand was calculated the same as for Baseline Scenario One.

Total AMA population is the sum of large, small and exempt population projections plus Indian population, which was assumed to remain constant from the 2000 Census figure.

9.2 Description of Supply Methodology and Assumptions

Individual supply assumptions were made for each large provider based on the DAWS for designated providers or historical use of supplies for undesignated providers, with renewable supplies capped based on treatment capacity limitations or allocations. It is assumed that providers holding a DAWS will use their renewable supplies to the fullest extent feasible as indicated on their DAWS. Groundwater allowance and replenishment would be used as necessary to maintain the DAWS. CAP water use by undesignated providers was based on continuation of existing direct use, and annual storage and recovery as feasible to meet demand, within the limitations of supply, storage, and recovery, on a provider by provider basis. The remainder of undesignated demand is groundwater. Direct use of reclaimed water increases (*See Figure 9-2*) because all new subdivisions after 1995 must comply with the consistency with management goal requirement of the AWS Rules through replenishment by the CAGRD, by utilizing their own renewable water supplies, and through use of the groundwater allowance.

Urban irrigation supply was held at the average ratio of supply sources used from 1985 through 2006.

Small providers and exempt well population use only mined groundwater in all three baseline scenarios.

9.3 Overview of Municipal Results

Although the recent reduction in residential construction due to current economic conditions has not been accounted for in any of the three baseline scenarios, the Municipal sector represents significant potential demand in the Phoenix AMA. The three baseline scenarios differ significantly, with Baseline Scenario Three, the highest demand scenario, being more than 40 percent greater than Baseline Scenario One, the lowest demand scenario. In all three baseline scenarios, groundwater is not the primary water supply. Surface water continues to be the predominate source of municipal water supply. In Baseline Scenarios One and Two, groundwater is the second largest source of supply, however; CAP water use exceeds groundwater use in Baseline Scenario Three.

9.3.1 Baseline Scenario One Results

In Baseline Scenario One, projected Municipal demand is 33 percent greater in 2025 at 1,490,773 acre-feet (*See Figure 9-1*) than in 2006 when it was 1,118,409 acre-feet.

Groundwater demand increases by almost 74 percent, from 252,072 acre-feet in 2006 to 438,311 acre-feet by 2025 (*See Figure 9-2*).

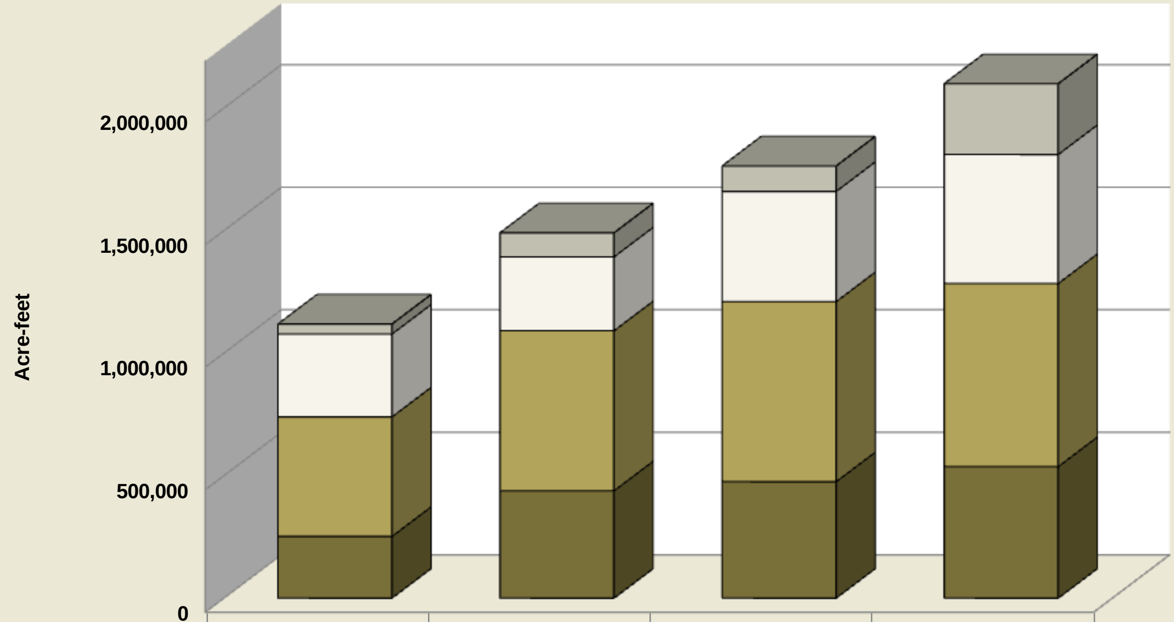
The proportion of Municipal sector demand increases from 50 percent of total AMA demand in 2006, to 59 percent in 2025 (*See Figure 8-1*).

9.3.2 Baseline Scenario Two Results

Municipal demand in Baseline Scenario Two is almost 58 percent greater than the 2006 municipal demand, increasing from 1,118,409 acre-feet in 2006 to 1,763,467 acre-feet in 2025 (*See Figure 9-1*).

Groundwater demand in Baseline Scenario Two increases over 88 percent from 252,072 acre-feet in 2006 to 475,294 acre-feet in 2025 (*See Figure 9-2).*

Figure 9-2 2025 Projected Municipal Supplies
Phoenix Active Management Area



	2006	2025 Scenario	2025 Scenario	2025 Scenario
TOTAL	1,118,409	1,490,773	1,763,467	2,099,210
Reclaimed Water	40,639	97,940	103,514	288,576
CAP	338,101	301,189	449,798	526,493
Surface Water	487,598	653,334	734,862	747,174
Groundwater	252,072	438,311	475,294	536,968

The proportion of Municipal sector demand increases from 50 percent of total AMA demand in 2006, to almost 60 percent in 2025 (*See Figure 8-1*).

9.3.3 Baseline Scenario Three Results

Municipal demand in Baseline Scenario Three is 88 percent higher than the 2006 municipal demand, increasing from 1,118,409 acre-feet to 2,099,210 acre-feet by 2025 (*See Figure 9-1*).

Groundwater demand in Baseline Scenario Three increases 113 percent from 252,072 acre-fee in 2006 to 536,968 acre-feet (*See* Figure 9-2*)*.

The proportion of Municipal sector demand increases from 50 percent of total AMA demand in 2006, to 61 percent in 2025 (*See Figure 8-1*).

10. INDUSTRIAL PROJECTIONS

As discussed in Section 3.1.2, the Industrial sector is made up of a number of different subsectors. When completing the Industrial projections, three projected baseline scenarios were developed for each Industrial subsector in the AMA. This method allowed for individual subsector analysis resulting in a broad range of potential Industrial demand in the AMA. The Phoenix AMA Industrial subsectors are turf-related facilities, electric power generation, sand and gravel, feedlots, dairies, and the generic catch all category other Industrial. Metal mining, although not historically a Phoenix AMA subsector, was also included in future projections due to a potential new mine in the AMA. Subsector demand scenarios were added together to derive the AMA's range of the total Industrial demand projections.

10.1 Description of Demand Methodologies and Assumptions

The Phoenix AMA Industrial demand projections were developed using a combination of methods:

- *Trend line* analysis and *regression* analysis were generally used to predict future water use if an industrial subsector's historical water use had a strong relationship ($R^2 > 0.6$) to either time or population. Future water use was then projected by using the trend of past water use as it related to time or population. Trend line analysis was also used to study the rate of growth or decline in the number of facilities within a subsector over time. This analysis was especially helpful in detecting when established water use trends start to change.
- Generally, if a subsector did not exhibit a strong relationship to time or population, then one of the following methods were used: the scenario was developed by AMA staff or sector professional based on professional judgment, or the *average historical use* or *current use* was *held constant thought time*. Subsectors, such as dairies, that are based on a commodity generally fit into this category. See Appendix 5 for more details on the specific methodology used in projecting each Industrial subsector.

As mentioned previously, it is important to note that ADWR defines an Industrial user as an entity that uses water for a non-agricultural purpose and does not receive water from a municipal source. Generally, Industrial users have their own wells and associated water rights or withdrawal permits. The Industrial sector predominately uses groundwater to meet its demand; however, non-groundwater supplies are counted in this sector if they are not supplied by a municipal provider. See Appendix 5 for a more detailed description of individual Industrial subsector assumptions.

Factors Driving Future Industrial Use in Phoenix

The major factors driving future Industrial demands in the Phoenix AMA are population growth and the health of the economy. With the AMA's population estimates reaching 6 to 7 million people by 2025, turf related facilities and electric power generation, already the two largest industrial subsectors, are expected to grow as well.

Turf water demand is strongly tied to population growth. Although currently more than half of the water used by the turf subsector in the Phoenix AMA is served by the municipal sector, industrial turf facilities account for a large portion of the water use. Historical water use trends for the turf sector, both Municipal and Industrial, show a strong linear relationship to time and population. However, a trend line analysis on the number of golf course facilities in the Phoenix AMA shows a significant leveling off in new courses being built after 2000. With golf courses being the largest turf subsector, this slow down may indicate a future non-linear relationship between turf water use and population.

Future forecasts for electric power generation are also strongly tied to population growth, both inside the state as well as in neighboring states. Arizona Public Service (APS) projects a more than 50 percent increase in electricity needed from 2009 to 2025 (APS resource plan 2009 through 2025). They also predict that 65 percent of that energy will come from 2009 resources while the remaining will come from additional or new resources, some of that will be in the form of renewable energy resources, i.e., solar power. APS estimates that the estimated growth in Arizona's electricity demand over the next 20 years is close to 100 percent. Although many of the newly proposed power plants, including solar power, maybe located outside of the AMAs, the Phoenix AMA will likely be the location of some of this additional power generation.

10.1.1 Baseline Scenario One Demand Methodology and Assumptions

Baseline Scenario One for the Phoenix AMA assumes:

- Turf water demand would follow population projections used in Municipal Scenario One in a non linear fashion;
- Electric power generation water demand would increase modestly from current levels (Logarithm Trend line);
- Sand and gravel water demand would stay relatively constant at average Historical demand;
- Dairy water use would continue to decrease at relatively the same rate it has in recent years (it was assumed that dairies would continue moving out of the AMA at a fairly rapid rate as Phoenix urbanization increased); and
- “Other” use would stay constant at its historical average.

Feedlot water demand in 2006 was less than one percent of the Phoenix AMA’s industrial use and was therefore not included in future projections.

Assumptions for scenarios were based on the following sources: Data Management's Correlation Study of Sand and Gravel and Population, Golf Course Facility Graph, Dairy Analysis Graphs, Data Management’s Industrial Projections by Trend lines Study, APS Resource Plan 2009 through 2025, and the Resolution Copper website.

10.1.2 Baseline Scenario Two Demand Methodology and Assumptions

- Turf water demand would follow population projections used in municipal Scenario Two in a non-linear fashion;
- Electric power generation water demand would increase moderately over time (Power Trend line);
- Sand and gravel water demand would stay relatively constant at average Historical demand;
- Dairy water use would continue to decrease but not as rapidly as it has in recent years;
- Metal mining demand would begin in approximately 2019 at 20,000 acre-feet and remain constant through the projection period; and
- “Other” use would stay constant at its historical average.

10.1.3 Baseline Scenario Three Demand Methodology and Assumptions

Baseline Scenario Three made the following assumptions:

- Turf water demand would follow population projections used in municipal Scenario Three in a non-linear fashion;
- Electric power generation water demand would increase linearly over time (Linear Trend line);
- Sand and gravel water demand would stay relatively constant at average Historical demand;
- Dairy water use would hold constant through time at 2006 use;
- Metal mining demand would begin in approximately 2019 at 20,000 acre-feet and remain constant through the projection period; and

“Other” use would stay constant at its historical average.

10.2 Description of Supply Methodology and Assumptions

The assumption was made that Industrial demand would be served by the same supplies in the same proportions as in 2006, with some minor exceptions based upon specific information available to ADWR (*See Figure 10-2*). This supply methodology was similar to the one used in the 3MP when supply proportions from 1995 were projected forward.

In 2006, the Phoenix Industrial demand was met primarily with groundwater and reclaimed water. Industrial demand was met by 55 percent groundwater and approximately 39 percent reclaimed water; a majority of the reclaimed water is used at the Palo Verde Nuclear Generating Station.

Table 10-1 2025 Projected Industrial Demand by Facility Type Phoenix Active Management Area

Type of Facility	2025 Scenario One	2025 Scenario Two	2025 Scenario Three
Large-Scale Power Plants	76,148	89,990	107,365
Turf-Related Facilities	86,311	86,676	92,531
Mining	0	20,000	20,000
Sand and Gravel Operations	9,500	9,500	9,500
Dairies	3,704	5,000	10,000
Other	14,500	14,500	14,500
Total	**190,163**	**225,666**	**253,896**

Note: All volumes are in acre-feet.

10.3 Overview of Industrial Results

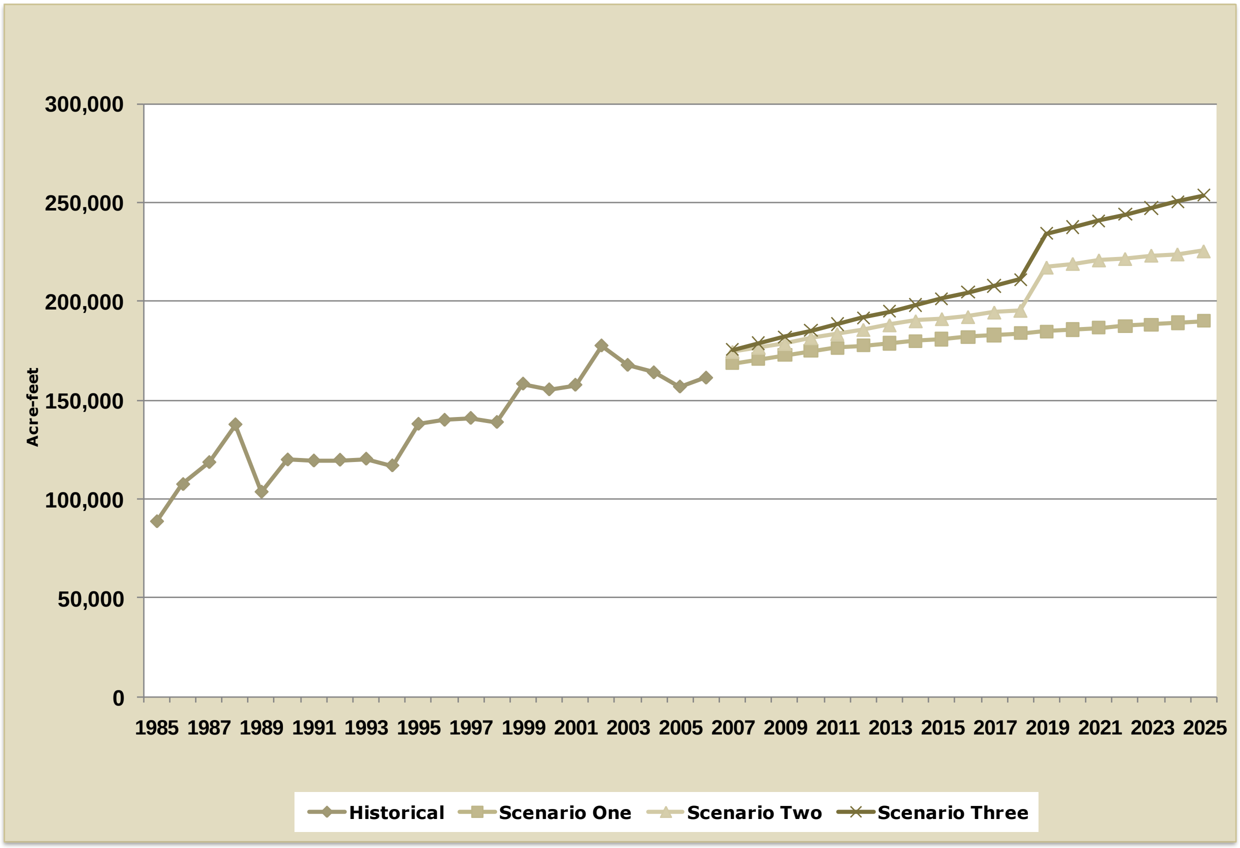
Historically, Industrial demand in the Phoenix AMA has seen a steady increase associated with sustained population growth and urbanization. From 1985 to 2006, the Phoenix AMA Industrial demand grew by more than 80 percent. Baseline Scenarios One through Three illustrate a reasonable range of potential future industrial use in the AMA ranging from 18 percent to 57 percent growth by 2025 (*See Figure 10-1).*

10.3.1 Baseline Scenario One Results

In Baseline Scenario One, Industrial demand continues to increase slightly throughout the projection period. In Baseline Scenario One, total Industrial demand is approximately 190,163 acre-feet in 2025, approximately 18 percent higher than the 2006 total demand (*See Table 10-1).*

By 2025, approximately 56 percent of the demand by 2025 is met with groundwater, approximately 39 percent of the demand is met with reclaimed water, 5 percent is met with surface water and 1 percent is met with CAP (*See Table 10-1* and *Figure 10-2*). As previously discussed, these are approximately the same percentages as in 2006.

Figure 10-1 2025 Historical and Projected Industrial Demand Phoenix Active Management Area



10.3.2 Baseline Scenario Two Results

In Baseline Scenario Two, total Industrial demand is 225,666 acre-feet in 2025; a volume that is approximately 40 percent higher than the 2006 total. Industrial demand in Baseline Scenario Two assumes a greater population than Baseline Scenario One and includes additional demands at a proposed mine near Superior, Arizona beginning in 2019 (*See Table 10-1)*.

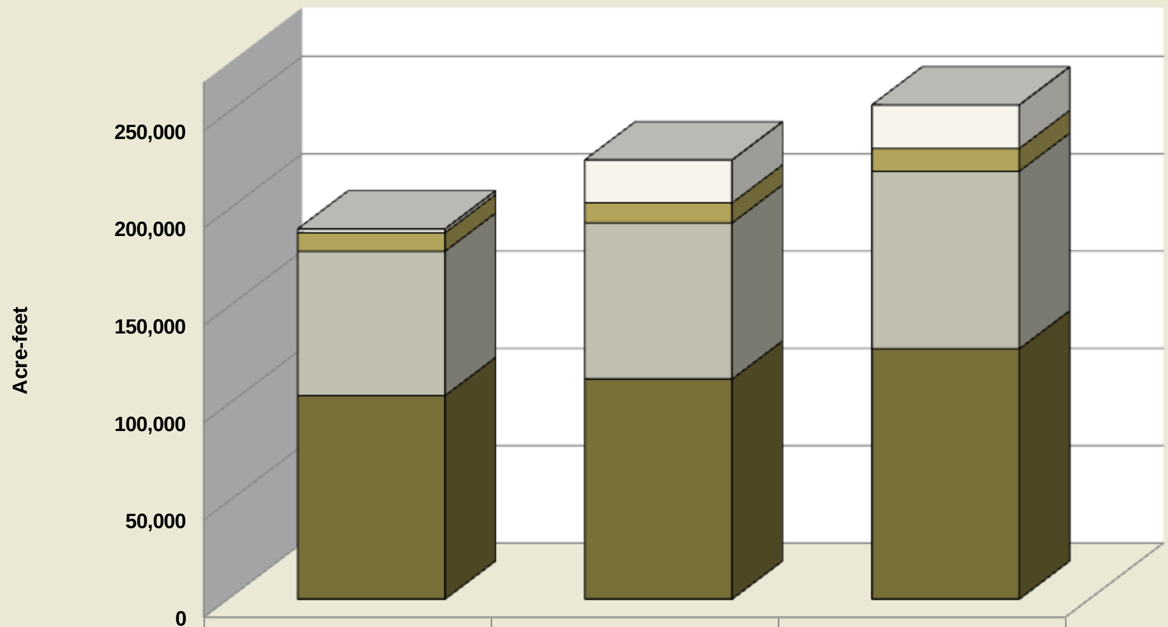
As previously discussed, the supply percentages remained the same in all Baseline Scenarios and mirror supplies utilized in 2006.

10.3.3 Baseline Scenario Three Results

In Baseline Scenario Three, total Industrial demand is 253,896 acre-feet in 2025; a volume that is 57 percent higher than the 2006 total. Industrial demand in Baseline Scenario Three assumes a greater population than Baseline Scenario Two and includes additional demands at a proposed mine near Superior, Arizona beginning in 2019 (*See Figure 10-1).*

As previously discussed, the supply percentages remained the same in all Baseline Scenarios and mirror supplies utilized in 2006.

Figure 10-2 Historical and Projected Industrial Demands
Phoenix Active Management Area



	2025 Scenario One	2025 Scenario Two	2025 Scenario Three
TOTAL	190,163	225,666	253,896
CAP	1,902	22,057	22,339
Surface Water	9,508	10,283	11,695
Reclaimed Water	74,164	80,210	91,219
Groundwater	104,590	113,116	128,643

11. AGRICULTURAL PROJECTIONS

11.1 Description of Demand Methodology and Factors Driving Agricultural Demands

Total Agricultural demand is the sum of the IGFR demands. These demands were categorized as non-exempt IGFR, exempt IGFR, and Waterlogged IGFR demands. For definitions or more information regarding these classes of users, please refer to Section 5-3.

Three baseline demand scenarios were developed for each demand sector. The overall Agricultural demand scenarios were then calculated by adding together the individual demand scenarios. This method allowed for the greatest range of future potential demand.

The Phoenix AMA individual Agricultural demand factors projections were developed using a combination of methods:

- *Trend line analysis* of historical water use (where the x-value is a measure of time)
- *Regression analysis* using historical water use and population (where the x-value, usually population, is a factor other than time)
- *Multiple regression analysis* (where there are several independent variables such as time, population, certified irrigation acres and precipitation)
- *Projections by AMA staff or sector professionals*
- Advanced tools such as the *AMA urbanization tool*

Some components of Agricultural demand for the Phoenix AMA were common to all scenarios. Non-Exempt IGFR demand was highly correlated with Non-Exempt IGFR acres and precipitation, so the same regression model was used. Variations in Non-Exempt demand were solely based on the demand factors. By contrast, Exempt IGFR demand exhibited fluctuation with no upward or downward trends, so projections were based on average historical water use (+/- one standard deviation for alternative scenarios).

11.1.1 Baseline Scenario One Demand Methodology and Assumptions

Baseline Scenario One for the Phoenix AMA includes the following assumptions:

- Non-Exempt and Waterlogged Area IGFR acreage would urbanize as projected by the AMA Urbanization Tool in the Maricopa County portion of the AMA and based on Assured Water Supply Certificates in the Pinal County portion;
- Precipitation was held constant at the 1985-2006 historical average;
- Exempt IGFR demand was held at the 1985-2006 historical average minus one standard deviation; and
- Waterlogged IGFR demand per acre was projected to increase with time and vary with precipitation, although total Waterlogged IGFR acreage was projected to decrease based on the AMA Urbanization Tool.

11.1.2 Baseline Scenario Two Demand Methodology and Assumptions

Baseline Scenario Two for the Phoenix AMA made the following assumptions:

- Non-Exempt IGFR acreage would urbanize based on population, but the rate would decrease over time;
- Precipitation was held constant at the 1985-2006 historical average;
- Exempt IGFR demand was held at the 1985-2006 historical average; and
- Waterlogged IGFR total demand was projected to increase with time and vary with precipitation, although total Waterlogged IGFR acreage was projected to decrease based on the AMA Urbanization Tool.

11.1.3 Baseline Scenario Three Demand Methodology and Assumptions

Baseline Scenario Three for the Phoenix AMA made the following assumptions:

- Non-Exempt IGFR acreage would urbanize based on population, but the rate would substantially decrease over time;
- Precipitation was held constant at the 1985-2006 historical average;
- Exempt IGFR demand was held at the 1985-2006 historical average plus one standard deviation; and
- Waterlogged IGFR total demand was projected to increase with time, although total Waterlogged IGFR acreage was projected to decrease based on the AMA Urbanization Tool.

11.2 Agricultural Supply Methodology and Assumptions

Similar techniques were used to examine the three baseline supply scenarios. Information about the current water portfolios for each irrigation district, large farm or other entity was included in the analysis.

Surface water and spill water were projected as one item rather than independently. Use of spill water was not independently projected because it depends on climate and management of reservoirs and the availability and volume is highly variable. The total projections were based on short-term average demand of surface water and spill water, compared to total IGFR acres.

CAP supplies were based on current CAP Non-Indian Agricultural (NIA) settlement pool allocations, recent use and projected demand. The total CAP NIA settlement pool water for all AMAs will be reduced by 25 percent in 2017 and by an additional 25 percent in 2024, reducing to zero after 2030. For the purposes of these projections, reductions were applied proportionately to each allottee's supply.

Reclaimed water supplies were based on current contracts and average historical reclaimed water use.

CAP and reclaimed water may be delivered to GSFs. GSF supply projections were based on current permits, and the projected amount of supplies available for storage. This supply is identified as in-lieu groundwater in this Assessment.

Projected demands not met by surface water, CAP, reclaimed water, or GSF/in-lieu water were assumed to be met by mined groundwater. See Appendix 6 for more details on the specific methodology used in projecting each demand and supply component.

11.3 Overview of Agricultural Results

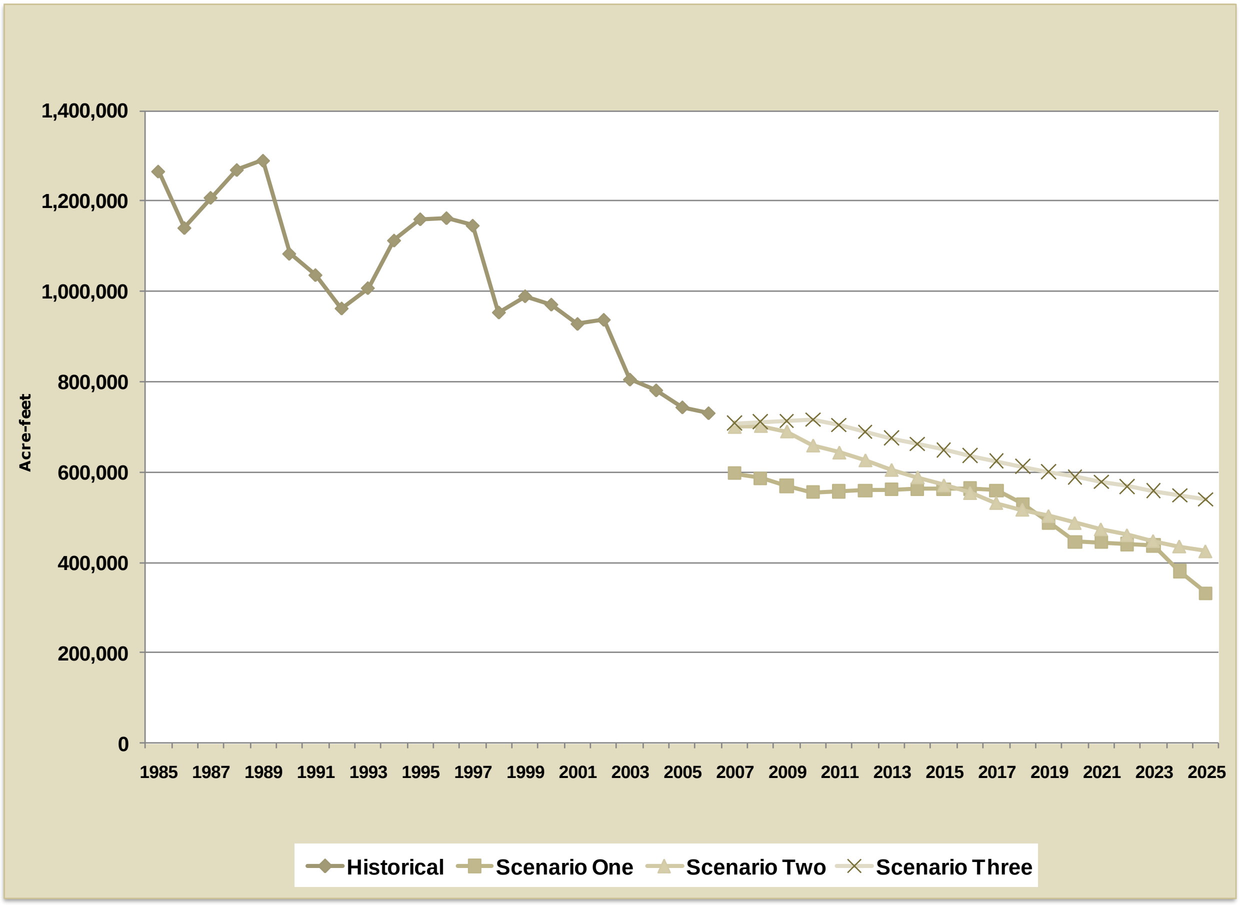
Historically, total Agricultural water demand in the Phoenix AMA has decreased as the AMA has urbanized and agricultural lands developed (*See Section 5-3*). Future agricultural demand in the AMA will most likely depend on the pattern of urbanization, the cost and availability of water supplies, crop prices, and precipitation in the AMA. Projection scenario results indicate that demand in 2025 could range from approximately 330,000 to 540,000 acre-feet (*See Table 11-1).*

Table 11-1 2025 Projected Agricultural Demand
Phoenix Active Management Area

Scenario	Total Water Use	Groundwater Use
One	331,836	256,772
Two	424,836	334,921
Three	539,356	418,681

All volumes are in acre-feet.

Figure 11-1 Historical and Projected Agricultural Demands Phoenix Active Management Area



11.3.1 Baseline Scenario One Results

In Baseline Scenario One, Agricultural demand decreases at punctuated intervals. By 2025, demand is projected to decrease by almost 52 percent, from 682,863 acre-feet in 2006 to 331,836 acre-feet in 2025 (*See Figure 11-1*). The demands in 2025 are projected to be met with approximately four percent CAP, nine percent reclaimed water, nine percent surface water, 13 percent in-lieu groundwater, and 65 percent groundwater (*See Figure 11-2*).

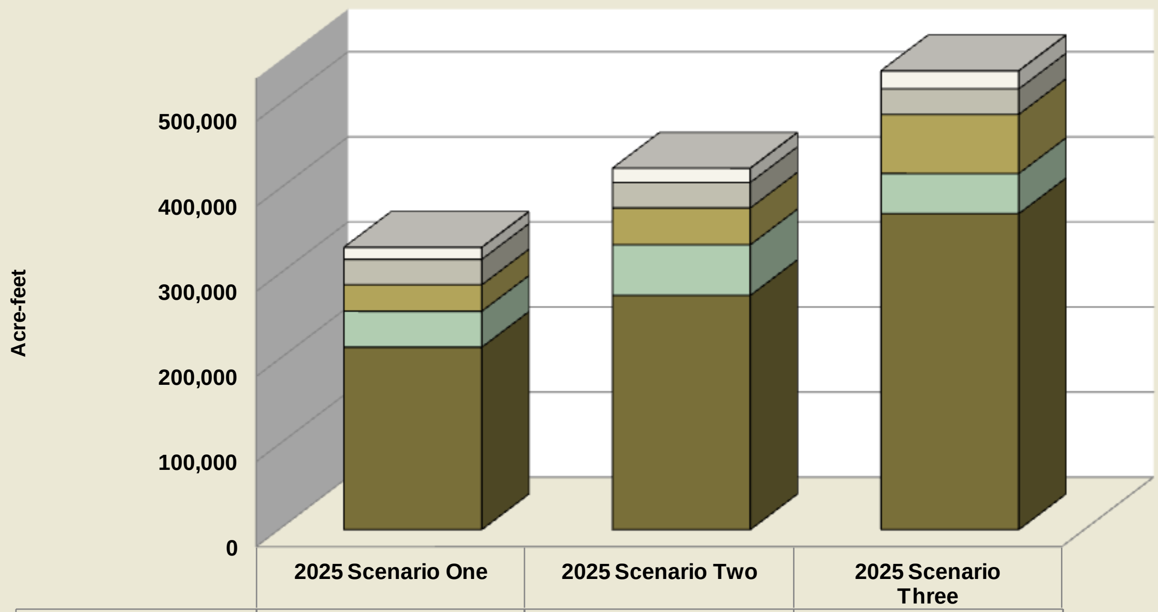
11.3.2 Baseline Scenario Two Results

In Baseline Scenario Two, Agricultural demand decreases by 38 percent, from 682,863 acre-feet in 2006 to 424,836 acre-feet in 2025 (*See Figure 11-1*). The demands in 2025 are projected to be met with approximately four percent CAP, seven percent reclaimed water, 10 percent surface water, 14 percent in-lieu groundwater, and 65 percent groundwater (*See Figure 11-2*).

11.3.3 Baseline Scenario Three Results

In Baseline Scenario Three, Agricultural demand decreases by 21 percent, from 682,863 acre-feet in 2006 to 539,356 acre-feet in 2025 (*See Figure 11-1*). The demands in 2025 are projected to be met with approximately four percent CAP, five percent reclaimed water, 13 percent surface water, nine percent in-lieu groundwater, and 69 percent groundwater (*See Figure 11-2*).

Figure 11-2 2025 Projected Agricultural Supplies
Phoenix Active Management Area



	2025 Scenario One	2025 Scenario Two	2025 Scenario Three
TOTAL ACRE-FEET	331,836	424,836	539,356
CAP	14,030	16,663	21,206
Reclaimed Water	30,000	30,000	30,000
Surface Water	31,034	43,253	69,470
In-Lieu Groundwater	42,281	59,530	47,181
Groundwater	214,491	275,391	371,499

12. INDIAN PROJECTIONS

Indian demand information is not reported to ADWR, therefore projecting demands and supply utilization can only be assumed based on historical trends and information obtained from Indian Settlements.

12.1 Description of Demand Methodology and Assumptions

Three baseline demand scenarios were developed for Indian demands within the Phoenix AMA (*See Figure 12-1)*. The primary use of water by Indian tribes or communities within the Phoenix AMA is for agricultural purposes. Generally, demand was projected based on evaluating trends in the available historical data, or reasonable assumptions regarding use based on settlement documents. No increase in demands were projected for the Indian Municipal.

12.1.1 Baseline Scenario One Demand Methodology and Assumptions

Baseline Scenario One for the Phoenix AMA includes the following assumptions:

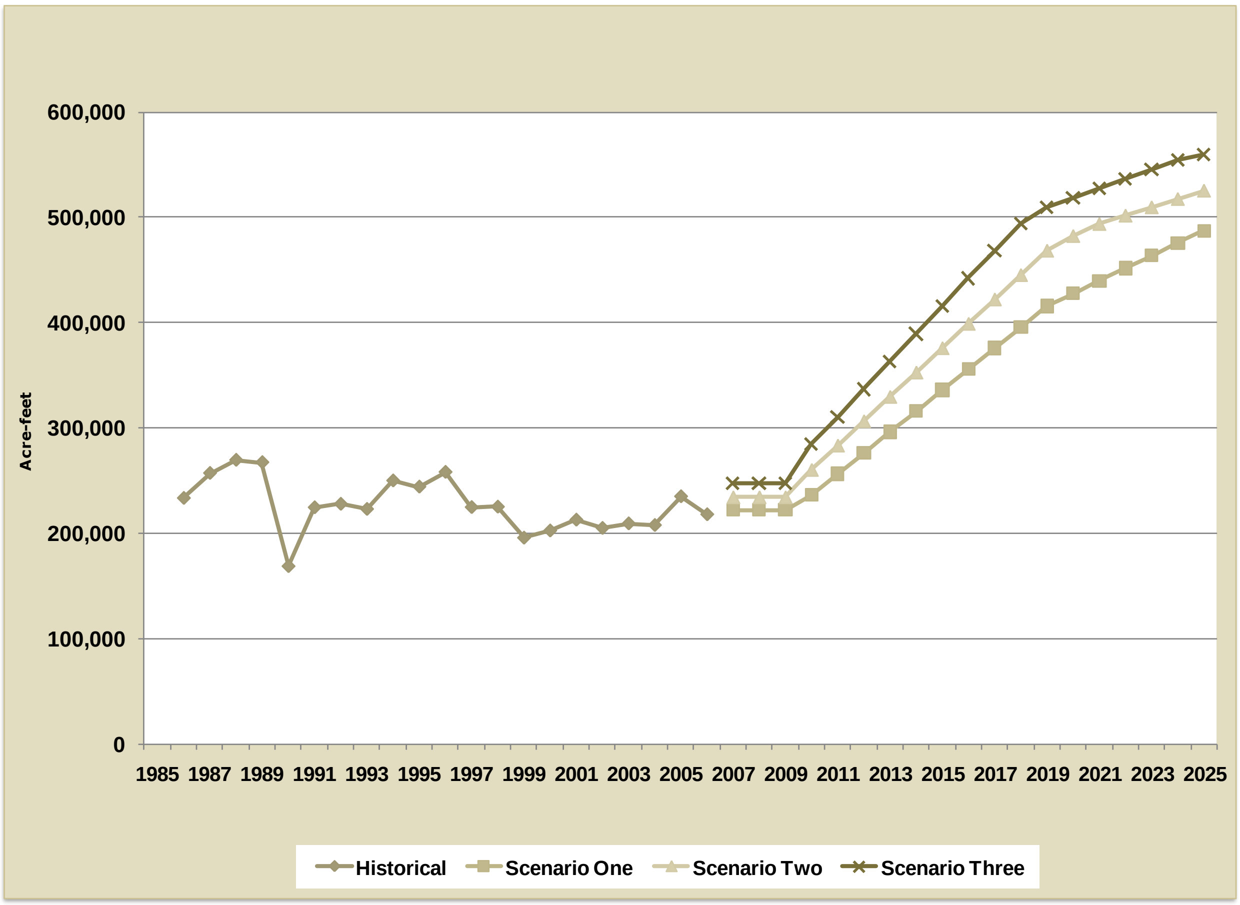
- New fields coming into production would be up to current efficiency standards;
- Low-intensity crops would be grown;
- Average surface water volumes would be available up to settlement amounts; and
- Minimum CAP allocations (based on settlement figures) would be used for agriculture, after allowances for leases and on-reservation Municipal, Industrial, and environmental uses.

12.1.2 Baseline Scenario Two Demand Methodology and Assumptions

Baseline Scenario Two for the Phoenix AMA includes following assumptions:

- New fields coming into production would be up to current efficiency standards;
- Medium-intensity crops would be grown;
- Average surface water volumes would be available up to settlement amounts; and
- Average CAP allocations (based on settlement figures) would be used for agriculture, after allowances for leases and on-reservation municipal, industrial, and environmental uses.

Figure 12-1 Historical and Projected Indian Agricultural Demand Phoenix Active Management Area



12.1.3 Baseline Scenario Three Demand Methodology and Assumptions

Baseline Scenario Three for the Phoenix AMA includes following assumptions:

- New fields coming into production would be up to current efficiency standards;
- High-intensity crops would be grown;
- Average surface water volumes would be available up to settlement amounts; and

- Maximum CAP allocations (based on settlement figures) would be used for agriculture, after allowances for leases and on-reservation municipal, industrial, and environmental uses

12.2 Description of Supply Methodology and Assumptions

Indian Agriculture in the Phoenix AMA has historically relied almost equally on groundwater and surface water supplies (*See* Section 5.4). The supply scenarios for the projections rely heavily on the supply portfolios outlined in settlement documents, resulting in a shift from groundwater use to use of CAP supplies.

12.3 Overview of Indian Results

Historically, Indian Agricultural demand has increased, while fluctuating somewhat due to water supply, climate, and economic conditions (*See Section 5.4*). Although future Indian Agricultural water demand is somewhat uncertain, it is expected to continue to increase in Phoenix AMA based on current settlements and projects (ADWR, 2006). Projection scenario results indicate that demand in 2025 could range from approximately 487,000 to approximately 559,000 acre-feet (*See Table 12-1)*.

Table 12-1 2025 Projected Indian Agricultural Demand Phoenix Active Management Area

Scenario	Total Water Use	Groundwater Use
One	487,061	23,605
Two	525,228	61,772
Three	559,306	95,850

Note: All values are in acre-feet.

12.3.1 Baseline Scenario One Results

In Baseline Scenario One, demand increases by almost 124 percent, from 217,779 acre-feet in 2006 to 487,061 acre-feet in 2025. The demands in 2025 are projected to be met with approximately 51 percent CAP, 43 percent surface water, five percent groundwater and less than one percent reclaimed water (*See Figure 12-1).*

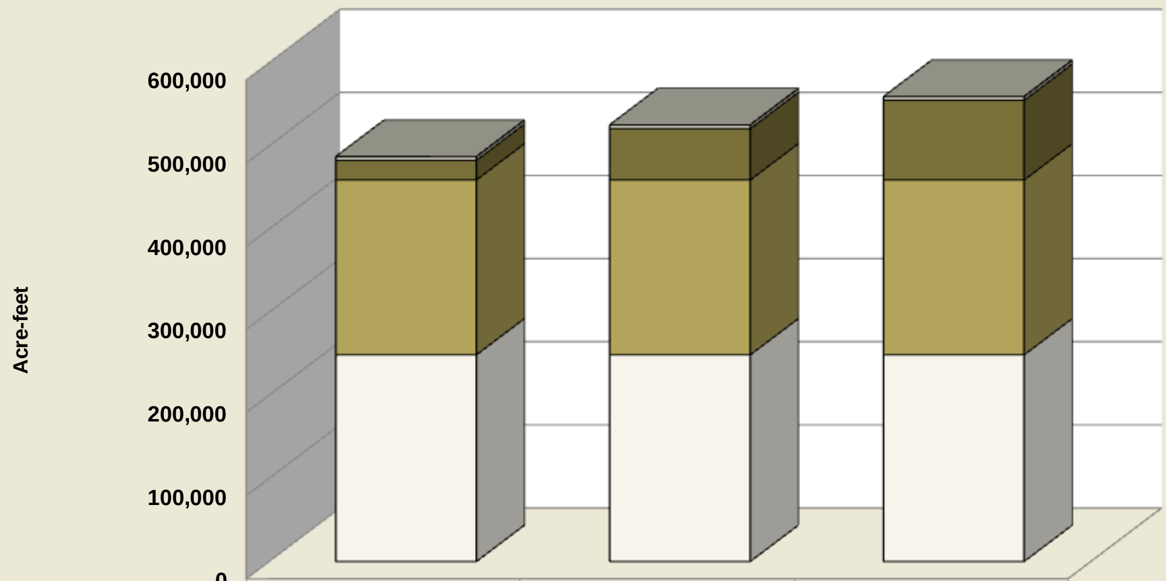
12.3.2 Baseline Scenario Two Results

In Baseline Scenario Two, demand increases by 141 percent, from 217,779 acre-feet in 2006 to 525,228 acre-feet in 2025. The demands in 2025 are projected to be met with approximately 47 percent CAP, 40 percent surface water, 12 percent groundwater and less than one percent reclaimed water (*See Figure 12-1*).

12.3.3 Baseline Scenario Three Results

In Baseline Scenario Three, demand increases by 157 percent, from 217,779 acre-feet in 2006 to 559,306 acre-feet in 2025. The demands in 2025 are projected to be met with approximately 44 percent CAP, 38 percent surface water, 17 percent groundwater and less than one percent reclaimed water (*See Figure 12-1*).

Figure 12-2 2025 Projected Indian Agricultural Supplies
Phoenix Active Management Area



	2025 Scenario One	2025 Scenario Two	2025 Scenario Three
TOTAL ACRE-FEET	487,061	525,228	559,306
Reclaimed Water	4,500	4,500	4,500
Groundwater	23,605	61,772	95,850
Surface Water	210,400	210,400	210,400
CAP	248,556	248,556	248,556

13. RECHARGE PROJECTIONS

In the Phoenix AMA, historical recharge activity fluctuated between storage at USFs and GSFs. In the projections, the majority of recharge activity consists of storage at USFs; the primary differences in the three baseline scenarios are the volumes of the various source waters stored.

A significant amount of recovery occurs in all three baseline scenarios, however, between 65 percent and 80 percent of all the water stored during the period remains in storage in all three scenarios.

13.1 Projection Methodology of CAP Recharge at Groundwater Savings Facilities

Historically in the Phoenix AMA the majority of recharge was CAP storage at GSFs. Due to the reduction in agricultural acres in the projections, and an assumption that the AWBA and the CAGRD would focus on storing at USFs in the future, storage shifts away from GSFs and becomes dominated by USF storage in all three baseline scenarios. However, GSF storage still accounts for a significant amount of underground storage in the Phoenix AMA in the future.

The Overall Projection of CAP Available to Store

The amount of CAP water available to store was projected by examining and accounting for all projected uses of CAP, direct as well as stored, for all three CAP AMAs.

Municipal CAP use was projected based on individual assumptions of supply utilization for each large provider. Assumptions were based on information included in applications for DAWS, historical use of CAP water, current and future water treatment capacity, and a review of current ability to store and recover CAP water.

A volume of CAP water stored by municipal providers was projected for each year. At a maximum, this could be equal to the total CAP M&I allocation of each provider minus any direct CAP use. Generally, if a provider was directly using less than their allocation, the remaining volume was assumed to be stored up to the provider's maximum permitted underground storage capacity for CAP water. Recovered water was assumed to be a portion of the volume assumed to be stored that year (annual recovery), except in years in which the provider's recovered volume exceeded the amount the provider stored; any amount over and above the amount stored is assumed to be recovery of long-term storage credits.

CAP use in both the Industrial and Agricultural sectors was projected based on information obtained from CAP users in those sectors and from past trends.

Potential Indian CAP use was projected based on review of settlement documents.

Arizona Water Bank

AWBA staff prepared the initial projections of Excess CAP water use by the AWBA; adjustments were made based on ADWR's projected CAP water use by other users. The projections (except for 2007 and 2008 for which historical data was used) are based on the assumptions used to develop the AWBA's Ten-Year Plan of Operation for 2010 through 2019 (AWBA Plan), adopted June 17, 2009. The assumptions in the AWBA Plan were carried forward to 2025 for the purposes of this Assessment.

The assumptions also incorporated CAWCD's Procedure to Distribute Excess Water for 2010 through 2014, adopted by the CAWCD Board of Directors in 2009. In anticipation of increasing demands for excess CAP water, CAWCD staff developed a strategy for distributing excess CAP water among competing demands. Under this strategy, CAWCD created four pools of excess CAP water, in addition to the previously established CAP NIA settlement pool, that guide how excess water will be distributed when demand for this supply exceeds the availability of the supply. One of these pools is for the AWBA, the CAGRD and the United States Bureau of Reclamation for a fixed volume of 175,000 acre-feet per year. The AWBA's portion of the pool is determined by subtracting the CAGRD's projected storage amount. Although the CAWCD Procedure to Distribute Excess Water is for a five-year period, it was assumed that it, or a similar policy, would continue through 2025. The AWBA's annual storage in each of the three CAP AMAs was also based on the availability of funding and storage capacity in the AMAs. The two main funding sources for the AWBA are withdrawal fees and *ad valorem* taxes levied by CAWCD. Expenditure of these funds is for the benefit of the AMA/county in which they were collected. The last year of *ad valorem* collections is 2016, leaving withdrawal fees as the principal funding source for the AWBA. Although funding is typically the limiting factor in the Pinal and Tucson AMAs, it does not become a limiting factor in the Phoenix AMA until after *ad valorem* tax collections cease.

Finally, the AWBA projections include interstate banking for SNWA after all funding sources and capacity for Arizona storage are utilized. Water stored on behalf of SNWA could include Colorado River supplies acquired by CAWCD and the AWBA's SNWA funds.

Adjusting the Amount of CAP Available to Store

Adjustments to the amount of CAP available to store were approached comprehensively for the CAP AMAs. In some years, the total of the projected uses exceeded the assumed available CAP supply, which varies year to year (*See Table 14-1*). In this situation, the projected storage of CAP water in each AMA was reduced based on the CAWCD Procedure to Distribute Excess

Water. In other years, the sum of all projected uses of CAP water across all three AMAs was less than the volume of CAP water assumed to be available. In this situation, the surplus was distributed based on the CAWCD Procedure to Distribute Excess Water. Although the policy extends through the year 2014, the projection scenarios presume that the policy continues, rather than reverting to a pre-policy assumption after the year 2014. If any AMA did not have to capacity to store its portion of the surplus, the surplus was moved to another AMA that had the capacity to store it. This adjustment is based on the assumption that all CAP water available will be fully utilized in each projection year.

13.2 Projection Methodology of Reclaimed Water Recharge at Groundwater Savings Facilities

Reclaimed water is primarily stored at USFs in the Phoenix AMA and under the baseline scenarios this is projected to continue into the future. However, a significant amount of reclaimed water storage at GSFs is projected to occur in all three baseline scenarios between 2007 and 2025.

The Overall Projection of Reclaimed Water Available to Store

Projecting reclaimed water storage began with a projection of the volume of reclaimed water supply in the AMA. The available reclaimed water supply was projected using a "reclaimed water GPCD." The reclaimed water GPCD was calculated by dividing historical reclaimed water generated by historical population. The reclaimed water GPCD was then multiplied by the projected large provider population to project future reclaimed water generated.

The projected uses of reclaimed water by all water use sectors were subtracted from the amount projected to be generated. In the Municipal sector, reclaimed water use was projected based on individual assumptions for each large provider. Assumptions were based on information included in the providers' DAWS, historical use of reclaimed water, current and future wastewater treatment capacity, and a review of current ability to store and recover reclaimed water.

The remaining reclaimed water supply was divided in half, with half assumed to be additional reclaimed water stored and half assumed to be discharged. The volume of reclaimed water available for storage varied each year based on the difference between the projected populations among the three scenarios.

Reclaimed water storage at GSFs decreases over time as agricultural acres diminish due to urbanization in the projection scenarios. The remaining available reclaimed water that is not used directly or discharged is assumed to be stored at USFs, even above and beyond the currently permitted capacity of reclaimed water USFs. The assumption is that additional, local USFs will be permitted that will be able to store the increased supply of reclaimed water.

13.3 Projection Methodology of CAP Recharge at Underground Storage Facilities

CAP storage at constructed underground storage facilities is the primary type of recharge occurring in the Phoenix Active Management Area. This is anticipated to continue to be the situation through at least 2025. For purposes of this Assessment, the operational capacity for underground storage of CAP in the Phoenix AMA was assumed to be 440,000 acre-feet per year. Because the Phoenix AMA has the greatest operational underground storage capacity of the three CAP-using AMAs, CAP water was moved into the Phoenix AMA in years where there was insufficient storage capacity to store CAP water in other AMAs. This assumption was made in order to fully utilize CAP water, which is presumed to occur in each projection year in this Assessment.

13.4 Projection Methodology of Reclaimed at Underground Storage Facilities

After the total volume of reclaimed water generated that could be stored was determined (see Section 13.2, above) and the GSF reclaimed water stored subtracted out, the remaining reclaimed water was assumed to be stored at USFs. The amount of agricultural land in production has a direct effect on the volume of reclaimed water available to be stored at USFs in the scenarios. Baseline Scenario Two has a higher Agricultural demand, and hence the ability to utilize more GSF reclaimed water than Baseline Scenario One. This means that relatively less reclaimed water is available for USF storage in Baseline Scenario Two than in Baseline Scenario One.

13.5 Projection Methodology of Surface Water Recharge at Underground Storage Facilities

ADWR projected the annual storage and recovery of surface water based on information included in the DAWS. ADWR did not make an assumption regarding what portion of surface water recharge was Plan 6 and non-Plan 6. Surface water stored was projected in lump sum, based on the need of a water provider to annually store and recover surface water to meet individual service area demand and maintain the DAWS into the future. This is the reason why *Table 13-2* does not show any additional Plan 6 storage.

13.6 Overview of Artificial Recharge Results

13.6.1 Baseline Scenario One Results

The projected volume of CAP stored at GSFs in the year 2025 is 34,215 acre-feet. This is a decrease of about 64 percent from the 93,804 acre-feet volume stored in 2006 (*See Table 13-1*). The projected volume of reclaimed water stored at GSFs in the year 2025 is 8,066 acre-feet. This is a decrease of 73 percent from the volume stored in 2006.

The amount of CAP stored at Constructed USFs in 2025 is almost six percent greater, or 12,933 acre-feet more than the amount stored in 2006. The amount of CAP stored at Managed USFs in 2025 is about 12 percent less, or 1,884 acre-feet less than the amount stored in 2006.

Reclaimed water stored at Constructed USFs is projected to be155,567 acre-feet in the year 2025 in Baseline Scenario One. This is an increase of over 500 percent over the volume stored in 2006.

Surface water that is annually stored and recovered decreased from 20,713 acre-feet in 2006 to 13,264 acre-feet in 2025 in Scenario One, a decrease of almost 36 percent.

Cumulative USF CAP that is projected from 2007 through 2025 in Scenario One is 3,540,632 acre-feet, added to the 1,214,642 acre-feet stored in 2006 results in a total storage of CAP through USFs in 2025 of 4,755,274 acre-feet.

The total reclaimed water stored in USF by 2025 is projected to be 2,295,646 acre-feet, due to an additional 1,995,606 acre-feet to be stored between 2007 and 2025.

The total volume of surface water that is annually stored and recovered is projected to be 295,849 acre-feet between 2007 and 2025.

In Baseline Scenario One, the projected cumulative amount of GSF CAP storage from 2007 through 2025 is 1,436,695 acre-feet. Thus, by 2025, the total GSF CAP storage in Baseline

Table 13-1 2006 Historical and 2025 Projected Artificial Recharge Phoenix Active Management Area

Recharge Facilities	2006	Scenario One	Scenario Two	Scenario Three
Groundwater Savings Facility				
Number of Facilities	11			
CAP Stored	93,804	34,215	48,173	30,146
Reclaimed Water Stored	30,000	8,066	11,357	17,036
Underground Storage Facilities (Constructed)				
Number of Facilities	41			
CAP Stored	222,707	235,640	83,585	9,779
Surface Water Stored	20,713	13,264	13,264	13,264
Reclaimed Water Stored	25,569	155,567	135,253	174,107
Underground Storage Facilities (Managed)				
Number of Facilities	3			
CAP Stored	16,054	14,170	14,170	14,170
Reclaimed Water Stored	1,595	0	0	0
Total Delivered to Storage	**410,442**	**460,923**	**305,802**	**258,501**

Note: Volumes are in acre-feet. Figures reflect water delivered to be stored, minus losses.

Scenario One, including the amount of water that had been stored through 2006, is 3,499,688 acre-feet.

The total reclaimed water stored in GSF by 2025 is projected to be 513,721 acre-feet, due to an additional 360,331 acre-feet to be stored between 2007 and 2025.

These figures reflect the volume of water stored, not including cuts to the aquifer or physical losses (*See Table 13-2*).

13.6.2 Baseline Scenario Two Results

The projected volume of CAP stored at GSFs in the year 2025 is 48,173 acre-feet. This is a decrease of about 49 percent from the 93,804 acre-feet volume stored in 2006 (*See Table 13-1)*. The projected volume of reclaimed water stored at GSFs in the year 2025 is 11,357 acre-feet. This is a decrease of 62 percent from the volume stored in 2006.

The amount of CAP stored at Constructed USFs in 2025 is 62 percent less, or 139,122 acre-feet less than the amount stored in 2006. The amount of CAP stored at Managed USFs in 2025 is 12 percent less, or 1,884 acre-feet less than the amount stored in 2006.

Reclaimed water stored at Constructed USFs is projected to be135,253 acre-feet in the year 2025 in Baseline Scenario Two. This is an increase of 429 percent over the volume stored in 2006.

Table 13-2 2006 and Projected Cumulative Artificial Recharge Credits Through 2025 Phoenix Active Management Area

Long Term Storage Credits	2006	Scenario One	Scenario Two	Scenario Three
Underground Storage Facilities	41			
CAP	1,214,642	4,755,274	2,994,410	2,054,913
Reclaimed Water	300,040	2,295,646	2,200,798	2,349,152
Surface Water (Plan 6)	6,922	302,771	725,694	745,564
Total	1,521,604	7,353,691	5,920,903	5,149,629
Groundwater Savings Facilities	11			
CAP	2,062,993	3,499,688	3,611,528	3,230,945
Reclaimed Water	153,391	513,721	536,788	607,641
Total	2,216,384	4,013,409	4,148,317	3,838,586
TOTAL USF/GSF Storage	3,737,988	11,367,101	10,069,219	8,988,215
Arizona Water Bank				
Intrastate	1,213,547	1,752,364	1,559,193	1,432,791
Interstate - Nevada	23,820	23,820	23,820	23,820
TOTAL WATER BANK	1,237,367	1,776,184	1,583,013	1,456,611
CAWCD/CAGRD				
CAWCD	339,881			
CAGRD	1,146	477,101	290,704	181,108
Conservation District Account	50,900			
Replenishment Reserve Account	16,953			
TOTAL CAWCD/CAGRD	408,880			
Recovery	496,802	1,604,976	2,417,462	3,017,578
Credits Remaining in Storage	**3,241,186**	**9,762,125**	**7,651,758**	**5,970,638**

Note: Volumes are in acre-feet. “Credits Remaining in Storage” is calculated by totaling Total USF/GSF storage minus Recovery.

Surface water that is annually stored and recovered decreased from 20,713 acre-feet in 2006 to 13,264 acre-feet in 2025 in Scenario Two, a decrease of almost 36 percent. This volume is the same in all three baseline scenarios

Cumulative USF CAP that is projected from 2007 through 2025 in Scenario Two is 1,779,768 acre-feet, added to the 1,214,642 acre-feet that had already been stored by 2006 results in a total storage of CAP through USF in 2025 of 2,994,410 acre-feet.

The total reclaimed water stored in USF by 2025 is projected to be 2,200,798 acre-feet, due to an additional 1,900,759 acre-feet to be stored between 2007 and 2025.

The total volume of surface water that is annually stored and recovered is projected to be 718,772 acre-feet between 2007 and 2025.

In Baseline Scenario Two, the projected cumulative amount of GSF CAP storage from 2007 through 2025 is 1,548,535 acre-feet. Thus, by 2025, the total GSF CAP storage in Baseline Scenario Two, including the amount of water that had been stored through 2006, is 3,611,528 acre-feet.

The total reclaimed water stored in GSF by 2025 is projected to be 536,788 acre-feet, due to an additional 383,398 acre-feet to be stored between 2007 and 2025.

These figures reflect the volume of water stored, not including cuts to the aquifer or physical losses (*See Table 13-2*).

13.6.3 Baseline Scenario Three Results

The projected volume of CAP stored at GSFs in the year 2025 is 30,146 acre-feet. This is a decrease of 69 percent from the 93,804 acre-feet volume stored in 2006 (*See Table 13-1*). The projected volume of reclaimed water stored at GSFs in the year 2025 is 17,036 acre-feet. This is a decrease of 43 percent from the volume stored in 2006.

The amount of CAP stored at Constructed USFs in 2025 is 96 percent less, or 212,928 acre-feet less than the amount stored in 2006. The amount of CAP stored at Managed USFs in 2025 is 12 percent less, or 1,884 acre-feet less than the amount stored in 2006.

Reclaimed water stored at Constructed USFs is projected to be174,107 acre-feet in the year 2025 in Baseline Scenario Three. This is an increase of over 580 percent over the volume stored in 2006.

Surface water that is annually stored and recovered decreased from 20,713 acre-feet in 2006 to 13,264 acre-feet in 2025 in Scenario Three, a decrease of almost 36 percent. This volume is the same in all three baseline scenarios.

Cumulative USF CAP that is projected from 2007 through 2025 in Scenario Three is 840,271 acre-feet, added to the 1,214,642 acre-feet that had already been stored by 2006 results in a total storage of CAP through USF in 2025 of 2,054,913 acre-feet.

The total reclaimed water stored in USFs by 2025 is projected to be 2,349,152 acre-feet, due to an additional 2,049,113 acre-feet to be stored between 2007 and 2025.

The total volume of surface water that is annually stored and recovered is projected to be 738,642 acre-feet between 2007 and 2025.

In Baseline Scenario Three, the projected cumulative amount of GSF CAP storage from 2007 through 2025 is 1,167,952 acre-feet. Thus, by 2025, the total GSF CAP storage in Baseline Scenario Three, including the amount of water that had been stored through 2006, is 3,230,945 acre-feet.

The total reclaimed water stored in GSF by 2025 is projected to be 607,641 acre-feet, due to an additional 454,251 acre-feet to be stored between 2007 and 2025.

These figures reflect the volume of water stored, not including cuts to the aquifer or physical losses (*See Table 13-2*).

14. ADDITIONAL SCENARIOS

14.1 CAP Shortage Projected Scenarios

This Assessment includes three additional scenarios incorporating reduced CAP supplies in recognition of potential climate change impacts, resulting in a shortage of CAP supplies. The consensus of an international panel of climate science experts, the International Panel on Climate Change (IPCC), is that the southwestern United States is likely to experience significant impacts from warming, particularly in the water resources sector (Intergovernmental Panel on Climate Change, 2007). IPCC predicts with high confidence that average temperatures will continue to increase. There is now also a strong indication of reductions in winter precipitation in northern Mexico and the southern portions of the southwestern United States. This means that even if total precipitation increases on average across the globe, drought is likely to become an even greater problem in the region than it is today, perhaps becoming the new "normal" (Seagar & Ting, 2007). The IPCC findings also conclude that the intensity of precipitation is likely to increase in future climate scenarios for the southwestern United States. Therefore, both extremes of precipitation – floods and droughts – will increasingly challenge water managers in the region. Increases in temperature, particularly in summer, will affect demand for water in Arizona. Higher temperatures lead to more demand for electricity for air conditioning; more water required to support agriculture, landscaping, and ecosystems; and more evaporative losses from reservoirs, etc.

Across the Colorado River watershed, runoff information generated from the output of a strong majority of the 22 global climate models predicts that flow in the Colorado River will be reduced over the next century. These reductions in flow are primarily a result of drying caused by higher temperatures which would result in reduced soil moisture, increased evapotranspiration and reservoir losses. As the flow in the Colorado River is already fully allocated, any reductions in flow will have consequences for the many water managers who rely on the Colorado River as a source. Additionally, within Arizona, predicted losses of snowpack along the Mogollon Rim and other high elevation areas will likely change the volume and timing of peak runoff and may impact downstream users and habitat (Jacobs, 2009).

Several climate change models exist for the southwestern region of the United States, but at this time, are not localized enough to be useful for the purposes of this Assessment. Instead, ADWR incorporated a period of reduced surface water availability by using actual historical supply records as described below, and developed a CAP shortage scenario. A shortage on the Salt/Verde was not incorporated at this time.

14.1.1 CAP Shortage Projection Methodology

In addition to the three baseline scenarios discussed in section 8 through 13, an additional three projection scenarios were prepared that included projecting a shortage of CAP supply. Demand was not altered for any of the shortage projection scenarios; therefore, reclaimed water supply remained unaffected, as did reclaimed water recharge.

ADWR Colorado River Management (CRM) staff, based on the 100-year record of Colorado River flow, generated the projected CAP shortage values. CRM based their calculations on the actual volume of water available on the Colorado River, which varies from year to year. CRM generated 101 different sequences using the BOR's Colorado River System Simulation RiverWare computer model. Forty-nine of the one hundred one sequences simulated shortages. The range of shortages is from 320,000 acre-feet to 5,275,400 acre-feet for the period 2009 to 2025. The ADWR Water Management Division selected a representative shortage sequence from 2012 to 2019 because it fell into the time period that was being evaluated to use as a shortage scenario for this Assessment. The projected CAP availability and shortage volumes from the sequence selected are shown in *Table 14-1* below.

Table 14-1 CAP Shortages for Shortage Scenarios All CAP Active Management Areas

Year	Projected CAP Availability	Shortage	Shortage Supply
2009	1,433,223	0	1,433,223
2010	1,414,442	0	1,414,442
2011	1,412,872	0	1,412,872
2012	1,411,303	320,000	1,091,305
2013	1,409,733	400,000	1,009,733
2014	1,408,164	480,000	928,473
2015	1,406,594	400,000	1,006,596
2016	1,405,025	480,000	926,753
2017	1,403,455	400,000	1,003,457
2018	1,401,885	400,000	1,001,887
2019	1,400,550	400,000	1,000,553
2020	1,399,215	0	1,399,215
2021	1,397,902	0	1,397,902
2022	1,382,590	0	1,382,590
2023	1,381,277	0	1,381,277
2024	1,379,964	0	1,379,964
2025	1,378,651	0	1,378,651
Sum of Shortage	**23,826,844**	**3,280,000**	**20,546,844**

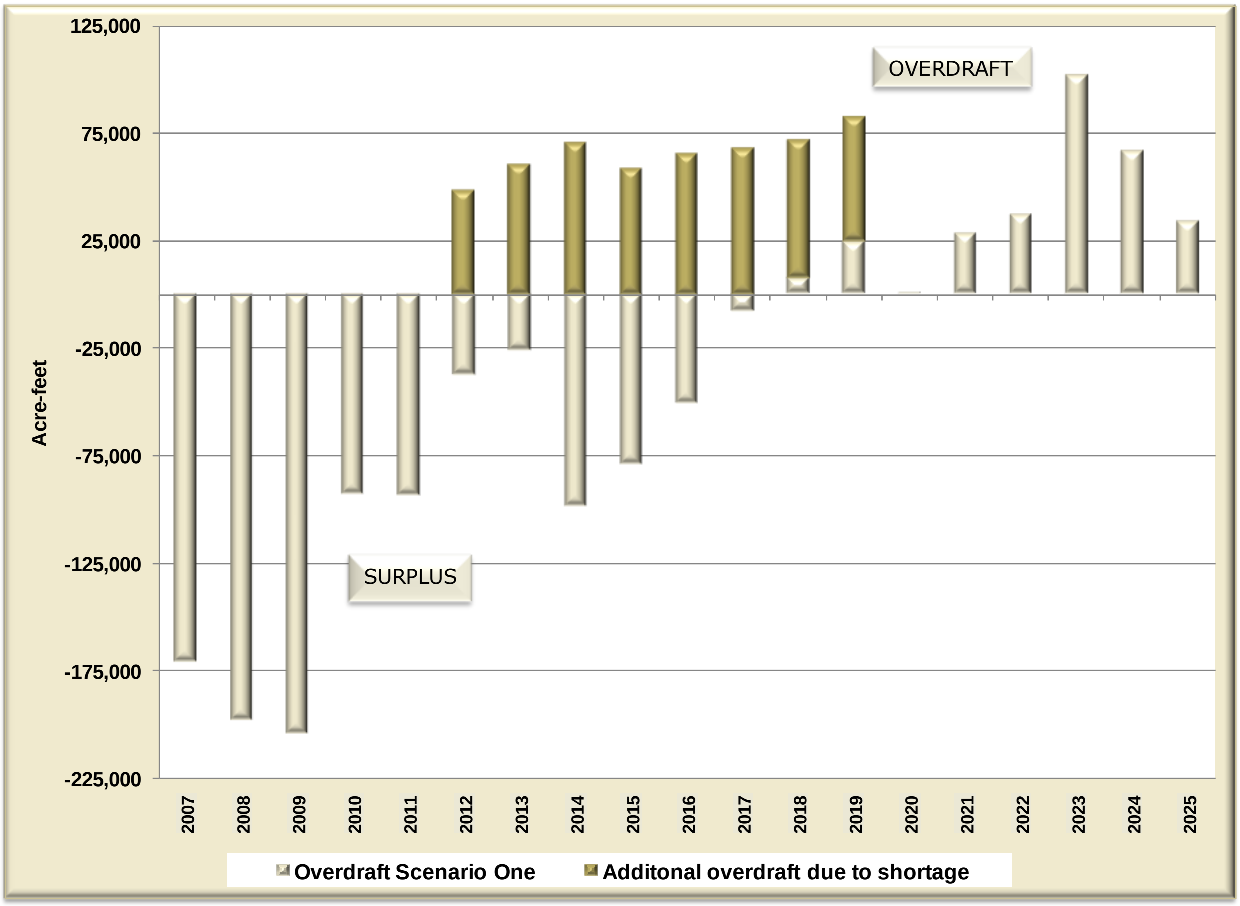
Note: All volumes are in acre-feet.

The shortage volumes for years 2012 through 2019 were subtracted from the assumed CAP availability for each year as projected by CRM to generate the shortage projection in those years. Then, the projected volume of CAP use was cut back, using the CAWCD Procedure to Distribute Excess Water Policy, to adjust CAP use to meet the shortage supply. In some years in all three shortage scenarios, the shortage went beyond the excess CAP and cut into the CAP NIA settlement pool water. In this case, the shortage to the CAP NIA settlement pool water was pro-rated among the three CAP AMAs based on the projected Agricultural direct CAP use in non-shortage years.

14.1.2 CAP Shortage Projection Results

Because the shortages mostly affect excess CAP water, cumulative projected overdraft between 2007 and 2025 is between 19 and 165 percent larger due to the projected CAP shortage. This is due to the decreased availability of excess CAP water stored, a decrease in CAP availability to the agricultural sector both as in-lieu CAP and as pool supply, and a corresponding increase in groundwater pumping in the Agricultural sector to make up for the lost supply. *Figure 14-1*, *Figure 14-2*, and *Figure 14-3* show the relative difference in projected annual overdraft between non-shortage and shortage scenarios for each year from 2007 through 2025.

Figure 14-1 Shortage Scenario One Projected Annual Overdraft With and Without CAP Shortage Phoenix Active Management Area



Up to this point, the shortage has been viewed on an annual basis. However, the overall effect of a shortage of this type on the entire projection period from 2007 through 2025 is shown in *Table 14-2* . Cumulative projected overdraft, where the overdraft of each year is added for a cumulative effect, increases between 413,886 and 492,741 acre-feet due to the shortage, which ranges from 19 to 164 percent.

Due to the significant volume of lagged agricultural incidental recharge, canal seepage, and net natural recharge compared to projected groundwater withdrawals, all three baselines scenarios are in surplus for several years at the beginning of the projection period. Surplus appears as negative overdraft in *Table 14-2*. The shortage scenarios eliminate the surplus and instead, put the AMA into an overdraft situation.

Figure 14-2 Shortage Scenario Two Projected Annual Overdraft With and Without CAP Shortage Phoenix Active Management Area

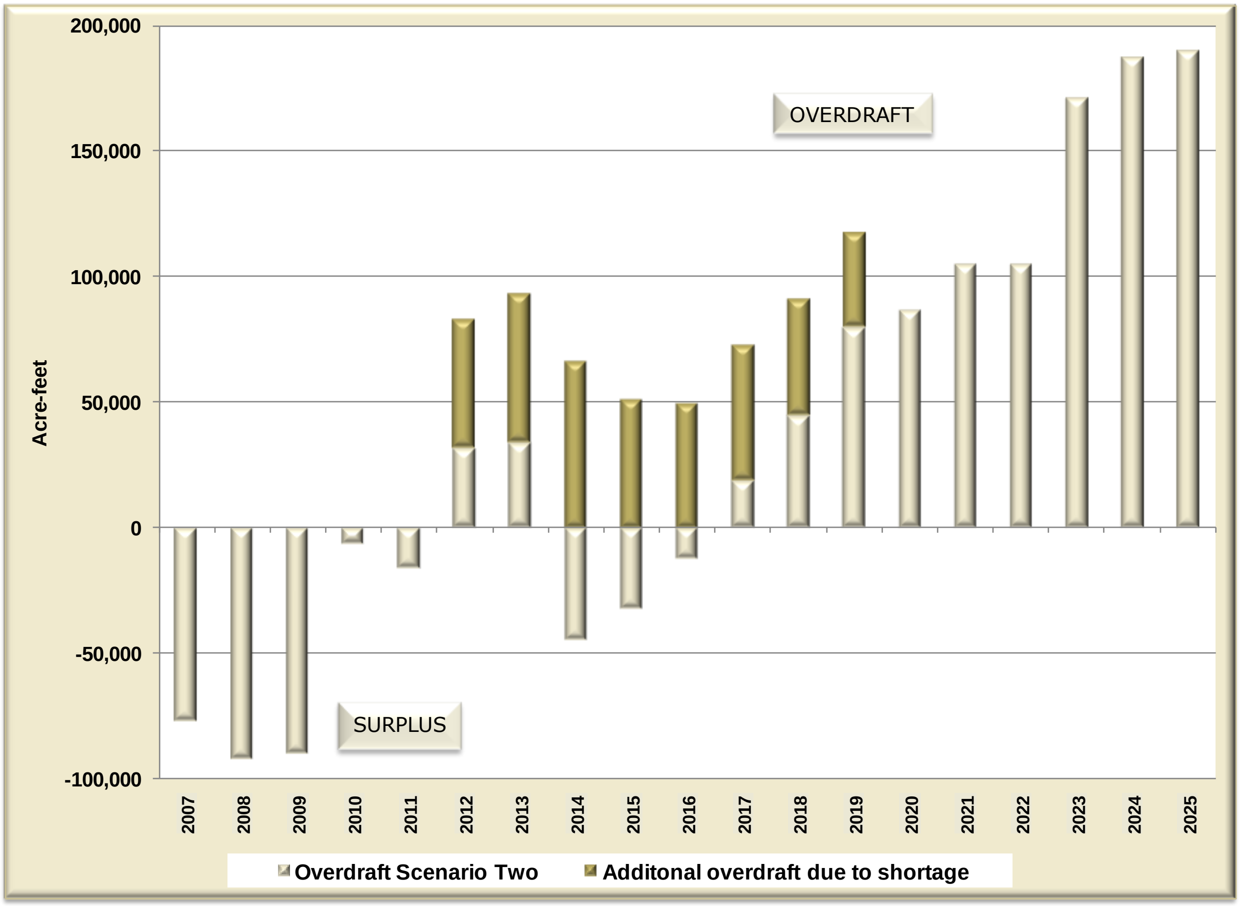


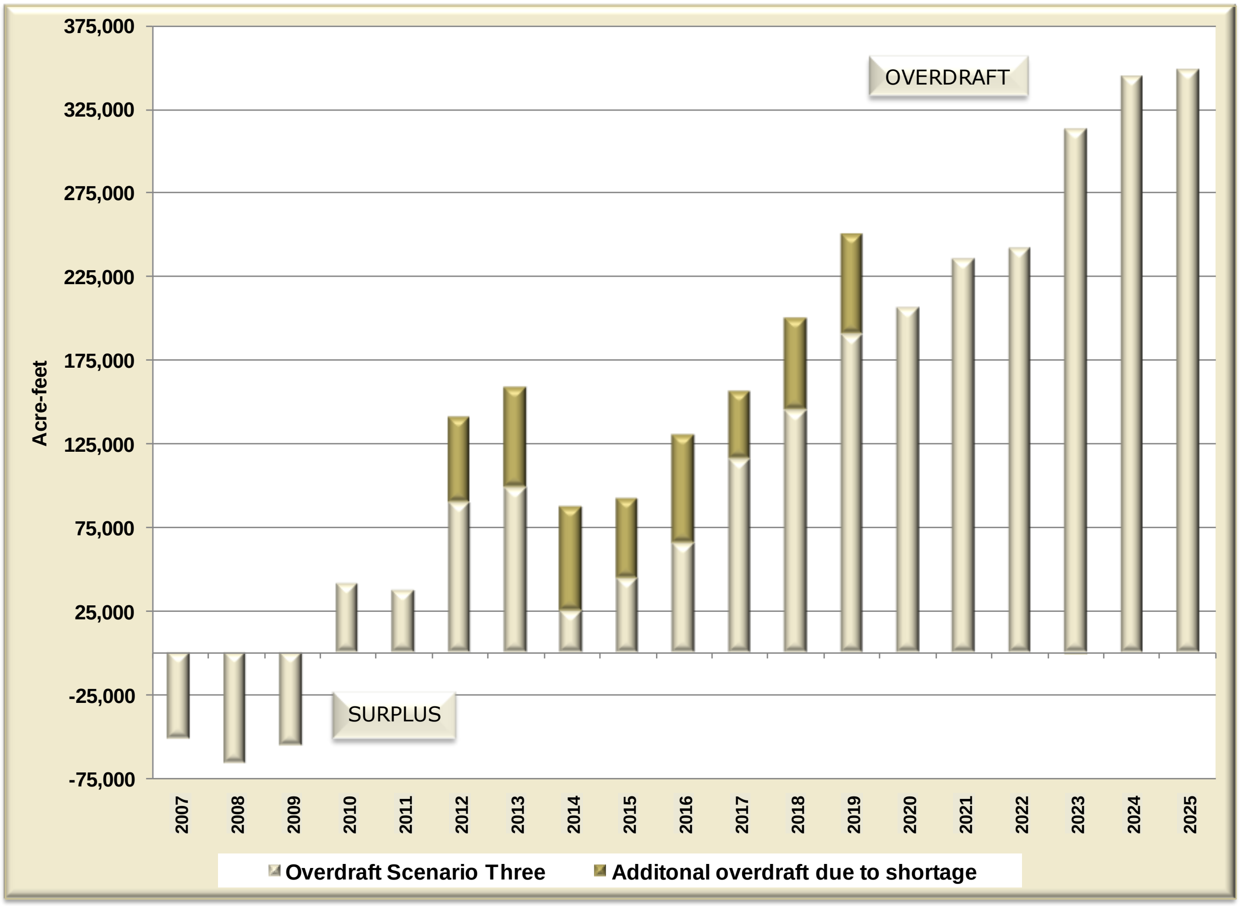
Table 14-2 Shortage Scenarios – Cumulative Projected Overdraft Phoenix Active Management Area

YEAR	2010	2015	2020	2025
Baseline Scenario One				
Cumulative Overdraft	-665,020	-999-986	-1,027,285	-759,323
Cumulative Additional Overdraft due to Shortage	0	237,788	492,741	492,741
Total Overdraft Shortage Scenario One	**-665,020**	**-762,198**	**-534,544**	**-266,582**
Baseline Scenario Two				
Cumulative Overdraft	-266,068	-295,073	-78,753	678,769
Cumulative Additional Overdraft due to Shortage	0	226,974	413,886	413,886
Total Overdraft Shortage Scenario Two	**-266,068**	**-68,100**	**335,133**	**1,092,655**
Baseline Scenario Three				
Cumulative Overdraft	-131,130	165,556	888,482	2,370,381
Cumulative Additional Overdraft due to Shortage	0	220,152	439,584	439,565
Total Overdraft Shortage Scenario Three	**-131,130**	**385,708**	**1,328,065**	**2,809,946**

Note: Volumes are in acre-feet.

The most substantial impacts of the shortage are on the AWBA and on the CAGRD, which store excess CAP water, the lowest priority CAP supply.

Figure 14-3 Shortage Scenario Three Projected Annual Overdraft With and Without CAP Shortage Phoenix Active Management Area



14.1.3 Shortage Scenario One Results

Shortage Scenario One (using Baseline Scenario One demands) predicts that storage of CAP water at USFs is 262,515 acre-feet less by the year 2025 (after evaporative-transmission losses and the cut to the aquifer are subtracted out of the total volume of water delivered to be stored). Storage of CAP at GSFs is only slightly less by 2025. This is due to the underlying assumption that the majority of the storage in the Phoenix AMA occurs at USFs for the projected years. Most of the reduction in storage is a reduction in water storage by the AWBA. The second biggest impact is a reduction (231,878 acre-feet) in CAGRD replenishment and storage (*See Table 14-3*).

Table 14-3 Shortage Scenario One Projected Artificial Recharge Phoenix Active Management Area

Long Term Storage Credits	**2006**	**2025 Baseline Scenario One**	**2025 Shortage Scenario One**
Underground Storage Facilities			
CAP	1,214,642	4,755,274	4,492,759
Reclaimed Water	300,040	2,295,646	2,295,646
Surface Water (Plan 6)	6,922	6,922	6,922
Total	1,521,604	7,057,842	6,795,327
Groundwater Savings Facilities			
CAP	2,062,993	3,499,688	3,498,856
Reclaimed Water	153,391	513,721	513,721
TOTAL	3,737,988	11,071,252	10,807,904
Arizona Water Bank			
Intrastate	1,213,547	1,752,364	1,510,803
Interstate - Nevada	23,820	23,820	23,820
Total	1,237,367	1,776,184	1,534,623
CAWCD/CAGRD			
CAWCD	339,881		
CAGRD	1,146	477,101	245,223
Conservation District Account	50,900		
Replenishment Reserve Account	16,953		
Total	408,880		
Recovery	**496,802**	**1,604,976**	**1,604,976**
Credits Remaining in Storage	**3,241,186**	**9,466,276**	**9,202,928**

Note: all values are in acre-feet. "Credits Remaining in Storage" is calculated by subtracting Recovery from the "Total USF/GSF Storage".

14.1.4 Shortage Scenario Two Results

Shortage Scenario Two (using Baseline Scenario Two demands) shows that 246,533 fewer acre-feet of CAP are stored at USFs in the shortage scenario than in the non-shortage scenario. GSF storage is reduced by 127,093 (See *Table 14-4*). There is more cut to GSF storage in Shortage Scenario Two than in Shortage Scenario One because the agricultural sector has a higher demand in Scenario Two, and hence, more potential for GSF storage than in Scenario One. Again, the AWBA take more than half the shortage reduction, and the CAGRD takes a reduction of 133,077 acre-feet.

14.1.5 Shortage Scenario Three Results

CAP stored at USFs is 164,511 acre-feet less and CAP stored at GSFs is 204,474 acre-feet less in Shortage Scenario Three than in Baseline Scenario Two (See *Table 14-5*). Scenario Three has the highest Agricultural demand of the three scenarios, and thus the greatest potential for GSF storage. However, Scenario Three also has the greatest amount of groundwater use, so in Baseline Scenario Three GSF storage is not as high as the other two scenarios, but in the shortage scenario, GSF storage is cut more, moving Agricultural users to even higher groundwater use in order to simulate the upper end of potential Agricultural groundwater use.

Table 14-4 Shortage Scenario Two Projected Artificial Recharge Phoenix Active Management Area

Long Term Storage Credits	2006	2025 Baseline Scenario Two	2025 Shortage Scenario Two
Underground Storage Facilities			
CAP	1,214,642	2,994,410	2,747,857
Reclaimed Water	300,040	2,200,798	2,200,798
Surface Water (Plan 6)	6,922	6,922	6,922
Total	1,521,604	5,202,131	4,955,577
Groundwater Savings Facilities			
CAP	2,062,993	3,611,528	3,484,435
Reclaimed Water	153,391	536,788	536,788
TOTAL	3,737,988	9,350,447	8,976,801
Arizona Water Bank			
Intrastate	1,213,547	1,559,193	1,424,941
Interstate - Nevada	23,820	23,820	23,820
Total	1,237,367	1,583,013	1,448,761
CAWCD/CAGRD			
CAWCD	339,881		
CAGRD	1,146	290,704	157,627
Conservation District Account	50,900		
Replenishment Reserve Account	16,953		
Total	408,880		
Recovery	**496,802**	**2,417,462**	**2,417,462**
Credits Remaining in Storage	**3,241,186**	**6,932,986**	**6,559,339**

Note: all values are in acre-feet. “Credits Remaining in Storage” is calculated by subtracting Recovery from the “Total USF/GSF Storage”.

Due to the high demand in Baseline Scenario Three, the CAGRD replenishment obligation, and thus, the need to store CAP, is also greatest. Of the three shortage scenarios, only Shortage Scenario Three has a greater cut to the CAGRD than to the AWBA, due to this highest projected replenishment obligation of the three scenarios. Unfortunately, due to the high demands in Baseline Scenario Three, there is little excess water to begin with leaving the CAGRD limited supplies to use for replenishment. Similarly, the AWBA is affected most in Shortage Scenario Three even before the shortage calculation, due to the relative lack of excess in Baseline Scenario Three compared to Baseline Scenarios One and Two.

14.1.6 Shortage Implications

Assuming the various projected CAP shortages do materialize, there are significant implications for both the AWBA being able to meet its obligations and the CAGRD’s ability to meet its replenishment obligations.

Table 14-5 Shortage Scenario Three Projected Artificial Recharge Phoenix Active Management Area

Long Term Storage Credits	**2006**	**2025 Baseline Scenario Three**	**2025 Shortage Scenario Three**
Underground Storage Facilities			
CAP	1,214,642	2,054,913	1,890,402
Reclaimed Water	300,040	2,349,152	2,349,152
Surface Water (Plan 6)	6,922	6,922	6,922
Total	1,521,604	4,410,987	4,246,477
Groundwater Savings Facilities			
CAP	2,062,993	3,230,945	3,026,471
Reclaimed Water	153,391	607,641	607,641
TOTAL	3,737,988	8,249,573	7,880,590
Arizona Water Bank			
Intrastate	1,213,547	1,432,791	1,389,480
Interstate - Nevada	23,820	23,820	23,820
Total	1,237,367	1,456,611	1,413,300
CAWCD/CAGRD			
CAWCD	339,881		
CAGRD	1,146	181,108	130,157
Conservation District Account	50,900		
Replenishment Reserve Account	16,953		
Total	408,880		
Recovery	**496,802**	**3,017,578**	**2,838,620**
Credits Remaining in Storage	**3,241,186**	**5,231,996**	**5,041,969**

Note: all values are in acre-feet. “Credits Remaining in Storage” is calculated by subtracting Recovery from the “Total USF/GSF Storage”.

If the CAGRD is not able to meet its obligation, future development may be curtailed for a period of time due to the difficulty of applicants for future subdivisions to meet the consistency with goal requirement of the AWS Rules. In some cases, if the shortage is deep enough to reduce allocations of CAP significantly, designated providers may rely on pumping pursuant to their groundwater allowance balance in order to meet the consistency with goal requirement. A further implication of the shortage may be a temporary increase in the number of extinguishments of grandfathered groundwater rights. Although the amount of credits that may be accrued pursuant to extinguishment of GFRs is finite, extinguishment credits could be used to bridge a shortage gap and allow developments to continue. Storage of reclaimed water may increase to the maximum extent feasible, but this supply is limited based on the volume of reclaimed water generated and is linked to overall demand.

If financing were available, the AWBA may be able to explore other methods of meeting its contract obligations. The AWBA is currently working on strategies to deal with a potential shortage.

If the shortages impact the CAP NIA settlement pool, farmers may begin fallowing their fields, rather than demand remaining constant as has been projected here. However, crop prices would need to be high enough to offset the increased cost associated with using groundwater for maintained Agricultural demand to be a reasonable assumption.

In summary, it appears that shortages of the magnitude projected in the three Shortage Scenarios has more of an impact on the availability of excess CAP water and affects the AWBA and CAGRD more than those with CAP contracts or sub-contracts. There is still a negative impact on overdraft in 2025, due to reductions in artificial recharge and the benefits from the cut to the aquifer, as well as possible impacts from reduced replenishment by the CAGRD. In the event of the shortages above, Municipal and Agricultural water users have some flexibility to shift to groundwater supplies before demand reduction activities are required, although this is a management decision of the water user.

14.2 Maximized Reclaimed Water Use Scenario

In addition to Baseline Scenarios One, Two, Three and the Shortage Scenarios, a Maximized Reclaimed Water Use Scenario was developed for the Phoenix AMA. Given the fact that a large volume of reclaimed water is already being put to use in the Phoenix AMA in each of the scenarios and because all three scenarios show the AMA in a safe-yield condition for at least some of the projected years, it seemed reasonable to develop an alternative scenario that increased the projected annual reclaimed water use in the AMA to project the best reasonable surplus condition and its anticipated duration. Specifically, this scenario was developed to analyze whether the goal of safe-yield could be achieved and maintained by maximizing annual reclaimed water use.

In the Maximized Reclaimed Water Scenario, new reclaimed water usage and storage assumptions were applied to Baseline Scenario One, which was chosen since it was the scenario with the most years in the projection period that were at safe-yield. Similar to the Shortage Scenarios, demand was not altered from Baseline Scenario One. The only changes in the template assumptions were an increase in the total amount of reclaimed water used annually, both directly and indirectly through recharge and recovery, as well as the cumulative amount of reclaimed water stored and the type of recharge facility used. The type of facility where reclaimed water is stored is important because 50 percent of the reclaimed water stored at a Managed USF is cut to the aquifer, whereas there are no cuts to the aquifer at Constructed USFs.

In the Maximized Reclaimed water Scenario, planners explored whether it was possible to get to and maintain safe-yield with increased direct use and storage and recovery of reclaimed water.

14.2.1 Background

In 2006, ADWR estimates that a little more than 340,000 acre-feet of reclaimed water was generated in the Phoenix AMA. Of this total amount generated, about 185,000 acre-feet was used (directly or indirectly through recharge and recovery) to meet annual demands in the AMA based on use of reclaimed water reported on Annual Water Withdrawal and Use Reports. This accounted for approximately 54 percent of the total reclaimed water generated in the AMA.

Much of the reclaimed water generated in the Phoenix AMA originates at the 91st Avenue Wastewater Treatment Plant. This plant treats wastewater from five of the major cities in the AMA, Glendale, Mesa, Phoenix, Scottsdale and Tempe. These cities, referred to as the Sub-Regional Operation Group (SROG) have an agreement pertaining to liability and ownership and operation of the 91st Avenue Wastewater Treatment Plant. According to the City of Phoenix website, “The original 91st Avenue WWTP, a five mgd cooperative venture between Glendale and Phoenix, was built in 1958. This plant was later replaced with a 45 mgd plant that was subsequently expanded throughout the years. The capacity of the 91st Avenue WWTP is now 179 mgd."(Phoenix, 2010)

The Arizona Municipal Water Users Association (AMWUA), in its pamphlet "AMWUA: One for Water" states "AMWUA members fully utilize their reclaimed water for multiple purposes that benefit their communities. Reuse includes crop irrigation and nurseries; irrigation of parks, school playgrounds, and golf courses; commercial and industrial non-potable needs; and community water features. Reclaimed water is stored by AMWUA members for future use through recharge to groundwater aquifers and to sustain the Tres Rios and Rio Salado Habitat Restoration Projects." AMWUA recognizes that "As the population grows, the volume of reclaimed water produced increases, emphasizing reclaimed water's significance as a dependable resource when overall demand increases. Reclaimed water is a renewable and stable water source used to lessen dependence on other water supplies and to reduce, stop, or reverse declining groundwater levels."(AMWUA, 2009)

In addition to municipal reclaimed deliveries to non-residential customers, storage facilities and crop irrigation, industrial users, namely Palo Verde Nuclear Generating Station, use significant amounts of reclaimed water. Palo Verde Nuclear Station uses approximately 60,000 AF annually, and Agricultural users in the AMA use approximately 30,000 acre-feet of reclaimed water annually.

14.2.2 Methodology and Assumptions

In the Maximize Reclaimed Water Use Scenario, it was assumed that reclaimed water supplies used to meet Municipal demand would increase from approximately 342,000 acre-feet or approximately 64 percent of the volume of reclaimed water projected to be generated in 2025 (under Baseline Scenario One), to approximately 506,000 acre-feet or approximately 95 percent of the total volume of reclaimed water projected to be generated by 2025. As noted earlier, Baseline Scenario One reclaimed water assumptions were based on DAWS water supply projections, historical use of supplies and current treatment and delivery capacity.

Municipal Reclaimed water Use

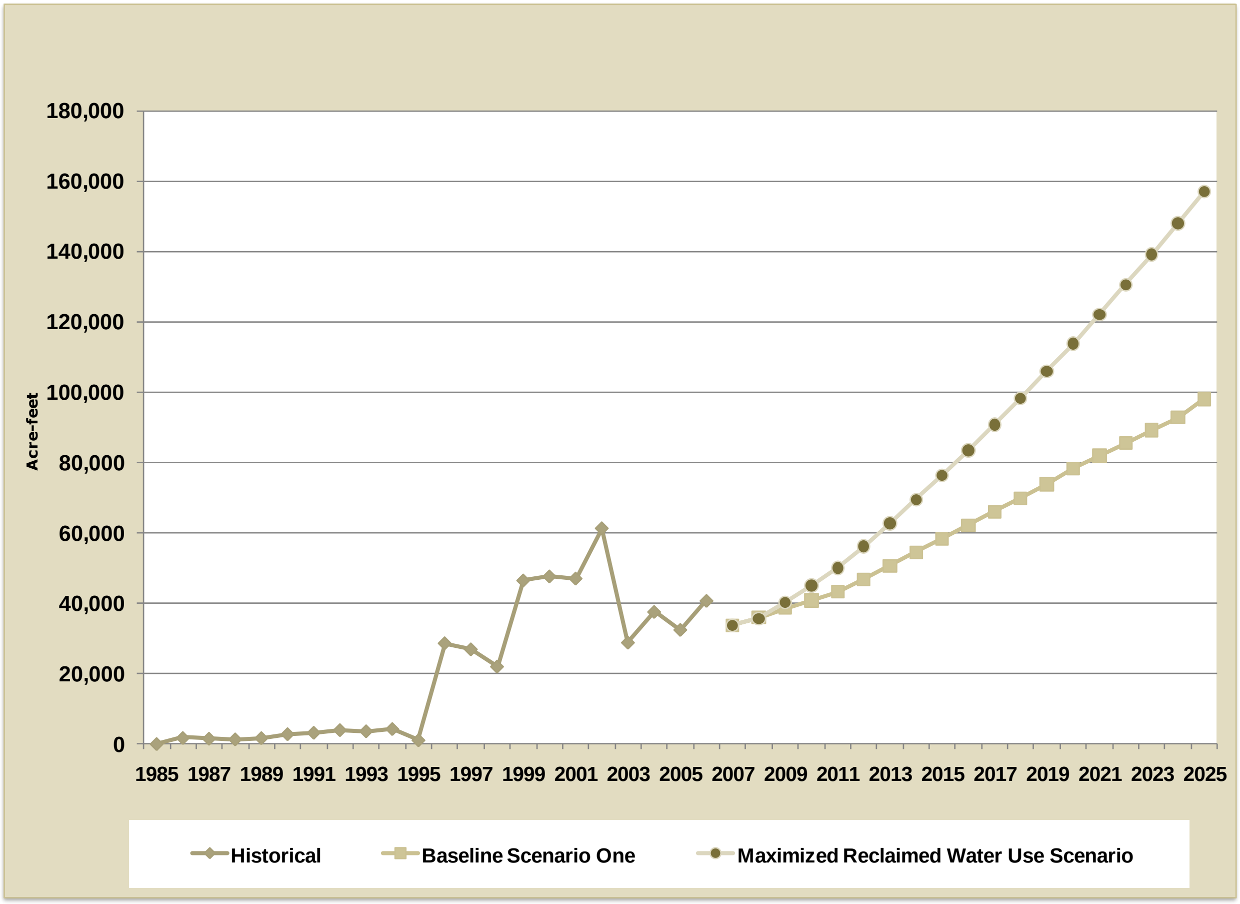
Municipal direct reclaimed use is projected to be almost 7 percent of total municipal demand by 2025 in Baseline Scenario One. In the Maximized Reclaimed Water Use Scenario, this was gradually increased to achieve 10 percent of total municipal demand by 2025 (*See Figure 14-4*).

The increased reclaimed water use in the new scenario assumes that expanded treatment capacity and infrastructure would need to be built in order to meet the increased use of Municipal reclaimed water. No specific assumptions were made as to which customers would use the additional reclaimed water. Currently, the main recipients of municipally served reclaimed water in the Phoenix AMA are turf facilities. New users, however, should not necessarily be confined to the current reclaimed system or necessarily be turf facilities.

Industrial Reclaimed Water Use

In the Industrial sector, it was assumed that reclaimed water usage would increase from approximately 74,000 acre-feet or approximately 39 percent of the total demand in Baseline Scenario One by 2025 to approximately 82,000 acre-feet or approximately 43 percent of the total demand in the Maximized Reclaimed Water Use Scenario (*See Figure 14-5*). This increase is based on the assumptions that half of all projected new turf related facilities will use reclaimed water and that all projected new uses associated with electric power generation will be met with reclaimed water.

Figure 14-4 Maximized Municipal Reclaimed Water Use
Phoenix Active Management Area



Agricultural Reclaimed Water Use

Although historically used, reclaimed water was not projected to increase above the volume in projected in Baseline Scenario One. In the Maximized Reclaimed Water Use Scenario, direct use of reclaimed water is held constant at 30,000 acre-feet per year.

Reclaimed Water Recharge Assumptions

General assumptions about the amount of reclaimed water stored at Managed vs. Constructed USFs in this special scenario are identical to Baseline Scenario One. It is assumed that all reclaimed water stored at USFs is in constructed facilities, to avoid the 50 percent cut to the aquifer. The proportion of GSF to USF storage is the same in the Maximized Reclaimed Water Use Scenario as in Baseline Scenario One. However, the Maximized Reclaimed Water Use Scenario assumes that the volume of reclaimed water discharge does not increase as production of reclaimed water increases, but that all the additional reclaimed water that is not used directly is stored (*See Figure 14-6)*. This assumption means that all water providers begin storing reclaimed water, including private water companies and cities and towns not part of SROG. Although this increase in stored water does not have an immediate impact on safe-yield, the long-term storage credits generated can be used to offset groundwater pumping in the future.

Figure 14-5 Maximized Industrial Reclaimed Water Use
Phoenix Active Management Area

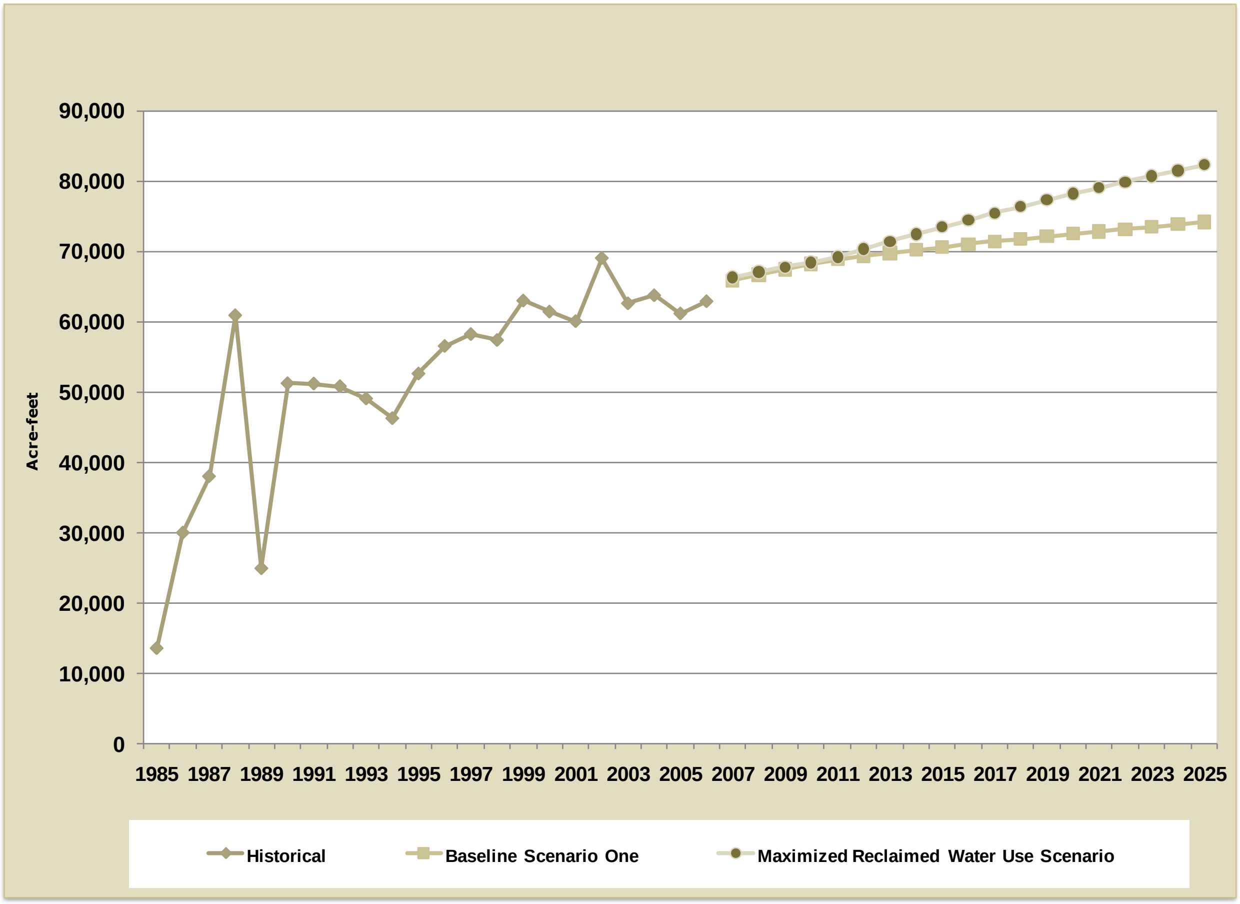
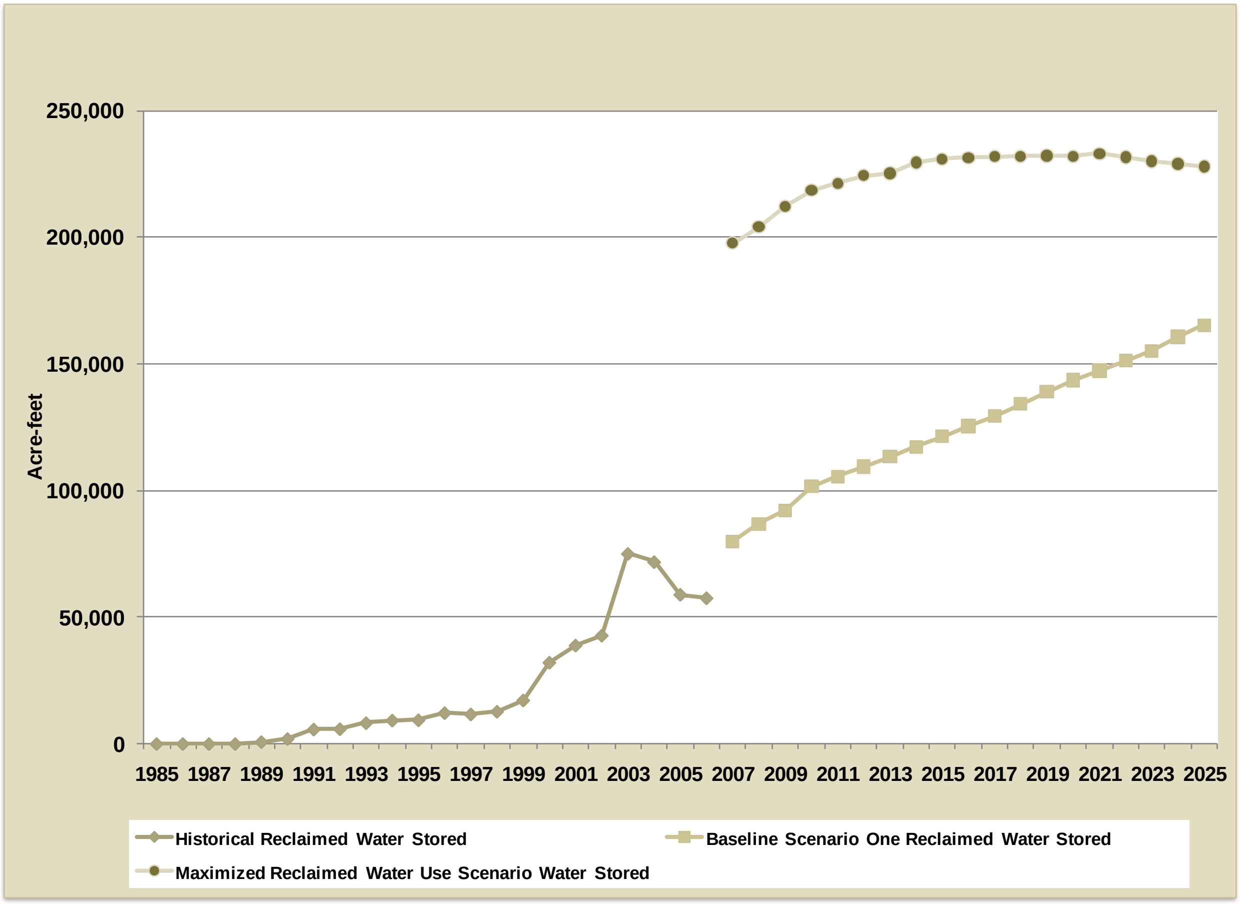


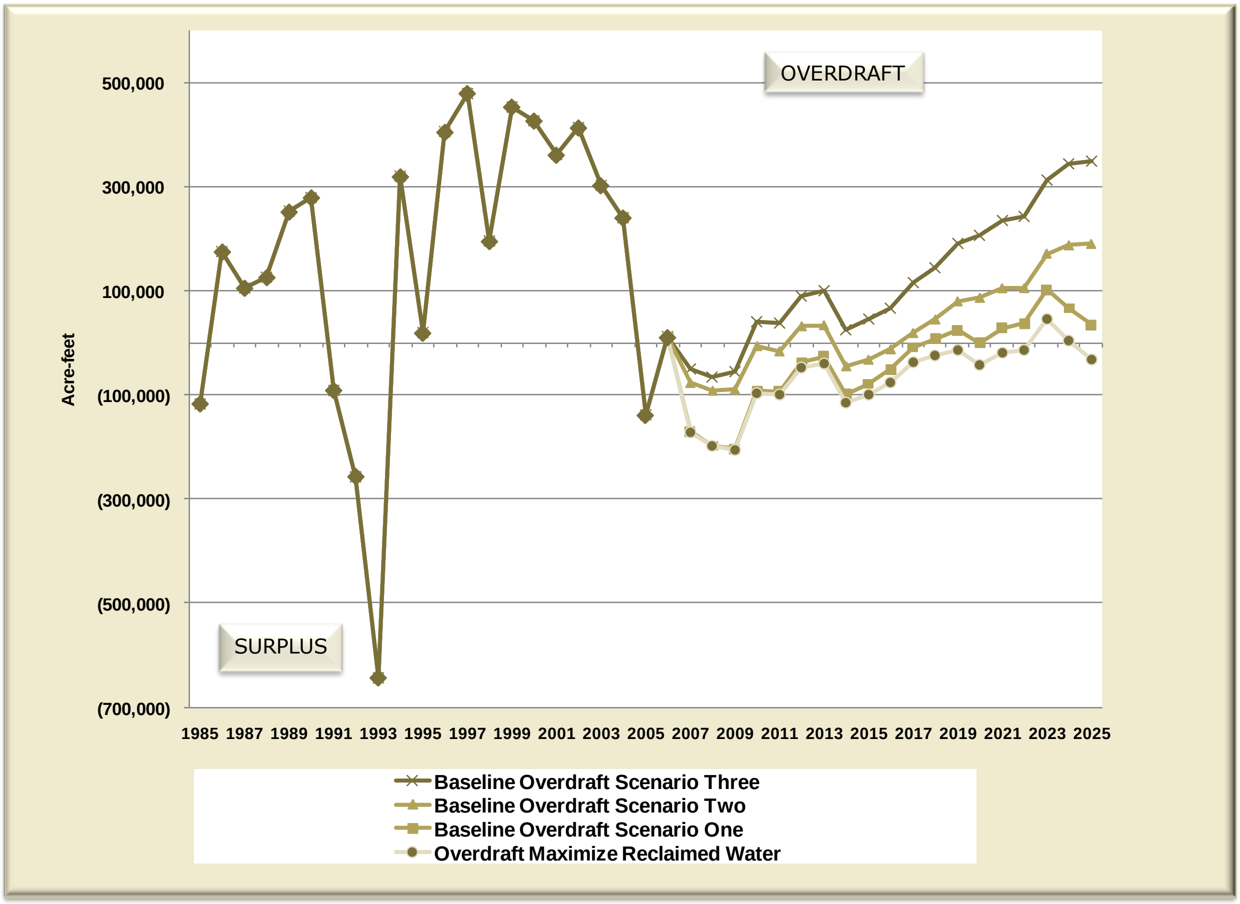
Figure 14-6 Maximized Reclaimed Water Stored
Phoenix Active Management Area



14.2.3 Maximized Reclaimed Water Use Scenario Results

The Phoenix AMA has a large and growing supply of reclaimed water that, if more fully utilized on an annual basis, could significantly help the AMA's efforts to reach safe-yield by 2025. Results of the Maximized Reclaimed Water Scenario indicate that by increasing annual reclaimed water use in the Municipal and Industrial sectors, and maintaining the current volume of Agricultural reclaimed use, the Phoenix AMA could be in a surplus condition for several years prior to 2025, and be fairly close to safe-yield in the year 2025, assuming Baseline Scenario One demands. It is important to note, that although this scenario did not consider utilization of credits, those could help further reduce overdraft as well as reduce logistical challenges of getting reclaimed water from its source to a suitable end user. The chart below illustrates that by increasing the annual use of the Phoenix AMA's reclaimed water supplies, annual overdraft could significantly be reduced and in some years be eliminated resulting in a safe-yield condition or surplus (*See Figure 14-7*).

Figure 14-7 2025 Projected Overdraft Maximized Reclaimed Water Scenario vs. Baseline Projections Phoenix Active Management Area



Groups such as the SROG cities, the AMWUA and the Governor's newly formed Blue Ribbon Panel on Water Sustainability continue their efforts to increase reclaimed water use regionally as well as on a statewide basis. The Governor's Blue Ribbon Panel on Water Sustainability is focusing on opportunities to increase the use of reclaimed water throughout the state by examining the constraints such as public acceptance, infrastructure needs, and regulatory constraints that currently exist and limit the increased use of this valuable resource.

14.3 100% Reclaimed Water Use Scenario

In addition to the Maximized Reclaimed Water Use Scenario, ADWR developed a 100% Reclaimed Water Use Scenario. This scenario explored the possible impact of putting all reclaimed water to use, such that reclaimed water discharge is held constant at the 2006 volume and does not increase. The counter-intuitive effect of this approach is that the increased discharge is transferred to underground storage, which does not have a cut to the aquifer for reclaimed water. This actually increases the amount of overdraft from the Maximized Reclaimed Water Use scenario because the percolation of reclaimed water discharge does not occur.

PART IV THE FOURTH MANAGEMENT PLAN PROCESS

The Code requires ADWR to develop Management Plans for each AMA to assist the AMA in achieving its management goal. The Management Plans contain conservation requirements for the Municipal, Industrial and Agricultural sectors; however, they do not apply to the Indian water use sector. While the Management Plans provide requirements for reductions in water use – it is not the only tool available to ADWR for achieving the management goals and should not be viewed as such.

ADWR has developed Management Plans for each of the previous management periods using similar, yet increasingly more complicated approaches. The 1MP (1984 – 1990) was the first comprehensive attempt to manage groundwater within the AMAs. Development of the mandatory conservation requirements used a very straightforward approach, based on water supply and demand quantification.

The 2MP (1990 – 2000) employed a more advanced supply and demand analysis incorporating current and future conditions. In the development of conservation requirements ADWR put more emphasis on aggressive and cutting-edge conservation practices for the three main water use sectors. Water supply augmentation was also integrated into the water management strategies in addition to a newly created Conservation and Augmentation Assistance grants program.

The 3MP (2000-2010) was the mid-point of the 45-year timeframe from the inception of the Code in 1980 to the year 2025 by which safe-yield was to be attained. The 3MP recognized the impacts of the other water management programs not addressed through the Management Plans, including the AWS Rules; the Underground Storage and Recovery Program; the CAGRD; and the AWBA. Because of the recognition of these additional management programs, supply and demand analysis vastly improved. However, the conservation requirements included in the 3MP were strikingly similar to the 2MP.

The 3MP for the AMAs, as well as the findings of the subsequently formed local AMA "Safe-Yield Task Force" (or other similarly named stakeholder groups) and the Governor's Water Management Commission in 2001, made a series of observations that should frame the development of future water management strategies. Although these observations recognized certain differences among the AMAs, there were fundamental similarities. The principal observations were:

1) While significant progress has been made since the enactment of the Code, it is unlikely that the statutory goals of the AMAs will be met, given the current authorities granted to ADWR;
2) While it is projected that most AMAs will continue to make progress toward achievement of their goals as currently unused renewable water supplies become utilized, we may begin to move in the opposite direction if increased demands outstrip the availability of renewable supplies.
3) Localized areas within AMAs are and will continue to experience water management problems disproportionate to those of the AMA as a whole due to infrastructure and renewable water supply access, continued allowable groundwater pumping by grandfathered uses, and recovery of LTSCs outside the areas of impact of the recharge facilities.

These observations are a mixture of "good news/bad news". It is good news from the standpoint that the existing programs and authorities have served this State, most specifically the AMAs, well. We should all be proud of the work accomplished and the progress made to date. The bad news is that with the current authorities, it will be almost impossible to meet the management goals, and may over time move us farther away. These goals are the fundamental underpinnings to ensuring a long-term sustainable water supply for the State of Arizona. The 4MP must emphasize ensuring sustainable water supplies and the effective and efficient management of the State's most precious resource for Arizona to thrive.

So what should the 4MP look like? The Management Plans to date have served us well; however, they are not really planning tools that provide succinct options for future water management decisions. They are excellent tools in identifying current and projected water use, mandatory conservation requirements, and potential directions and initiatives that could be pursued to move toward goal achievement and wise, long-term water management. The Management Plans should provide more concise direction regarding what is needed to get to the ultimate goal.

ADWR will approach the 4MP more as a Plan for success than a document that simply identifies the statutory requirements for the main water using sectors. In this Plan ADWR, in cooperation with the public, will build on past successes but recognize that additional observations should be considered, including:

1) Conservation will only get us so far. We will continue to address meaningful conservation requirements, but also will review the “incentives” for utilization of renewable water supplies, reduce the complexity and the administrative workload necessary to implement these programs, and be diligent in their enforcement.
2) Have serious discussions regarding the AMA goals and the implications to the State of not reaching them.
3) Consider different approaches to water management among the AMAs, recognizing local conditions and community values.
4) Address the limitations of the Management Plans and underlying authorities as we determine what course of action to follow.
5) Recognize sub-area issues and consider alternative management strategies to address areas where conditions are positive and conditions are negative.
6) Develop, in cooperation with local water users and other water resource entities (CAWCD, AWBA, CAGRD, etc), a long-term water management strategy to get the AMAs where we need them to be by identifying what specific actions/steps we need to take and what resources will be required to accomplish this strategy.

BIBLIOGRAPHY

ADWR. (2010). *Arizona Water Atlas: Executive Summary (Vol. 1).* Phoenix: Department of Water Resources.

ADWR. (2010). *Arizona Water Atlas: Active Management Area Planning Area* (Vol. 8). Phoenix, Arizona: Arizona Department of Water Resources.

ADWR. (2010, September). *Assessments.* Retrieved September 2010, from Arizona Department of Water Resources, Water Management Division: http://www.azwater.gov/AzDWR/WaterManagement/Assessments/default.htm

ADWR. (2006). *Technical Assessment of the Gila River Indian Community Water Rights Settlement.* Phoenix, AZ: Arizona Department of Water Resources.

ADWR. (1999). *Third Management Plan for Phoenix Active Management Area 2000-2010* (1st Publication ed.). Phoenix, Arizona: Arizona Department of Water Resources.

ADWR. (2003). *Third Management Plan for Tucson Active Management Area* (1st Modification ed.). Phoenix, Arizona: Arizona Department of Water Resources.

AMWUA. (2009). *amwua.org.* Retrieved 2010, from amwua.org: http://www.amwua.org/page_images/water_resources_brochure_2009.pdf

Arizona State University. (2009). Planning Integrated Research for Decision Support for Climate Adaptation and Water Management: A Focus on Desert and Coastal Cities. (pp. 10,11). Tempe, Arizona: Arizona State University.

Doeing, B. J., Williams, D. T., & Bradley, J. B. (1997). Gas pipeline erosion failures: January 1993 floods, Gila River Basin, Arizona. *Reviews in Engineering Geology, Volume XI* , 26.

Freihoefer, A., Mason, D., Jahnke, P., Dubas, L., & Hutchinson, K. (2009). *Regional Groundwater Flow Model of the Salt River Valley, Phoenix Active Management Area, Model Update and Calibration. Modeling Report NO. 19.*

Hetrick, J., & Roberts, D. (2004). Trends in non-Indian agricultural water use within the Phoenix Active Management Area. *The Future of Agricultural Water Use in Arizona: A conference Dialogue.* Casa Grande, AZ.

Hotel Internet Marketing by eMax. (2009, August 1). *Additional Enterprises*. Retrieved 2009, from Fort McDowell Resort Destination: http://fortmcdowelldestination.com/additional-enterprises.html

Intergovernmental Panel on Climate Change. (2007). *Climate Change 2007: The Physical Science Basis: Summary for Policymakers Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.*

ITCA. (2003). *Gila River Indian Community*. Retrieved July 1, 2009, from Inter Tribal Council of Arizona: http://www.itcaonline.com/tribes_gila.html

Jacobs, K. L. (2009, November). Personal Communication.

Needham, R. A. (2005). *An Impact Assessment of Water conservation Policy in Agriculture: The Arizona Goundwater Management Act of 1980.* Masters Thesis, University of Arizona, Agricultural and Resource Economics, Tucson.

Needham, R., & Wilson, P. N. (2005). Water Conservation Policy in Arizona Agriculture: Assessing the Groundwater Management Act of. (G. Frisvold, & R. Tronstad, Eds.) *Arizona Review: Economic Perspectives on Arizona's Agriculture and Natural Resources , 3* (1), 13 - 15.

Phoenix, C. o. (2010). *Sub-Regional Operating Group (SROG)*. Retrieved 2010, from phoenix.gov: http://phoenix.gov/PCD/srog.html

Salt River Pima-Maricopa Indian Community . (2009). *About the Salt River Pima-Maricopa Indian Community*. Retrieved August 1, 2009, from Salt River Pima-Maricopa Indian Community: http://www.srpmic-nsn.gov/community/

Seagar, R., & Ting, M. e. (2007). Model Projections of an Imminent Transistion fo a More Arid Climate in Southwestern North America. *Science* , 1181-1184.

Sustainability of semi-Arid Hydrology and Riparian Areas. (2009, November 1). *Scenario Development*. Retrieved November 30, 2009, from SAHRA-Ensuring Water in a Changing World: http://www.sahra.arizona.edu/scenarios/

United States Department of Agriculture. (2009). *Quick Stats.* Retrieved April 24, 2009, from National Agricultural Statistics Service: http://www.nass.usda.gov/Data_and_Statistics/Quick_Stats/

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APPENDICES

Appendix 1 Assumptions Used for Large Municipal Providers

Category	Scenario
Demand	**SCENARIO ONE**: The Association of Governments population projections for each large provider were used, based on water service area boundaries. The population projection for each large provider x the TMP conservation requirement for each provider equals large provider demand.
	SCENARIO TWO: For undesignated providers, statistical trend line population projections x the 2000-2006 average GPCD for each provider were used. For designated providers, the provider's designation of assured water supply demand was used.
	SCENARIO THREE: 1985-1999 growth rate population projection was broken down to each large provider by adjusting each provider's population up by the percent that the AMA large provider Maximum population projection is greater than the AMA large provider Likely population projection for each year, 2007-2025. The maximum population projection for each large provider x the 2000-2006 average GPCD rate for each provider equals large provider demand.
Supply	Individual assumptions were made for each provider based on the designation of assured water supply for designated providers, and historical use of supplies for undesignated providers, capped based on treatment capacity. Assumed primarily direct use of renewable supplies, then storage, then groundwater.

Appendix 2 Assumptions Used for Small Municipal Providers

Category	Scenario
Demand	**SCENARIO ONE:** The Association of Governments population projections were used. Small providers were projected in sum as a municipal subsector. Small provider demand is calculated using the TMP conservation requirement for new single family housing units.
	SCENARIO TWO: The 1990-2000 average growth rate of "balance of county" population from MAG was used to project small provider population in 2007. Then small provider population was ramped up linearly to equal the projected small provider population by MAG in 2025. Small provider population x 2006 GPCD for small providers equals small provider demand.
	SCENARIO THREE: The projection of population and demand for small providers in Scenario Three is identical to Scenario Two.
Supply	100% groundwater

Appendix 3 Assumptions Used for Urban Irrigation

Category	Scenario
Demand	The 1985-2006 average urban irrigation demand was held constant for all scenarios.
Supply	The 1985-2006 average for each source, CAP, surface water and reclaimed water, was used. Groundwater is remainder of demand.

Appendix 4 Assumptions Used for Exempt Well Users

Category	Scenario
Demand	**SCENARIO ONE**: Exempt well population is the remainder of the Association of Governments total AMA population after large provider, small provider, and Indian population projections are subtracted out. The TMP single family models for new development, and the 2000 Census average persons per household for Maricopa County were used to calculate projected exempt well demand for each year, 2007-2025.
	SCENARIO TWO: Exempt well population is the remainder of the Association of Governments total AMA population after large provider, small provider, and Indian population projections are subtracted out. The TMP single family models for new development, and the 2000 Census average persons per household for Maricopa County were used to calculate projected exempt well demand for each year, 2007-2025.
	SCENARIO THREE: The exempt well population is projected using the 1985-1999 average historical growth rate of exempt well population. The projected exempt well population, the TMP single family models for new development, and the 2000 Census average persons per household for Maricopa County were used to calculate projected exempt well demand for each year, 2007-2025.
Supply	100% groundwater

Appendix 5 Assumptions Used for Industrial Demand and Supply Projections

User Category		Scenario
Turf	DEMAND	**SCENARIO ONE:** The line of regression of historical use and the log of population (as used in Municipal Scenario One Population numbers) was used; Multiple Regression using evapotranspiration, precipitation and population as x was also done to better explain annual fluctuation in water use.
		SCENARIO TWO: Used the line of regression of historical use and the log of population (as used in Municipal Scenario Two Population numbers); Multiple Regression using evapotranspiration, precipitation and population as x was also done to better explain annual fluctuation in water use.
		SCENARIO THREE: Used the line of regression of historical use and the log of population (as used in Municipal Scenario Three)
	SUPPLY	Assumed future groundwater and non-groundwater supplies used in the same proportion as used in 2006 total Industrial use.
Mining	DEMAND	**SCENARIO ONE:** Assumed no mining in Phoenix AMA
		SCENARIO TWO: Assumed production at Resolution begins in 2019 at 20,000 AF/year
		SCENARIO THREE: Assumed production at Resolution begins in 2019 at 20,000 AF/year

User Category		Scenario
	SUPPLY	Assumed Recovered CAP used
Sand & Gravel	DEMAND	**SCENARIO ONE:** Historic average held constant through time
		SCENARIO TWO: Historic average held constant through time
		SCENARIO THREE: Historic average held constant through time
	SUPPLY	Assumed future groundwater and non-groundwater supplies used in the same proportion as used in 2006 total Industrial use
Dairy	DEMAND	**SCENARIO ONE:** Assumed water use would continue to decline at a rate similar to the changing ratio of Phoenix dairies to Pinal dairies over the last decade or so
		SCENARIO TWO: Assumed continued declining water use but at a slower rate than Scenario One
		SCENARIO THREE: Current water use held constant through time
	SUPPLY	Assumed future groundwater and non-groundwater supplies used in the same proportion as used in 2006 total Industrial use
Electric Power	DEMAND	**SCENARIO ONE:** Used the log trend line of the historical water use
		SCENARIO TWO: Used the power trend line of the historical water use
		SCENARIO THREE: Used the linear trend line of the historical water use
	SUPPLY	Assumed future groundwater and non-groundwater supplies used in the same proportion as used in 2006 total Industrial use
Other	DEMAND	**SCENARIO ONE:** Historic average held constant through time
		SCENARIO TWO: Historic average held constant through time
		SCENARIO THREE: Historic average held constant through time
	SUPPLY	Assumed future groundwater and non-groundwater supplies used in the same proportion as used in 2006 total Industrial use
Feedlot	DEMAND	Assumed zero use in all scenarios, as 2006 use was only 56 acre-feet.
	SUPPLY	N/A

Appendix 6 Assumptions Used for Agricultural Projections

Category	ITEM	SCENARIO	METHODOLOGY
Demand Factors	Irrigation Acres (> 10 acres)	One	Acres based on Urbanization Tool and professional review of AWS certificates issued in Pinal County portion of AMA; capped at previous year's acreage.
		Two	Semi log regression vs. population for non-Waterlogged, non-Exempt acres, plus Waterlogged acres based on Urbanization Tool; both are capped at the previous year's acreage. The concept behind this is that less growth will occur on Ag land over time.
		Three	Power regression vs. population for non-Waterlogged, non-Exempt acres, plus Waterlogged acres based on Urbanization Tool; both are capped at previous year's acreage.
	Maximum GW Allotment (>10 acres)	ALL	Average allotments per acre in 2004-2006, multiplied by irrigation acres.
Demand	IGFRs > 10 AC	ALL	Multiple linear regression vs. non-Waterlogged, non-Exempt irrigation acres and precipitation, using historical average precipitation.
	IGFRs < 10 AC	One	Historic Average minus one standard deviation
		Two	Historic Average
		Three	Historic Average plus one standard deviation
	Waterlogged IGFRs	One	Waterlogged Acres based on Urbanization Tool, times multiple regression of water use per acre vs. time and precipitation, using historical average precipitation.
		Two	Multiple linear regression vs. time and precipitation, using historical average precipitation.
		Three	Linear trend with time
	Canal & other losses	ALL	Historic average percentage of losses multiplied by sum of demands
Supply	Groundwater	ALL	Demand not met by other sources.
	IN-LIEU GROUNDWATER (CAP)	ALL	Proportional to Use > 10 Acres", based on 2000-2006 average ratio. Capped at sum of Muni, GRD, AWBA, and Excess user projected volumes.
	GSF (Reclaimed Water)	ALL	Assume for 2007 only RID Reclaimed water: 30,000 Acre-feet per year from Phoenix, reducing in proportion to "Use > 10 Acres"
	Surface Water	ALL	Power regression of SW plus Spill 5-yr average vs. total IGFR Acres. Due to the complexity of projecting Spills, this projection is for the sum of surface water and spill water.
	CAP	ALL	2007-2008 from CAP Delivery info. 2009 from CAP NIA Pool Allocations. 2010-2025 proportional to Non-Exempt, non-Waterlogged IGFR Acres, based on 2005-2006 average ratio, with 25% reductions to the Pool occurring in 2017 and 2024.
	Reclaimed Water	ALL	Includes reclaimed (30K acre-feet) contracted to BWCDD from 91st Ave WWTP. Held constant due to no substantial projected decreases in Waterlogged demand.
	Spill	ALL	Due to the complexity of projecting spills, this was included with surface water; see above.
	Other	ALL	Mostly tailwater. Kept proportional to Total Demand, based on 1985-2006 average ratio.

Category	ITEM	SCENARIO	METHODOLOGY
Incidental Recharge	Total	ALL	22% of total demand not including GSF or canal losses, plus 50% of canal losses.

Appendix 7 Assumptions Used for Indian Agricultural Projections

Category	Item	Scenario	Methodology
Demand	Total	One	Sum of scenario one projections for each Community/Reservation, based on settlements, historical use, and current projects underway.
		Two	Sum of scenario two projections for each Community/Reservation, based on settlements, historical use, and current projects underway.
		Three	Sum of scenario three projections for each Community/Reservation, based on settlements, historical use, and current projects underway.
Supply	Groundwater	ALL	All demand not met by other sources, individually capped based on settlements.
	Surface Water	ALL	Amounts available per settlements and based on historical average supplies and use, along with current projects.
	CAP	ALL	Amounts based on demand, with increased use due to current projects, individually capped based on settlements. Includes projected CAP exchange for reclaimed water included in the GRIC settlement.
	Reclaimed Water	ALL	GRIC Settlement amount from Chandler (not CAP Exchange Reclaimed Water)

Appendix 8 Assumptions Used for Recharge Projections

Storer	Permit Type	Facility Type	Source	Assumption
Municipal	USF	Constructed	CAP	Individual projections of CAP water stored by large municipal providers were prepared, based on the provider's designation, historical use patterns, M&I allocation, and ability to store CAP water. The total USF storage minus the managed storage equals USF constructed storage. NOTE: In years where other AMAs are not able to store all projected CAP water due to operational capacity constraints, the additional excess CAP water is assumed to be stored at USF constructed facilities in the Phoenix AMA.
			Surface Water	Individual projections of surface water stored by large municipal providers were prepared, based on the provider's assumed average annual surface water availability, ability to directly treat and deliver surface water, and demand that could be met with annual storage and recovery of surface water. Designation applications and historical use patterns were reviewed to develop individual annual storage and recovery of surface water projections for each provider.
			Reclaimed Water	A "reclaimed water" GPCD" was calculated by dividing historical reclaimed water generated by historical population. The reclaimed water GPCD was multiplied by the projected large provider population to project future reclaimed water generated. The amount of projected uses of reclaimed water, including storage, was subtracted from the amount projected to be generated. The remaining amount was divided in half, with half assumed to be additional reclaimed water stored and half assumed to be discharged. In PHXAMA, reclaimed water GSF was projected under the Agricultural sector. GSF reclaimed water was subtracted from the total reclaimed water projected to be stored. Then, the volume of USF managed reclaimed water was subtracted. The remaining volume is USF constructed reclaimed water stored. The volume of reclaimed water available for storage varied each year based on the differences between the projected population among the three scenarios.
		Managed	CAP	This was held constant at 14,313 acre-feet/year based on historical storage patterns.
			Reclaimed Water	There is only one entity projected to do managed reclaimed water storage and this is projected to be at the permit capacity each year through 2025 in all three scenarios.
	GSF		CAP	Individual projections of CAP water stored by large municipal providers were prepared, based on the provider's designation, historical use patterns, M&I allocation, and ability to store CAP water. The sum of the projected CAP storage by municipal providers, the water bank, the GRD and others was compared to the agricultural planner's projection of GSF CAP. The lower of the two figures was used.
			Reclaimed Water	In PHXAMA, reclaimed water GSF was projected under the Agricultural sector.
Water Bank	USF	Constructed	CAP	Projections of USF CAP in Phoenix AMA were prepared by the AWBA and are based on financing and available storage capacity.
	GSF		CAP	Projections of GSF CAP in Phoenix AMA were prepared by the AWBA and are based on financing and available storage capacity. If CAP was not fully utilized in any year, the remaining amount was divided among the 3 AMAs based on the CAWCD Distribution of Excess Water policy. The sum of the projected CAP storage by municipal providers, the water bank, the GRD and others was compared to the agricultural planner's projection of GSF CAP. The lower of the two figures was used.

Storer	Permit Type	Facility Type	Source	Assumption
GRD	USF	Constructed	CAP	The projected volume of GRD replenishment obligation was assumed to be stored except for some years under the maximum scenario where the 1.595 total CAP use was exceeded, in those years, the amount over the 1.595 was divided between the 3 AMAs based on the CAWCD Distribution of Excess Water policy, and the difference assumed to be met with reclaimed water storage.
			Reclaimed Water	No GRD reclaimed water storage is assumed except for some years under the maximum scenario where CAP use in sum for the three AMAs exceeded the total CAP presumed to be available (1.595 maf). For those years the volume the projected CAP use that exceeded 1.595 maf was divided between the AMAs based on the CAWCD Distribution of Excess Water policy, and this remaining amount of obligation was assumed to be met with the additional reclaimed water available to store.
	GSF		Reclaimed Water	In PHXAMA, reclaimed water GSF was projected under the Agricultural sector.