CHAPTER

8

Augmentation and Recharge Program

8.1 INTRODUCTION

The purpose of the Augmentation and Recharge Program is to encourage the development, delivery, storage, and use of renewable water supplies now and in the future. The water supply Augmentation and Recharge Program, in combination with conservation program efforts, is intended to support achievement of the safe-yield management goal for the Tucson Active Management Area (AMA). Increasing the use of renewable water supplies, particularly Central Arizona Project (CAP) water and effluent instead of using groundwater, is a key component of achieving safe-yield.

For the purposes of this chapter, "supply augmentation" means increasing the availability and use of renewable water supplies such as CAP water and effluent instead of groundwater. "Recharge" means storage of water supplies for future use pursuant to the Underground Water Storage, Savings and Replenishment Act. A.R.S. § 45-801, *et seq.*

Although achieving basin-wide safe-yield remains the Tucson AMA's groundwater management goal, the objectives of the Augmentation and Recharge Program in the third management period reflect an increased awareness and improved understanding of the importance of water resource management on a smaller scale. Since the development of the Second Management Plan, new information has been obtained on the physical availability and distribution of water supplies and the potential for subsidence. Recent United States Geological Survey (USGS) publications have heightened concern regarding the potential for subsidence, particularly in Tucson's Central Wellfield. A basin-wide "paper balance" between supply and demand for groundwater does not address the concerns of the public and many groundwater users about the effects of ongoing depletions in some areas and water level rises elsewhere in the AMA. The Third Management Plan incorporates a new focus on site-specific or "critical area" water management.

In the Tucson AMA, development of alternative supplies and recharge are key elements in meeting water management needs at the local or subregional level. The Arizona Department of Water Resources (Department) will work in cooperation with AMA water users to address critical area needs and attain the regional and local water supply management goals of the AMA. The specific goals and objectives of the Augmentation and Recharge Program are described in section 8.6.

The emphasis of the Department's supply augmentation program will be to encourage and facilitate the replacement of groundwater use with the efficient use of the currently available renewable supplies. The Department will continue to explore other potential water supply augmentation alternatives, such as importing additional surface water through the CAP canal. However, the primary focus for the third management period will be to take advantage of the current availability of excess CAP water and the growing effluent supply.

Although the Colorado River is currently in a surplus condition and some municipal entities do not have enough annual demand or the physical access necessary to use their CAP water allocations directly, these conditions are likely to change in the relatively near future. Future shortages are anticipated on the Colorado River system when the Upper Basin States (Colorado, New Mexico, Wyoming, and Utah) use more of their allocations and in periods of drought. In the short term, the Department is providing incentive programs to encourage development and use of alternative supplies; nevertheless, conservation activities will continue to play an important role in achieving safe-yield. Efficient use of all water supplies will be necessary to supply our future water demand.

The state's Underground Water Storage, Savings, and Replenishment (UWS) Program is an important component of the Third Management Plan Augmentation and Recharge Program. Recharge provides a cost-effective means of storing water that is currently available in the AMA but that has no direct use. Additionally, the program can be an effective tool in helping to mitigate problems due to changes in water levels, depending upon where storage and recovery occurs.

While the Department and the Arizona Water Banking Authority (AWBA) will support local efforts to augment the AMA's water supplies, the Department recognizes that the principal responsibility for developing and storing water supplies remains with the region's water providers. The Department will work with the community to encourage use and storage of renewable supplies and facilitate these activities when possible. The current scope of the Department's activities in supply augmentation includes the following:

- Director's Roles and Authorities. In addition to other statutory roles and authorities, the director of the Department is designated as the representative of the State of Arizona in Colorado River and interstate water issues; advisor to the Secretary of the Interior in allocating water among users; coordinator of Arizona's review and comments on water development proposals by the United States Army Corps of Engineers, Secretary of the Interior and Secretary of Agriculture; and manager of the state's water rights to ensure achievement of water management objectives. The director is also the Chairperson of the AWBA and serves on the Arizona Water Protection Fund (AWPF) Commission.

- Regulatory and permitting authority. The Department's regulatory and permitting authority regarding use of groundwater rights and development of underground storage and recovery projects helps to ensure that these uses of water are consistent with water management objectives.

- Staff support to the Arizona Water Banking Authority and the Arizona Water Protection Fund. The Department's staff assist the AWBA and the AWPF Commission in carrying out their mandates. Both entities are operated in close coordination with Departmental activities.

- Regulatory incentives. Regulatory incentives established in the Agricultural, Municipal, and Industrial Conservation Programs of the management plans are designed to facilitate the implementation of water supply augmentation activities by water users.

- Technical assistance. The Department provides various kinds of technical assistance to the public, for example: (1) assisting with permits and water rights issues; (2) participating in research and feasibility studies; (3) supporting hydrologic investigations; (4) providing review of proposals, applications, and draft permits; and (5) participating in legislative activities.

- Financial assistance. The augmentation, conservation assistance, and monitoring fund, as well as specifically budgeted appropriations, provide financial assistance to entities implementing augmentation projects or studies that contribute to achieving the AMA's management goals or resolving regional water management issues.

- Data management and public information. The Department's responsibility for accumulation and dissemination of water use and water supply data provides the information necessary to develop water management plans, implement augmentation projects, and conduct research related to resolving water management issues.

- Facilitation and coordination. The facilitation and coordination of augmentation and recharge activities, particularly between jurisdictions and multiple regulatory agencies, is an important component of the Department's statewide and regional water planning responsibilities.

The remainder of this chapter is organized as follows:

- Assessment of Physical Conditions and Use of Renewable Supplies
- Status of Supply Augmentation and Artificial Recharge in the Tucson AMA
- Assessment of Second Management Plan Augmentation Program Activities

- Augmentation and Recharge Issues
- Augmentation and Recharge Program Goals and Objectives
- Third Management Plan Augmentation and Recharge Program
- Future Directions

This chapter describes the Department's role in water supply augmentation and summarizes why augmentation, recharge, and reuse are important in the Tucson AMA based on current and projected water use patterns, the physical effects of groundwater overdraft, and the availability and use of renewable supplies in the AMA. Regulatory and institutional factors and permitting considerations affect augmentation and recharge efforts. An evaluation of the Second Management Plan program shows both the success of the Department's programs in responding to changing conditions and the need to develop new management tools. Assessment of the status of supply augmentation and recharge efforts in the AMA helps reveal the scope of the water resource management problem. Statutorily required elements and regulatory provisions are addressed in the Third Management Plan Augmentation and Recharge Program, section 8.7. The Future Directions section focuses primarily on changes in the Groundwater Code (Code) and Assured Water Supply Rules (AWS Rules) that could assist in achieving safe-yield.

8.2 ASSESSMENT OF PHYSICAL CONDITIONS AND USE OF RENEWABLE SUPPLIES

8.2.1 Groundwater Supply and Use

The following section summarizes current water use patterns, the physical effects of groundwater overdraft, and the current availability and use of alternative supplies.

8.2.1.1 Groundwater Overdraft and Limits of Physical Supply

Total water use in the AMA was approximately 317,400 acre-feet in 1995. About 97 percent of this demand, 307,000 acre-feet, was met by groundwater. However, annual natural and incidental recharge was estimated to be only 143,100 acre-feet in 1995. The 1995 groundwater overdraft was therefore approximately 163,900 acre-feet. Thus, the Tucson AMA has been using groundwater at twice the rate of aquifer replenishment.

The demand for water is increasing as the population of the AMA grows. Projections indicate the AMA population may be almost 1.3 million by 2025, a 65 percent increase above the 1995 figure. The statutory goal of reaching safe-yield by 2025 cannot be achieved and maintained without both significant water conservation and supply augmentation.

8.2.1.2 Consequences of Groundwater Overdraft

As described in Chapter 2, groundwater overdraft is reflected in groundwater level declines. Figure 2-7 shows historical water level changes between approximately 1940 and 1995. During this time period, maximum water level declines were approximately 200 feet in the Tucson Central Wellfield, 150 feet in the vicinity of the ASARCO wellfield near Sahuarita, and 150 feet in Avra Valley.

Sustained groundwater mining in the AMA has had negative consequences and is expected to result in more problems if it continues. Over the past 50 years, lower water levels have destroyed riparian habitat, caused erosion, displaced existing water users, and reduced stream flows. Furthermore, because the most productive portion of the aquifer is being depleted, decreased well productivity and increased pumping costs are expected over time. Tucson Water has observed decreased productivity in many of its wells since the 1970s (Tucson Water, 1997). Because the salinity of groundwater tends to increase with depth, the quality of groundwater pumped is also expected to decrease as older groundwater from deeper parts of the aquifer is pumped.

The depletion of the groundwater supplies within Tucson Water's service area threatens the City's demonstration of assured water supply. Section 5.3 describes the Assured Water Supply Program (AWS Program) and requirements for Designations of Assured Water Supply. Tucson Water will not continue to meet the criteria in the AWS Rules unless renewable supplies are physically available within their service area in the near term. Renewable supplies, whether recharged and recovered or delivered directly, must physically be usable within the service area to relieve demands on the Central Wellfield. The Central Avra Valley Storage and Recovery Project (CAVSARP) is designed to meet these requirements.

Differential subsidence in developed areas can cause considerable damage to well casings, foundations, structures, underground utility lines, storm water drains, and sewage systems. A USGS report on subsidence potential (Hanson and Benedict, 1994) estimates that the land surface elevation in Tucson in the vicinity of downtown could subside between 1 and 12 feet by the year 2025 if pumping in the region continues at 1986 rates. Because dense development characterizes the land use in this area, the potential for infrastructure and other property damage is significant. USGS models also indicate there is potential for up to 4 feet of subsidence in the vicinity of the City of Tucson's Santa Cruz Wellfield (located north of Sahuarita) by the year 2025 (Hanson and Benedict, 1994).

In the Tucson AMA, there is already some evidence of aquifer compaction and associated land subsidence attributed to rapid aquifer dewatering. Fissuring, aquifer compaction, and subsidence have been observed in the Upper Santa Cruz Basin, especially in northern Avra Valley. In 1988, an earth fissure in Avra Valley damaged the CAP aqueduct in Pima County, costing about $50,000 in repairs (Slaff, 1993). The USGS has estimated that potential maximum subsidence from 1985 to 2024 could reach 14.7 feet in northern Avra Valley if 1970s pumpage rates were to continue (Hansen, Anderson, and Pool, 1990). Although a direct link to groundwater overdraft has not been proven, 1,700 sink holes have been reported in the San Xavier District (Hoffmann, Pool, Konieczki, and Carpenter, 1997). See Chapter 2, section 2.6, and Figure 2-9 for a more complete discussion of observed subsidence and potential for further subsidence in the AMA.

Because there is potential for significant damage due to subsidence in the Tucson AMA, mitigation of groundwater overdraft in subsidence-prone areas is one of the Department's primary groundwater management objectives.

8.2.1.3 Responsibility for Overdraft

Both historic use and recent growth are responsible for the decline in groundwater levels in the AMA. Though not all are currently being used, existing water rights (irrigation, Type 1, and Type 2 grandfathered rights) and withdrawal permits exceed natural and incidental recharge by a factor of about 2.8. All water use sectors contribute to achieving safe-yield through conservation programs, but opportunities for further conservation are limited. Water supply augmentation, increased substitution of renewable supplies for groundwater use, retirement of existing rights, and management of new uses are needed to mitigate groundwater overdraft in the AMA.

Of the agricultural, industrial, and municipal sectors, only new municipal use is legally required to utilize renewable supplies through acquisition of a Designation of Assured Water Supply or a Certificate of Assured Water Supply. All new subdivisions must demonstrate the use of renewable supplies (through direct use or storage and recovery) or join the Central Arizona Groundwater Replenishment District (CAGRD) so their groundwater pumpage will be replenished. Municipal providers with Designations of Assured Water Supply have been allocated a limited amount of groundwater that can be used at any time, either during times of shortage in CAP water deliveries or during the phase-in period of use of renewable supplies. Thus, municipal entities may continue to use groundwater to serve a percentage of their demand, potentially causing water levels to continue to decline even after the safe-yield goal is attained. The

flexibility of the AWS Program means it is difficult to project with certainty when providers will use their groundwater allocations and at what rate they will store CAP water for future use.

In terms of their Designation of Assured Water Supply, Tucson Water has the legal right to pump approximately 3.5 million acre-feet. Due to their program to purchase and retire agricultural land in the late 1970s and early 1980s in Avra Valley, the City of Tucson has a legislative appropriation of up to 2 million acre-feet of groundwater credits in addition to their assured water supply groundwater allocation of approximately 1.5 million acre-feet. However, due to the overdrafted condition of the City's wellfields, it may be difficult for them to continue to prove physical availability of groundwater to serve their customers, unless CAP water is used for direct potable delivery or is recharged and recovered for delivery in their service area.

Voluntary use of renewable supplies by many users is limited by economic disincentives. Without subsidies, the cost to deliver and use renewable supplies is generally higher than the cost to pump and use groundwater. Although state law mandates that no new land may be brought into agricultural production in the AMA, agricultural groundwater use could increase if more of the acreage with irrigation grandfathered rights (IGFR) is farmed. Industrial water users may acquire new groundwater withdrawal permits (e.g., general industrial use permits) and may obtain, through purchase or lease, currently unused non-irrigation grandfathered rights to pump groundwater. Current industrial rights and withdrawal permits alone exceed the annual volume of natural and incidental recharge in the AMA. Of particular concern in the Tucson AMA is the long-term groundwater demand of the copper mining industry, which is projected to remain a major groundwater user for the foreseeable future. There is no regulatory authority at this time to require industrial water users to convert to renewable supplies.

Beyond the needs defined by the AWS Program, augmentation is needed to offset continued agricultural and industrial demand, as well as the existing pumpage by municipal providers that do not have designations. At this time, the Department has not projected the magnitude of agricultural and industrial pumpage beyond 2025. However, based on the projections in Chapter 11, safe-yield may not be achieved by the year 2025. After 2025, it will become increasingly difficult to maintain a balance between groundwater supply and demand. Further overdraft (beyond that allowed through the AWS Program) will occur unless existing users switch to renewable supplies, new water users do not use groundwater, and additional conservation measures are implemented. Changes to existing groundwater management legislation and rules may be necessary to limit further groundwater overdraft and protect critical areas.

8.2.2 Renewable Supplies and Use in the AMA

The primary renewable supplies in the Tucson AMA are Colorado River water delivered via the CAP and effluent. Using CAP water is the primary alternative to groundwater use. Recycling effluent stretches the water supply and has other benefits related to water quality. The surface water resources in the AMA are a less significant renewable supply because much of the water that flows during storm events already naturally recharges within the AMA. Interbasin water transfers, cloud seeding, and watershed management are not likely to occur in the Tucson AMA during the third management period. The following section describes the major water supplies and how they are currently used in the AMA. For a broader discussion of renewable supplies in the AMA, see Chapter 2, section 2.8.

8.2.2.1 Colorado River Water and the Central Arizona Project

In 1964, the United States Supreme Court issued a final decree in the case of Arizona v. California, 376 U.S. 340 (1964) granting Arizona rights to 2.8 million acre-feet of mainstream Colorado River water for use within the state, to the extent that the water was available within the system. In 1968, Congress passed the Colorado River Basin Project Act which authorized construction of the CAP. Figure 1-1 shows the location of the CAP canal and terminal pipeline within the AMA. CAP water is the largest volume

renewable supply available for augmentation in the AMA. Economic, geographic, technical, political, and institutional factors affect the management, distribution, and use of this supply. The following sections describe the AMA's CAP water supply, current use by water use sectors, and supply reliability issues related to allocation priorities, Tucson's location at the end of the CAP line, and water user needs. Additional discussion of CAP water use issues may be found in chapters 2, 5, and 6 and in Appendix 8A.

8.2.2.1.1 Central Arizona Project Water Supply

The CAP is the most important source of renewable water supplies in the Tucson AMA. Annual CAP water allocations for the Tucson AMA total 215,333 acre-feet. Of this total, approximately 38,300 acre-feet are currently subcontracted to the Tohono O'odham and Pascua Yaqui Indians, and the remaining 177,033 acre-feet consists mostly of municipal subcontracts. Additional CAP water may be allocated as a result of the Southern Arizona Water Rights Settlement Act.

A list of existing CAP water allocations/contracts is presented in Table 8-1. Agricultural and copper mining water users declined CAP water subcontracts. In the Tucson AMA, CAP water use by non-Indian agriculture has been limited to groundwater savings facilities (GSF). Agricultural water use in the AMA is likely to decline with urbanization. Mines and other industrial users have expressed reluctance to pursue CAP water subcontracts because of water quality constraints, the costs associated with pretreatment, and limits on conversion to urban uses.

TABLE 8-1
CURRENT AND PENDING CENTRAL ARIZONA PROJECT CONTRACTS
TUCSON ACTIVE MANAGEMENT AREA

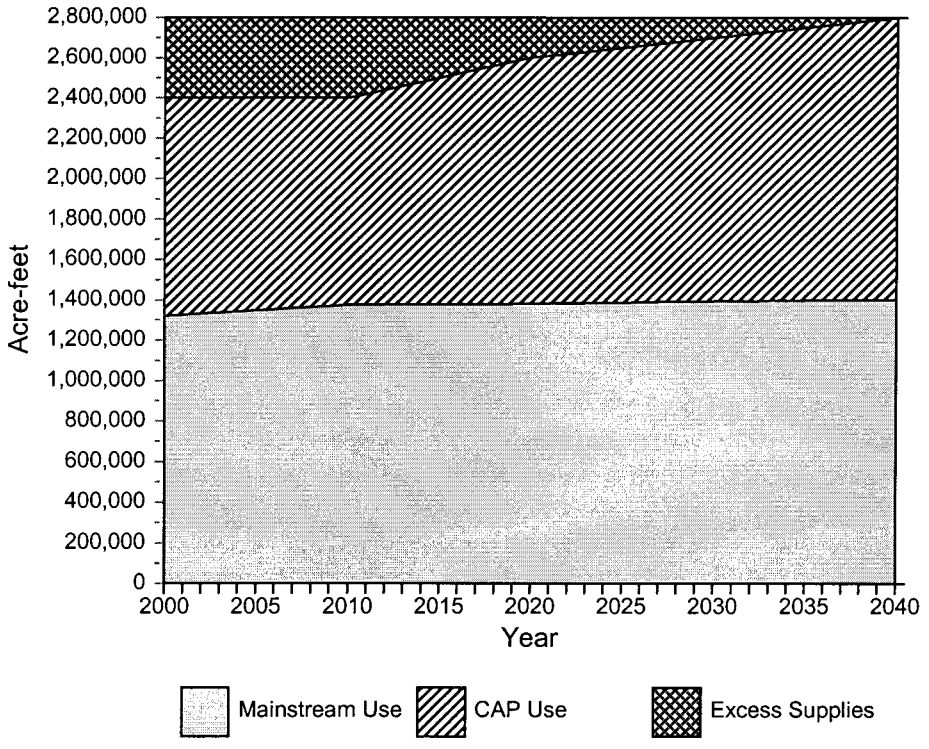
Entity	Allocation (acre-feet)
MUNICIPAL AND INDUSTRIAL SUBCONTRACTS	
City of Tucson	138,920
Arizona State Land Department	14,000
Metropolitan Domestic Water Improvement District [1]	8,858
Flowing Wells Irrigation District	4,354
Spanish Trail Water Company	3,037
Green Valley Water Company	1,900
Town of Oro Valley [2]	2,294
Midvale Farms	1,500
Community Water Company of Green Valley	1,337
Vail Water Company (formerly Del Lago Water Company)	786
Town of Marana [3]	47
INDIAN SUBCONTRACTS	
San Xavier (Tohono O'odham)	27,000
Schuk Toak (Tohono O'odham)	10,800
Pascua Yaqui	500
TOTAL	**215,333**

[1] Allocation transferred from Tucson Water
[2] Includes 1,652 acre-feet of allocation transferred from Canada Hills and 642 acre-feet of allocation transferred from Tucson Water
[3] Allocation transferred from Cortaro Water Users Association

In the short term, unused entitlements and surplus Colorado River supplies provide an opportunity to bring additional CAP water supplies into the AMA beyond existing allocations. Each year the Secretary of the Interior evaluates the Colorado River water supply and determines if it is a normal, surplus, or shortage water year. Unused entitlements (either surplus supplies or subcontracted water that is not ordered and used) can be contracted to other users on an annual basis. This provides an opportunity for the AWBA, the CAGRD, and users who would like to order CAP water in excess of their contract to acquire CAP water. The unused entitlements are a temporary resource, because as the Colorado River becomes more heavily utilized, less excess water will be available. Shortages due to increased use are anticipated on the Colorado River after 2015. Lower than average precipitation on the Colorado River watershed may also result in shortages. Because Arizona has a low priority right to Colorado River water, Arizona's full 2,800,000 acre-foot entitlement may not be available in drought years.

In anticipation of future shortages, the Department expects that renewable supplies will be recharged in the early years, while supplies are available and relatively inexpensive. The Department's projection of the maximum potentially available excess CAP water supplies is illustrated in Figure 8-1. This storage activity may cause temporary rises in water levels in some areas, which should not be confused with achieving and maintaining AMA-wide safe-yield over the long term. If this stored water will be recovered within the area of impact and used in future years to meet demand, it does not result in a permanent change in water levels.

FIGURE 8-1
ARIZONA PROJECTED MAXIMUM EXCESS COLORADO RIVER SUPPLIES



In addition to long-term storage and recovery, CAP water may be utilized through annual storage and recovery. This mechanism, although it involves recharge, is analogous to direct use because no long-term storage credits are generated.

8.2.2.1.2 Municipal Use of Central Arizona Project Water

The municipal sector has the largest allocations of CAP water in the Tucson AMA and offers the greatest opportunities for use of this source. The City of Tucson is the largest provider in the AMA, serves 78 percent of the population in the AMA, and holds the largest municipal CAP water contract in the state (138,920 acre-feet). The City of Tucson adopted a 110-year water resources plan in 1989 which envisioned that direct CAP water utilization (after filtration and disinfection) would serve 95 percent of the population by 1995. This was not achieved due to technical and public relations problems in delivery implementation.

In 1992, Tucson Water began direct delivery of treated CAP water to approximately 60 percent of its municipal customers. Direct delivery was discontinued to areas with older plumbing in 1993 due to problems with older plumbing systems, resulting in odor, discolored water, and damage to household appliances. Most of the "brown water" problems have been attributed to loosening of corrosion coatings in old cast iron water mains, galvanized steel water mains, and household plumbing due to changes in flow patterns through the distribution system, pH differences, and other inorganic chemical factors in the delivered CAP water. Tucson Water found in subsequent investigations that most of these problems can be eliminated by replacement of the older pipelines and changes in management of Tucson's treatment plant and distribution system.

In May of 1994, the City initiated a study to evaluate various alternative options for utilization of CAP water supplies. The options ranged from leasing or exchanging the water to treating with advanced membrane filtration to remove salinity and organic material. In October 1994, the CAP system was shut down statewide for siphon repairs on the canal, and in January 1995, the Tucson City Council voted not to return to direct deliveries until the water quality problems in the delivery system were addressed. Total CAP water use by Tucson in 1995 was consequently only about 10,200 acre-feet, primarily in the form of groundwater savings.

In response to water quality problems experienced when Tucson Water began direct distribution of treated CAP water, Tucson citizens approved an initiative which has had significant impacts on the management of water supplies in Tucson and throughout the AMA. The 1995 Water Consumer Protection Act (WCPA) amends the City of Tucson Code for a minimum of five years. After five years, portions of the Act will remain in effect until the citizens vote to repeal or amend it.

Among other provisions, the WCPA requires that CAP water only be used for sale, exchange or recharge, and to replace groundwater used by agriculture, industry, and landscape irrigation. In the City of Tucson, CAP water to be delivered for potable supply must be treated to concentrations equal or below the salinity, hardness, and dissolved organic concentrations of groundwater from the City's Avra Valley Wellfield. These standards are more stringent than the United States Environmental Protection Agency (EPA) drinking water standards. The groundwater from the Avra Valley Wellfield is relatively high quality. No decision has been made at this time when, or if, the City will return to direct delivery. Because the treatment requirements under the WCPA are expensive and may not be technologically feasible at the scale needed, a return to direct delivery of CAP water in the Tucson Water service area is not likely in the short term.

Although the WCPA directs the City of Tucson to address overdraft in the Central Wellfield through recharge, the WCPA effectively prohibits injection recharge, which may be the most promising technique given the limited availability of suitable surface recharge sites in the Central Wellfield. In the City of

Tucson, CAP water may not be recharged by direct injection unless the water is treated to the quality of Avra Valley groundwater and contains no detectable concentrations of disinfection by-products.

Passage of the WCPA substantially changed the City's CAP water utilization options from those envisioned at the time the Second Management Plan was prepared. Rather than an emphasis on direct delivery, Tucson Water is now expanding recharge activities. The Third Management Plan CAP water use assumptions are based on an all-recharge option. However, Tucson Water is participating in a pilot project with the United States Bureau of Reclamation (USBR) to investigate enhanced membrane filtration as a treatment method for CAP water in order to meet the water quality requirements of the WCPA. The possibility of direct potable use of CAP water for municipal supply in the future will depend on whether a treatment process can be identified and improvements made in the distribution system which will make the water quality acceptable to water customers at a cost that they are willing to pay.

Although the provisions and restrictions of the WCPA only apply to the City of Tucson, other municipal providers in the AMA have been reluctant to initiate direct delivery and injection projects and appear likely to use their CAP water allocations primarily through storage and recovery mechanisms in the near term. Metropolitan Domestic Water Improvement District (MDWID) has recharged CAP water at the Avra Valley Recharge Project since 1996. Several providers, including MDWID, Spanish Trail Water Company, Community Water Company of Green Valley, the Town of Oro Valley, and Green Valley Water Company, have been storing water at the Tucson AMA's four GSFs. Storage at the GSFs began in 1995. Furthermore, the Tucson region risks losing federal funding for a reservoir to increase the reliability of CAP water supply delivery because CAP water is not being used directly. See chapters 2 and 5 for additional information on CAP water use by municipal users. See Chapter 7 for additional information on water quality issues.

8.2.2.1.3 Agricultural Use of Central Arizona Project Water

Agricultural entities in the Tucson AMA, which include the Cortaro Marana Irrigation District (CMID), Avra Valley Irrigation District (AVID), and Farmers Investment Company (FICO), declined their CAP water allocations. Decisions not to sign a CAP water subcontract were made primarily due to CAP water costs. In the cases of AVID and FICO, infrastructure costs for the conveyance of CAP water to their farms was also an issue.

Agricultural use of CAP water in the Tucson AMA has been made possible by the Department's Groundwater Savings Program, which allows a water storer to earn storage credits for providing an alternative water supply to a water user who would have otherwise used groundwater. The cost of CAP water to a farmer operating a GSF varies depending on the CAP water provider and specific conditions of the storage agreement; however, GSF storage agreements typically provide CAP water to farmers at a cost lower than any other water source available to them. Through this program, there is an economic incentive for the farmer to use CAP water instead of groundwater. The entities supplying CAP water earn long-term storage credits. Because much of the agricultural land is close to the CAP canal, using CAP water through a GSF also minimizes the distribution costs for the water storer.

In 1997, agricultural use of CAP water in the Tucson AMA was approximately 25,000 acre-feet. This number is expected to increase in the short term but decrease over time as the demand for direct municipal use increases and as direct recharge facilities are developed. See Chapter 4 for further discussion of agricultural CAP water use and section 8.7.3 for current program incentives to encourage CAP water use.

8.2.2.1.4 Industrial Use of Central Arizona Project Water

There are limited opportunities for CAP water use by industrial users in the Tucson AMA. The cost of CAP water compared to groundwater, the lack of physical access to the CAP water supply, and institutional and water quality concerns constrain the economic use of CAP water by industry. The mines are the largest-volume industrial water user group in the AMA. Lack of delivery infrastructure, costs associated with CAP water quality as it affects mineral recovery, and the cost of CAP water compared to groundwater may preclude direct CAP water use. However, participation in groundwater savings projects may improve the economics of CAP water utilization for copper mining. Incentives to encourage CAP water use by industrial users are included in this plan in section 8.7.3. See Chapter 6 for further discussion of current and potential CAP water use by industrial users.

8.2.2.1.5 Central Arizona Project Water Supply Reliability

The reliability of CAP water supplies and the scheduling of deliveries has implications for the planning and operation of some recharge facilities and direct delivery for municipal use within the AMA. Arizona's CAP water has the lowest allocation priority among the Lower Division states of the Colorado River Basin. The Tucson AMA's location at the terminus of the project, the current lack of terminal storage facilities, and Tucson's lack of other surface water supplies increase the importance of CAP water supply reliability and scheduling.

The USBR conducted the Tucson Aqueduct System Reliability Investigation (TASRI). The focus of the TASRI study was to identify and evaluate methods to bring projected CAP water delivery reliability in the Tucson metropolitan area up to the same level as in the Phoenix metropolitan area. There were differing perceptions of the level of reliability needed, ranging from the need to eliminate water delivery interruptions due to CAP maintenance to providing storage for short-term emergency outages of up to 47 days. The USBR concluded a surface terminal storage reservoir with 15,000 acre-feet of usable storage capacity constructed at Black Wash near the Pascua Yaqui Indian Reservation would meet system reliability needs (USBR, undated). Independent local actions were proposed to provide the additional level of reliability required in the Tucson AMA.

Federal support for construction of the terminal storage reservoir is jeopardized due to changes in the City of Tucson's approach to using its CAP water allocation to meet the requirements of the City's 1995 WCPA. The absence of terminal storage may limit the opportunity to return to direct delivery.

Other municipal water users, the Tohono O'odham Nation, and some industrial water users are also concerned about delivery reliability. Design and operation of recharge facilities is affected by the likelihood of delivery delays and interruptions. Currently, the Southern Arizona Water Resources Settlement Act (SAWRSA) obligates the Secretary of the Interior to pay damages for failure to deliver CAP water to the Tohono O'odham Nation. Reliability is a key issue if the mines in the AMA are to utilize CAP water, because their processes operate 24 hours a day and maintaining the groundwater supply infrastructure as a back-up in case the CAP water supply is interrupted is a significant cost factor.

8.2.2.2 Effluent

Approximately 69,000 acre-feet of effluent were produced in 1995 within the Tucson AMA. Of this amount, only about 10,000 acre-feet, or 15 percent, was reused on turf facilities or delivered to agricultural users. About 56,000 acre-feet, or 81 percent, of the effluent produced was discharged to the Santa Cruz River bed. It is estimated that approximately 10 percent of the discharged effluent evaporates or supports riparian habitat. Because most of the effluent discharged to the river recharges the groundwater aquifer within the AMA, direct use of this effluent provides a limited but important increase in the total water

supply available to the AMA. There are several benefits to increasing direct use of effluent. The primary benefit is reserving high quality groundwater for potable use. Other benefits include the following:

- As more effluent is discharged to the Santa Cruz River, the chances increase that it could leave the AMA as surface water or groundwater outflow.

- Use of effluent for turf irrigation improves the quality of the water that is incidentally recharged because turf takes up nitrogen and phosphorus.

- When CAP water is the original source, effluent reuse increases the benefit of the CAP supply because the original potable use of the CAP water replaces a groundwater use and use of the resulting effluent also replaces a groundwater use.

- A potential localized benefit is the mitigation of subsidence impacts caused by overpumping of groundwater.

- Regulations governing the discharge of effluent to streambeds are expected to become more stringent. As this happens, direct use of effluent will prevent the need to upgrade wastewater treatment facilities.

Direct use or storage that results in keeping the effluent near where it was generated or moving the effluent back upstream increases the likelihood that it will benefit more users. Effluent could also be recharged or used in critical groundwater water level decline areas.

Management of the effluent supply is complicated by institutional factors. The decisions and policies of the jurisdictions controlling the supply and distribution of effluent will affect the use of effluent during the third management period. It should be noted that effluent could cease to be discharged to the Santa Cruz River if alternative plans for the effluent's use are developed. If this happens, the recharge that results from the current discharges will also cease. The effect on safe-yield will depend upon the decrease in groundwater pumping associated with the use that the effluent replaces.

Pima County owns and operates the wastewater system in the Tucson AMA but controls little of the effluent produced. Under an agreement related to the SAWRSA settlement, the Secretary of the Interior is assigned 28,200 acre-feet per year of the effluent discharged from the County's metropolitan wastewater treatment facilities. The City of Tucson controls 90 percent of the remaining effluent produced by County facilities under a 1979 intergovernmental agreement (IGA) and ten percent is controlled by Pima County.

The City of Tucson owns and operates a distribution system for reclaimed water (post-secondary-treated wastewater). The system is primarily used for turf irrigation. The Sweetwater Recharge Facility provides temporary underground storage and filtration to meet demands of the reclaimed water system. The facility uses spreading basins to recharge excess effluent during the winter. The effluent can be extracted via on-site recovery wells for use in the hotter months when irrigation demands are higher. A proposed in-channel effluent storage and recovery project will increase the volume of water that can be delivered through the reclaimed system in the future.

The proposed in-channel or managed effluent storage project may be expanded in the future to include the entire quantity of effluent discharged from the Ina and Roger Road plants that is controlled by the City of Tucson and the Secretary of the Interior. Although this type of credit cannot be used as a demonstration of assured water supply and credits are limited to 50 percent of the water stored, the manner and timing of the storage and recovery of these credits impacts the water budget for the Tucson AMA and may have local implications for water levels.

Although the supply of effluent is increasing with population and offers opportunities for augmenting the water supply, there are conditions in the Tucson AMA that could restrict effluent use:

- Expanding Tucson's reclaimed water distribution system would be costly.
- There is currently no distribution system that could make effluent available to many of the large agricultural users such as BKW Farms, AVID, and FICO.
- Chemical incompatibility of effluent and reclaimed water with metallurgical processes makes the use of effluent in mining operations problematic. Costs associated with constructing, operating, and maintaining a conveyance system to deliver the water to the mines is also prohibitive.
- Institutional/jurisdictional issues associated with using effluent pursuant to the 1979 IGA between the City of Tucson and Pima County have limited effluent use. The 1979 IGA is the subject of ongoing disputes between the City and County and other water providers.
- The SAWRSA settlement, which entitles the Secretary of the Interior to 28,200 acre-feet of effluent annually to settle Indian water rights claims will not be fully implemented until several lawsuits are resolved. Although various proposals are being investigated, the Tohono O'odham Nation has indicated that it does not want to use effluent directly, and no distribution or marketing mechanism for the Indian effluent allocation has been implemented to date.
- There are currently few proposed or developed sites situated for recharging effluent. Pima County has evaluated potential sites for effluent recharge, and both the City of Tucson and the County are in the process of developing small wetland effluent treatment and recharge projects. However, the capacity of the proposed wetland treatment and recharge projects is very limited.

Cooperative regional planning could help address some of the institutional, financial, and regulatory barriers to efficient effluent supply management and effluent use. A regional effluent management planning process began in 1997 with funding from the USBR in cooperation with the Tucson Regional Water Council. The mission of the Regional Effluent Planning Project (REPP) is to develop and implement a coordinated long-range effluent utilization plan and to construct projects in the Tucson AMA. This plan could address water supply needs of critical areas, water quality concerns, and ways to prevent water supplies from migrating out of the AMA.

8.2.2.3 Surface Water

In the upper stream reaches in the Santa Catalina Mountains and a few other areas in the AMA, surface water often flows year-round. Because the surface water eventually percolates to the groundwater aquifer as mountain front and stream bed recharge, this surface water is not a potential new source of renewable supply.

Because most of the intermittent storm-water run-off in the Tucson AMA already recharges naturally along the mountain fronts and in the washes of the AMA, storm-water run-off is also not a significant new source of renewable supply. Impacts to downstream surface water right holders must be taken into account if a storm water recharge project has the potential to affect downstream flows. In order to accrue recharge credits for recharge of storm water, one must demonstrate that the water recharged would have otherwise left the AMA.

Changing the distribution of storm-water recharge in the basin may help meet local water management objectives. Large-scale recharge projects designed solely to recharge storm water are often not cost-effective due to the small number of days of flow during each year. Some small-scale, multiple-use

projects incorporating storm-water recharge have been proposed in the Tucson AMA. A large number of households retaining storm water by harvesting runoff in swales, microcatchments, and tanks could cumulatively result in significant reductions in municipal demand for outdoor use. Retaining storm water in the soil and applying tank-stored storm water to landscaping reduces the need to use groundwater, imported CAP water, or effluent to meet this demand.

8.3 STATUS OF SUPPLY AUGMENTATION AND ARTIFICIAL RECHARGE IN THE TUCSON AMA

This section summarizes direct recharge and groundwater savings project activity; highlights some of the factors affecting recharge, including siting limitations and water quality issues; and gives an overview of how artificial recharge meets other water management objectives.

8.3.1 Recent Direct Recharge Activity - Underground Storage Facilities

Capacity to store renewable supplies in the Tucson AMA is relatively limited, although it has been increasing rapidly. Table 8-2 describes underground storage facilities (USF) permitted as of August 1998, and lists approximate storage volumes for each year from 1995-1997. As of August 1998, there were three USF projects with permits to store CAP water and one permitted project for effluent storage. Because some pilot permits have a maximum volume limit over the life of the permit and full-scale permits have limits on an annual basis, the volume of recharge under the permits may vary significantly from year to year. The calculated volume of credits accrued in USFs through 1997 was 13,856 acre-feet. The locations of projects with permits as of August 1998, projects with pending permits, and proposed sites are shown on Figure 8-2. Brief descriptions of the currently permitted projects are in Table 8-2. The project numbers used in the table are designations used by the Regional Recharge Committee (RRC). This committee of 22 hydrologists and engineers assessed recharge issues and opportunities in the Tucson area and published a report in 1996.

8.3.2 Recent Groundwater Savings Facility (In-Lieu) Activity

A GSF uses a renewable water supply "on a gallon-for-gallon substitute basis" in lieu of the groundwater it would otherwise have pumped. A.R.S. § 45-812.01(B). GSF permits have been obtained to replace groundwater used for irrigated agriculture with CAP water. In order to obtain a GSF permit, the applicant must demonstrate, among other things: (1) that the groundwater to be replaced would have otherwise been pumped; (2) that no other source of water, other than groundwater withdrawn within the AMA, is reasonably available; and (3) that the recipient of the renewable water could not reasonably be expected to use the renewable supply without the added benefits of operating a GSF.

The permit application also must show what evidence will be submitted with annual reports to prove the amount of groundwater saved. A.R.S. § 45-812.01(B) provides guidance on the kinds of information that should be included as evidence.

In the Tucson AMA, as of August 1998, there were four permitted GSFs. Their combined permitted capacity was 52,544 acre-feet per year. Applications for additional permits with a combined capacity of 8,441 acre-feet were pending. Table 8-3 describes the facilities, permitted storage volumes, and volume stored each year from 1995-1997. Figure 8-2 shows the locations of existing and proposed sites. A total of 53,967 acre-feet were stored in GSF's in the Tucson AMA between inception of the program and the end of 1997.

TABLE 8-2
PERMITTED UNDERGROUND STORAGE FACILITIES
TUCSON ACTIVE MANAGEMENT AREA

Facility Description and Status	Storage Permittee	Maximum Volume	Expires	1995 Storage AF	1996 Storage AF	1997 Storage AF
Avra Valley Airport USF - CAP Consists of four off-channel constructed shallow spreading basins. Facility is located northeast of the airport, less than one mile south of Tangerine Road and about one mile east of Sanders Road. CAWCD's pilot permit was for 8,300 AF. The 11,000 AFA full-scale facility permit expires in 2018. Facility is fully operational. RRC project #3.	CAWCD	over 2 years 8,300 AF	1998	NP	0.0	0.0
	MDWID	over 2 years 8,300 AF	1998	NP	2,794.1	3,435.0
	AWBA	8,000 AFA	1998	NP	NP	2,121.0
Pima Mine Road USF - CAP Consists of two off-channel shallow constructed spreading basins, each comprised of four cells. Facility is North of Pima Mine Road, along the Old Nogales Highway. CAWCD's 10,000 AF facility permit expires in 1999. Full-scale project is expected to have capacity of 30,000 AFA. RRC project #4.	CAWCD	over 2 years 10,000 AF	1999	NP	NP	0.0
	Tucson Water	over 2 years 10,000 AF	1999	NP	NP	0.0
Central Avra Valley Storage and Recovery Project USF - CAP Consists of three off-channel shallow spreading basins. Facility is located north of Mile Wide Road a mile west of Sanders Road. CAVSARP Pilot #1: Tucson Water's 500 AF facility permit expired in 1997. CAVSARP Pilot #2: Tucson Water's 10,000 AF facility permit expires in 1999. Application for a 5-year 15,000 AFA permit has been submitted. Full-scale capacity projected to be 60,000 AFA. Facility is fully-funded but expansion depends on results of pilot studies. RRC project #5.	Tucson Water	over 6 months 500 AF	1997	NP	153.6	202.0
	Tucson Water	over 2 years 10,000 AF	1999	NP	NP	1,007.0
	AWBA	over 2 years 10,000 AF	1999	NP	NP	1,000.0
Sweetwater USF- Effluent Consists of seven off-channel basins. Annual storage and recovery facility operated in association with Tucson's reclaimed water system. Facility is located along the Santa Cruz River near Roger Road. Tucson Water's 6,500 AFA facility permit expires in 2008. RRC did not evaluate this site in detail.	Tucson Water	6,500 AFA	2008	2,654	2,572.0	3,207.0
TOTAL				**2,654**	**5,519.7**	**10,972.0**

Losses (evaporation and cut to the aquifer) have not been subtracted from the storage volumes.
AF = acre-feet
AFA = acre-feet annually
AWBA = Arizona Water Banking Authority
CAP = Central Arizona Project
CAWCD=Central Arizona Water Conservation District
CAVSARP = Central Avra Valley Storage and Recovery Project
MDWID = Metropolitan Domestic Water Improvement District
NP = no permit in effect during this year
RRC = Regional Recharge Committee
USF = Underground Storage Facility

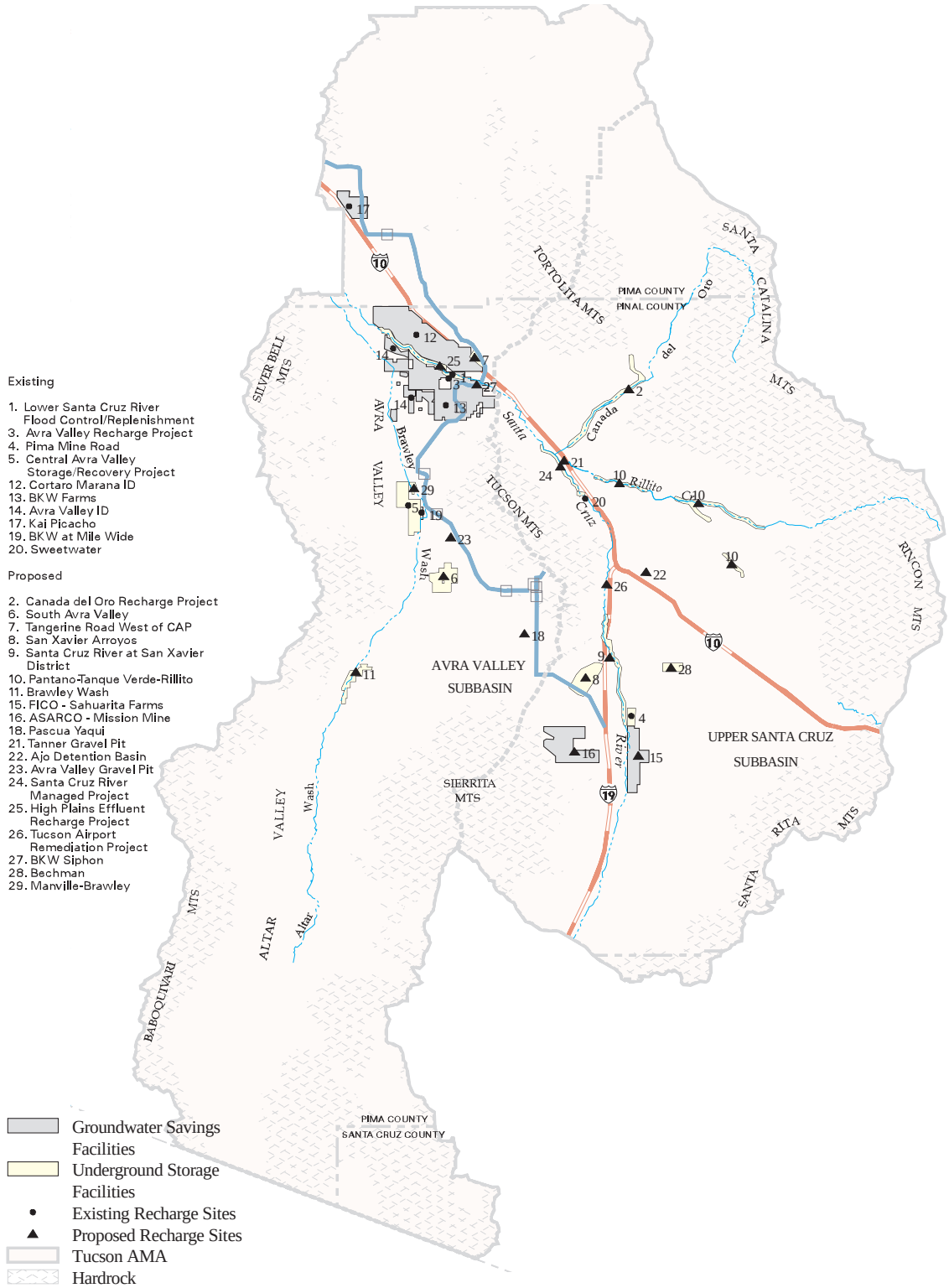


Figure 8- 2

Recharge Sites
Existing and Proposed

ORIGINAL SOURCE
Pima Association of Governments
Locations of Recharge Sites are Approximate

GSFs tend to be less expensive than USFs because very little construction is required for facilities located near the CAP canal. However, the benefits of GSFs and the opportunities for their use as a water management tool are mostly short-term. GSF storage capacity is likely to increase in the third management period, while unused CAP water allocations, excess CAP water, and storage sites close to existing conveyance infrastructure are available. In the long term, the volume of water used on irrigated agriculture is expected to decline due to urbanization of farmland and decreasing availability of CAP water.

GSFs are perceived by some local water interests as a postponement of groundwater level declines, because after the GSF contracts are completed, water users are likely to resume pumping groundwater in the area of storage. Temporary supply substitution through GSFs without extinguishment of some groundwater rights or other reduction in use will not solve local overdraft problems. Although GSFs were not originally conceived as a tool to address water management problems in critical areas, they can be used to address areas of overdraft, if the credits generated are recovered in locations where water supply availability is less critical. The relative benefits of USFs compared to GSFs must be analyzed on a site-by-site basis.

8.3.3 Limitations on Availability of Recharge Sites

Availability of suitable recharge sites affects direct recharge efforts in the Tucson AMA. The City of Tucson, Pima County, Metropolitan Domestic Water Improvement District (MDWID), Marana, Oro Valley, Central Arizona Water Conservation District (CAWCD), the Department, and others have participated in hydrogeological and other feasibility investigations of sites that may be suitable for recharge. The RRC and IPAG, in developing a regional recharge plan for the Tucson AMA, screened the available data for 37 proposed recharge project sites for project feasibility and potential to meet regional groundwater management objectives. More information about the planning process is in section 8.4.5.3.

Physical factors affecting recharge feasibility include infiltration rates, permeability, geochemistry, available storage, and the existence and extent of lower permeability or impermeable layers in the vadose zone. Although there are many locations within the AMA suitable for recharge, there are few single sites capable of accepting as large a volume of water as the Granite Reef Underground Storage Project site in the Phoenix AMA, which is likely to store approximately 75,000 acre-feet annually.

Availability of sites for basin or in-channel recharge is also limited by areas of existing contamination and potential contaminant sources. Some reaches of stream channels in the Tucson AMA are not suitable sites for developing surface recharge, because closed and active landfills and dumps and other land uses that could be sources of contaminants are located too close to the channels. The Department will not issue a permit for a proposed facility that may cause unreasonable harm based on evaluation of the application data.

Well injection recharge can be particularly useful in urban areas where there is insufficient space to develop a surface recharge site or land costs are too high for surface recharge to be economically viable. The cost to meet injection recharge water quality requirements under the 1995 WCPA discourages use of injection recharge methods within the City of Tucson.

Proximity to source water is a significant economic feasibility factor for siting effluent and CAP water projects because of the cost to construct and operate conveyance and distribution systems. Hydrogeologically suitable sites for recharge in some of the critical water level decline areas may be too far from existing effluent and reclaimed water delivery systems and the CAP canal to economically develop the sites. Use of the existing potable water supply system for CAP water deliveries could improve the economic viability of some recharge sites.

TABLE 8-3
PERMITTED GROUNDWATER SAVINGS FACILITIES
TUCSON ACTIVE MANAGEMENT AREA

Facility Description and Status	Water Storage Permittee	Maximum Volume AFA	Expires	1995 Storage AF	1996 Storage AF	1997 Storage AF
Cortaro Marana Irrigation District GSF Receives CAP water in lieu of pumping groundwater. Facility roughly located from Tangerine Road north to the Pima/Pinal County border and southwest of I-10 to one mile west of Trico Road. CAWCD's 10,000 AFA facility permit was conveyed to CMID. CMID's modified 20,000 AFA permit expires in 2008. The facility is fully-funded and currently operating. RRC #12.	CAWCD	10,000	2008	0	0	0
	Tucson Water	10,000	2003	5,902	9,581	6,327
	Spanish Trail	10,000	2003	NP	NP	3,419
	Community Water Company of Green Valley	10,000	2003	NP	NP	0
BKW Farms GSF Receives CAP water in lieu of pumping groundwater. Facility located south of Santa Cruz River to Emigh Road between Trico Road and Silverbell Road. CAWCD's 8,800 AFA facility permit expires in 2002. Facility is fully-funded. Application for expansion to 16,614 AFA has been submitted. RRC #13.	CAWCD	8,800	2002	1,000	0	0
	Community Water Company of Green Valley	8,800	2002	NP	NP	2,000
	Tucson Water	8,800	2002	3,235	5,080	6,648
	MDWID	2,000	2002	NP	2,000	0
Herb Kai Red Rock GSF Receives CAP water in lieu of pumping groundwater. Located in Pinal County, east of the Town of Red Rock, south of Neuman Peak Road to Park Link Road, and between I-10 and Pecan Road. Herb Kai's 11,231 AFA facility permit expires in 2006. The facility is operating. RRC #17.	MDWID	11,231	2006	NP	NP	1,136
	CAWCD	11,231	2006	NP	NP	0
	Spanish Trail	11,231	2006	NP	NP	3,915
	Town of Oro Valley	6,000	2006	NP	NP	1,150
	Green Valley Water Co.	500	1999	NP	NP	500
	Tucson Water	11,231	2006	NP	NP	0
Avra Valley Irrigation District GSF Receives CAP water in lieu of pumping groundwater. Located between Trico and Sanders Roads, on either side of Avra Valley Road, west of the Santa Cruz River. Herb Kai's 12,513 AFA permit expires in 2008. RRC #14.	MDWID	12,513	2008	NP	NP	NP
TOTAL				**10,137**	**16,661**	**25,095**

AF= acre-feet
AFA= acre-feet annually
CAP = Central Arizona Project
CAWCD= Central Arizona Water Conservation District
CMID= Cortaro Marana Irrigation District
GSF= Groundwater Savings Facility
MDWID= Metropolitan Domestic Water Improvement District
NP= no permit effective in this year.
RRC = Regional Recharge Committee

Recharge to help mitigate overdraft in the Central Wellfield is particularly constrained by these site availability issues. The critical area of water level decline primarily underlies densely urbanized areas of Tucson. Potential contamination sources, local regulations, and conveyance issues affect the feasibility of recharge in this area.

Recovery considerations are another constraint on potential recharge site development. Some of the concerns include where the facility is located with respect to the final use, whether the recovered water is determined to be groundwater under the influence of surface water and will therefore require filtering and disinfection, and whether the proposed recovery will be feasible under recovery permit requirements in areas of severe groundwater overdraft and high subsidence risk.

Additional discussion about the opportunities and limitations associated with siting direct recharge facilities can be found in the *Regional Recharge Plan* developed by the Tucson AMA Institutional Policy Advisory Group (IPAG) in 1998.

8.3.4 Water Quality Issues

Protecting and managing groundwater quality and matching water supplies of different quality to user needs maximizes the amount and utility of water available to the AMA. The Arizona Department of Environmental Quality (ADEQ) is the lead state agency in protecting and monitoring groundwater quality conditions (see Chapter 7 and Appendix 8A.4 for more information about ADEQ authorities). The Department is involved with water quality management through wellhead protection; well construction standards; permitting; and review, planning, and other activities associated with the ADEQ Water Quality Assurance Revolving Fund (WQARF) Program. Chapter 7 describes the Department's Water Quality Management Program in detail. This section focuses on water quality issues with respect to augmentation of water supplies.

Most of the groundwater supplies in the Tucson AMA meet all EPA and state drinking water standards. However, groundwater from some areas has contaminant levels that exceed the primary safe drinking water standards. There are concerns that remediation efforts to date have been inadequate at many sites. Substantial public education efforts are also needed. Chapter 7 describes many of the areas where groundwater quality is a concern in the Tucson AMA.

Tucson's 1995 Water Consumer Protection Act prohibits delivery of groundwater that has been treated by Tucson Water to remove contaminants, even if the resulting water quality meets all federal and state drinking water standards. Within the Tucson Water service area, use of treated groundwater supplies and achievement of maximum beneficial use of treated groundwater produced by mandated clean-ups are complicated by this provision.

Water quality considerations regarding recharge are site-specific. They are related to the ambient groundwater quality (which varies across the AMA), the soil chemistry, the quantity of water to be recharged, the degree of mixing with the ambient groundwater, past land-use practices, percolation rates, and residence time. The location, volume, and timing of recovery activities are also important in assessing water quality impacts.

Water withdrawn in the vicinity of a recharge site is often a mixture of the recharged water and ambient groundwater. In some areas of the AMA, recharge of CAP water would improve the quality of the ambient groundwater. In other areas, there may be increases in the concentration of total dissolved solids (TDS). TDS concentration is one of several parameters that affect the aesthetic qualities of drinking water. The typical concentration of TDS in CAP water is higher than the concentrations of TDS found in the groundwater currently being withdrawn from most areas of the AMA. Generally, artificial recharge processes, including percolation of water from surface basins through vadose zone soils, do not remove

TDS from recharging water. Older groundwater supplies in deeper parts of the aquifer than those layers that are currently being tapped are also likely to have higher concentrations of TDS and other inorganic parameters than the groundwater currently being supplied. See Chapter 7 for a more detailed discussion.

The impact of the implementation problems Tucson Water experienced with direct delivery has affected CAP water use plans beyond the City of Tucson. Public perception of CAP water quality, which was an issue even before direct delivery, has been affected regionally, and other communities in the AMA are reluctant to consider direct delivery of CAP water in the short term.

ADEQ is developing new rules to govern "groundwater under the influence of surface water." How ADEQ will interpret and enforce the surface water disinfection rules when the recharged CAP water and ambient groundwater is withdrawn from wells for potable use is a water quality issue for CAP water recharge projects statewide. If the recovered water is deemed to be groundwater under the influence of surface water, then both filtration and disinfection may be required, resulting in substantial increases in recovery costs. Whether the effects of soil aquifer treatment will be taken into consideration on a case-by-case basis has not been determined yet. (See Appendix 8A, section 8A.4.2, for more information regarding this requirement.)

Augmentation funds have been used to assess potential water quality impacts of recharge activities. The Department funded a study of selected disinfection by-product issues related to the recharge and recovery of CAP water. The Department also funded a water quality impacts evaluation as part of a study to assess the feasibility of delivering CAP water to water users in the Sahuarita-Green Valley Area. These projects are described further in chapters 7 and 9.

8.3.5 Integrating Artificial Recharge with Other Groundwater Management Objectives

Artificial recharge can play a role in meeting multiple planning objectives. Some artificial recharge projects may provide side benefits involving storage, flood control, groundwater quality management, subsidence prevention, infrastructure utilization, open space and recreation, and riparian habitat maintenance. The Department recognizes that multiple-purpose projects can provide significant benefits to the community. However, to be permitted as a USF and accrue long-term storage credits, the recharge project's primary purpose must be water storage (see section 8.7.2.2). The design focus of a USF should be to maximize recharge.

8.3.6 Regulatory and Institutional Setting for Recharge

The regulatory and institutional framework for recharge activities is complex. Statutory provisions and permitting considerations for USF facilities provide background for the USF Program section and explain certain policy considerations (see section 8.7.2). Other Department activities that affect the Augmentation and Recharge Program include the use of the augmentation, conservation assistance, and monitoring fund; AWPF grants; the AWS Program; and well spacing rules (see Appendix 8A).

The AWBA, the CAWCD, and the CAGRD play significant roles in water supply augmentation and recharge. An understanding of the roles, authority, programs, and policies of these institutions is essential for understanding CAP water availability, use, and reliability in the Tucson AMA.

Federal, state, and local regulations and policies and the actions of other institutions and agencies have significant impacts on recharge and supply augmentation efforts. Key factors include:

- Indian water rights settlements;
- ADEQ regulations and programs including aquifer protection permits (APP), water disinfection rules for groundwater under the direct influence of surface water, aquifer water quality standards (AWQS), and wastewater reuse permits;
- Federal Clean Water Act requirements including National Pollutant Discharge Elimination System (NPDES) permits (administered through ADEQ), and section 404 permits (administered by the United States Army Corps of Engineers);
- United States Fish and Wildlife Service (USFWS) activities and Endangered Species Act (ESA) requirements;
- The State Historic Preservation Act and local requirements for archaeological surveys;
- USBR activities and requirements of the Reclamation Reform Act (RRA);
- Local zoning and flood control regulations; and
- City of Tucson 1995 Water Consumer Protection Act.

The implications of several of these programs and policies are discussed in detail elsewhere in this chapter. Background information on many of the listed factors is in Appendix 8A.

8.4 ASSESSMENT OF SECOND MANAGEMENT PLAN AUGMENTATION PROGRAM ACTIVITIES

The Second Management Plan contained a thorough review of opportunities to supplement the water supplies of the AMA. It focused on six objectives that were thought to be most useful in supporting the augmentation efforts of the AMA. The following section is a review of the Second Management Plan program objectives and progress in meeting those objectives. Each subsection refers to an objective listed in the Second Management Plan.

8.4.1 Second Management Plan Objective 1: Maximum Use of Tucson AMA Central Arizona Project Allocations

Problems with utilization of the AMA's CAP water allocation relate to both allocation and distribution issues. Some entities hold subcontracts and are currently unable to use them. Other entities would like to use CAP water but have no way to physically access the water. Use of the City of Tucson's annual subcontract, the largest allocation in the state, has been delayed due to direct delivery problems as described in section 8.2.2.1.2.

The lack of conveyance structures to transport CAP water from the canal or the City of Tucson delivery system to other water providers and users in the AMA, and CAP water delivery reliability issues also inhibit use of CAP water subcontracts. The mines and agricultural users have declined CAP water subcontracts as discussed previously.

8.4.2 Second Management Plan Objective 2: Optimize Use of Central Arizona Project Canal System to Enable Delivery of "Surplus" Colorado River Water and Other Water to the AMA

The GSF program has utilized some excess CAP water and some CAP contract water. The AWBA now provides an opportunity to bring more surplus water into the region while it is available. The CAWCD operated the CAP canal at full capacity during parts of 1997, and the canal is expected to be at capacity at least during the summer months in the future. Although statewide CAP water deliveries have been near capacity, deliveries to the Tucson AMA have been limited primarily by the factors previously discussed. Opportunities to bring other water sources into the AMA via the canal have not been investigated by the Department.

8.4.3 Second Management Plan Objective 3: Maximize Recharge of Alternative Supplies to Groundwater

Several steps were taken toward achieving this objective, including recharge feasibility assessments; pilot projects which were designed, built, and operated in the second management period; and regional planning activities. Most of the recharge activity has been near the CAP canal.

Annual storage and recovery of effluent at Tucson's Sweetwater facility has occurred since 1987. An application for a facility permit for managed in-channel recharge of effluent in the Santa Cruz River is pending.

The Town of Marana and Pima County Flood Control District have submitted an application for a facility permit to recharge effluent and also effluent that is accounted for as surface water at the proposed High Plains recharge project. The application is for a two-year pilot to recharge 600 acre-feet. The facility would consist of five basins, with a total area of approximately four acres located along the south bank of the Santa Cruz River about 250 feet from the main channel.

The Department initiated a regional recharge planning effort in 1995. The planning process has provided a more complete picture of the geographical, political, institutional, legal, and technical issues associated with the development and implementation of recharge projects (see section 8.4.5.3).

Additional effluent recharge options have been identified in various forums, including the Regional Effluent Planning Process which was initiated in 1997 (see section 8.2.2.2).

8.4.4 Second Management Plan Objective 4: Augment Supplies Through Inter-regional Water Transfers and Exchanges

No inter-regional water transfers or exchanges were completed in the second management period. However, the 1992 Water Exchange Act may facilitate future exchanges.

8.4.5 Second Management Plan Objective 5: Resolve Technical, Institutional, Legal, and Environmental Constraints that Inhibit the Development of Beneficial Use of Alternative Supplies

The augmentation discussion presented in the Second Management Plan identified some legal and institutional issues which needed to be resolved before augmentation projects could be undertaken on a large scale. Examples of the issues identified include questions regarding ownership of rights to augmented water supplies, questions regarding liability for potential damages resulting from augmentation projects, and the need for laws or Department rules to provide incentives for water supply augmentation efforts. The following sections describe efforts during the second management period to respond to these issues.

8.4.5.1 Legislative Changes

Substantial legislative changes have been sponsored or supported by the Department to facilitate the augmentation of water supplies in the AMAs. In 1996, legislation established the AWBA for the purposes of increasing utilization of excess Colorado River supplies, primarily through recharge in the Phoenix, Pinal, and Tucson AMAs. For more information about the AWBA see section 8.4.5.2, section 8.7.1, and Appendix 8A.

In 1994, passage of the Underground Water Storage, Savings, and Replenishment Act integrated the various underground water storage programs adopted since 1986 into a single, unified program. This more

streamlined process was intended to facilitate development of recharge projects. The legislation also improved the recharge permitting system, addressed the assignability of long-term storage credits, and established accounting mechanisms for replenishment districts and conservation districts.

Legislation was also passed in 1994 to address recommendations by the Governor's CAP Advisory Committee for increasing the state's use of CAP water supplies. To encourage earlier use of CAP water, the legislation moved back the statutory date by which cities and towns with CAP allocations would have to prove an assured water supply from 2001 to 1998. The AWPF was established in 1994 to issue grants to water users for implementing projects to protect the state's rivers and streams, including the use of excess CAP water for riparian enhancement.

Other legislation has been enacted since adoption of the Second Management Plan that enhances the ability of water users to undertake augmentation projects. In 1993, legislation was enacted that created the CAGRD (administered by the CAWCD) to utilize excess CAP water to replenish groundwater used by district members in excess of their mined groundwater allocations under the Assured Water Supply Rules. The CAGRD allows water companies and subdivisions to meet the renewable water supply requirements of the AWS Rules.

The 1992 Water Exchange Act allows for the trade of any water supplies for any other water supplies between water users, as long as each water user has the legal right to use the water it gives in trade. This facilitates conjunctive use of surface water, groundwater, and effluent, and is particularly useful in the Phoenix AMA.

Although the 1991 Groundwater Transportation Act severely restricts the ability of municipal water providers to transfer groundwater from rural basins to urban areas, the act nonetheless provides a legal framework for certain interbasin transfers of groundwater supplies to assist in demonstrating an assured water supply. The Act reduces the conflict between rural and urban interests over importation of groundwater. This Act laid important groundwork for development of the AWS Rules, which are instrumental in ensuring the use of renewable water supplies in the AMAs.

Other legislation initiated since the adoption of the Second Management Plan provides additional incentives for the use of CAP water by reducing the level of conservation required for users who limit groundwater use to 30 percent or less of their total use and by allowing for the extinguishment of recharge credits to gain compliance with the municipal gallons-per-capita-per-day water use requirement.

8.4.5.2 Arizona Water Banking Authority

Arizona does not currently use its full annual 2.8 million acre-foot share of Colorado River water established through the court opinion in *Arizona v. California*, 373 US 546 (1963). Any of Arizona's apportionment that is not diverted from the mainstream of the river by Arizona is available for use in California or Nevada. The AWBA was established in 1996 as a means to increase the utilization of Arizona's Colorado River apportionment and to store unused Colorado River water to meet Arizona's future water supply needs. As Arizona directly uses more of its Colorado River apportionment, the amount of "excess" CAP water available to the AWBA for storage is expected to decrease over time. Arizona has the lowest priority right of the Lower Division states of the Colorado River basin. The availability of "excess" water would be less during periods of shortages, when Arizona is not allowed to divert the full 2.8 million acre-feet per year.

The objectives of the AWBA include: (1) protecting municipal and industrial users of CAP water from shortages or disruptions of the CAP system, (2) assisting in meeting the management objectives of the state Code, (3) assisting in the settlement of Indian water rights claims, (4) exchanging water to assist Arizona's Colorado River communities, and (5) exploring opportunities for interstate water banking with Nevada and

California. Although the AWBA has been working closely with the AMAs to identify storage opportunities that would also help support the water management objectives of each AMA, some of the recharge projects that are ideally located to meet some of these AWBA objectives may not assist the AMAs in meeting their specific water management goals.

Annual funding for the AWBA comes from four sources: an ad valorem property tax of four cents per $100 assessed valuation in the three-county CAP service area; $2.50 per acre-foot of the $3.00 per acre-foot groundwater withdrawal fee in the Tucson, Phoenix, and Pinal AMAs; general fund appropriations; and the proceeds of interstate banking activities. A.R.S. § 45-2425 describes how the water banking fund is collected, and A.R.S. § 45-2457 describes how each fund component may be used. The ad valorem tax collected for the AWBA in Pima County is estimated to be $1.4 million for 1998. The groundwater withdrawal fee should generate $700,000 in 1998.

Long-term storage credits accrued with general fund appropriations may be used by the AWBA only as follows: (1) to make water available to municipal and industrial users of Colorado River water in this state that are outside the CAWCD service area and to CAWCD for the purpose of meeting the demands of its municipal and industrial subcontractors (both are limited to situations when there are water shortages and require reimbursement), (2) to implement Indian water rights settlements, and (3) to fulfill the water management objectives of the Code.

Credits accrued with the withdrawal fees may only be used for the benefit of the AMA in which the monies were collected. These credits may be used for Indian water rights settlements or to meet the water management objectives of the Code. These funds can be used to store credits for future use or to store credits for extinguishment.

Credits accrued with the ad valorem tax may only be used to benefit the county in which the funds were collected. The AWBA is required to transfer the credits to CAWCD to meet the demands of CAWCD's municipal and industrial subcontractors during times of shortage.

Credits accrued with monies paid by California or Nevada agencies pursuant to the interstate banking provisions must be associated with a plan for forbearance from taking Colorado River water in the future. The AWBA, under certain conditions, is authorized to enter into interstate banking agreements with entities in Nevada and California. Under these agreements, the out-of-state entity would finance the storage of Colorado River water in Arizona. Later, when that entity needed additional water supplies, the AWBA would provide for the recovery of the previously stored water. The recovered water would be used in place of diverting Arizona's full mainstream Colorado River apportionment. The additional water left on the mainstream would be used by the participating out-of state entity. To the extent interstate water is stored in the Tucson AMA, the AMA would receive a short-term benefit of additional water supplies being imported into the AMA in advance, perhaps by decades, of when those supplies would be needed for direct use.

The AWBA is expected to play an important role in the Tucson AMA's water management plans for the third management period. The AWBA will bring additional CAP water into the AMA that would otherwise have been unavailable, and is expected to participate in developing additional water storage opportunities that will benefit the AMA. The Institutional Policy Advisory Group (IPAG) estimated in the November 1997 Report to the AWBA that the total recharge capacity that could be utilized by the bank in the Tucson AMA is 30,000 to 42,000 acre-feet per year, based on AWBA costs of $50 to $70 per acre-foot of CAP water, which may be optimistic.

The AWBA developed a Storage Facilities Inventory for the Phoenix, Pinal, and Tucson AMAs and published the results in March 1997. The AWBA inventory identified 18 proposed and existing recharge facilities in the Tucson AMA, including underground storage, groundwater savings, and effluent recharge

projects, but determined that much of this capacity might not be available to the AWBA because of existing storage obligations to other users and due to other factors. The AWBA concluded that of the three AMAs, only the Tucson AMA had inadequate storage facility capacity to meet the needs of the AWBA for the next ten years. Consequently, under the requirements of A.R.S. § 45-2453(A), the AWBA must develop and implement a plan for additional storage facilities in the Tucson AMA.

In developing and implementing the Facilities Plan, the AWBA is working with the Tucson AMA's regional recharge planning process. The AWBA stated in the Storage Facilities Inventory that the Facilities Plan should complement the Tucson AMA's Regional Recharge Plan to the greatest extent possible. Through this planning relationship, the Department anticipates that most of the AWBA's activities in the AMA will be consistent with local water management objectives. The plans of the AWBA to conduct recharge in the Tucson AMA in both 1997 and 1998 were limited by the slower than anticipated development of certain facilities. The Tucson AMA's specific recommendations to the AWBA regarding siting of storage facilities and contributions to water management appear in section 8.7.1

8.4.5.3 Regional Recharge Planning

Starting in 1995, with the support of the Groundwater Users Advisory Council (GUAC), the Tucson AMA initiated a voluntary planning process for development of the Regional Recharge Plan. Separate technical and policy committees were formed so that political and institutional considerations would not impede evaluation of the technical feasibility of recharge. In 1996, the RRC met to resolve technical issues and provide objective analysis of available data for the use of the political and institutional participants of the IPAG in developing the plan.

The RRC addressed several issues and developed consensus opinions on each issue. Thirty-four potential recharge projects, including seven GSFs, were identified and evaluated. The RRC selected 16 of the projects for a more detailed evaluation, which included a conceptual design and cost analysis. Projects were evaluated for their ability to maximize short-term (five year) recharge volume and long-term regional benefits. Figure 8-2 shows the approximate location of the direct recharge and groundwater savings sites the RRC evaluated in detail and locations of other sites. The RRC's findings were summarized in the September 5, 1996 Department report, "Regional Recharge Committee Technical Report."

IPAG defined the objectives and principles of the Regional Recharge Plan, assessed the recharge-related needs of water users through interviews, identified and described key policy issues, identified and ranked recharge objectives based on the needs assessment data, and developed project evaluation criteria based on these objectives. Physical evaluation criteria and technical data from the RRC were incorporated in the project evaluation criteria.

In November, 1997 IPAG developed a report that focused on storage opportunities for the AWBA, "Report to the Arizona Water Banking Authority." IPAG and Department staff completed the Regional Recharge Plan in 1998. The Regional Recharge Plan includes projections of regional recharge needs under various conditions, project combinations and options under various recharge demand scenarios that fulfill the regional plan criteria, available capacity and potential storage opportunities for the AWBA and other regional interests. It identified data gaps and project needs to address specific problem areas and water management needs such as subsidence risk in the City of Tucson's Central Wellfield and areas of poor water quality.

Implementation of the plan depends on the cooperation of the community, water providers, and political entities, and the willingness of these parties to address regional water management issues. The AWBA used information from the Regional Recharge Plan to develop the AWBA's Facility Plan for the Tucson AMA.

While legal and institutional barriers to augmentation efforts in the AMAs still exist, it is clear that many barriers that were present when the Second Management Plan was adopted have been removed as a result of the efforts of the Department, regulated water users, and other interested parties.

8.4.5.4 Santa Cruz Valley Water District

The Department assisted in the development of 1990 legislation which authorized the creation of a regional water district within the Tucson AMA. The Santa Cruz Valley Water District (SCVWD) was established in June 1991 to facilitate water resource management, especially access to renewable water supplies. Originally the SCVWD was known as the Tucson AMA Augmentation Authority. The scope of duties and authorized activities included the following: construction of water conveyance and recharge projects, facilitation of policy coordination and cooperation between government entities, issuance of revenue bonds, groundwater replenishment responsibilities, contracts and agreements to acquire water supplies for water exchanges and deliveries, provision of technical or financial assistance for developing water supplies to help meet water management goals, development of a comprehensive water resource augmentation plan, coordination of water conservation efforts, provision of miscellaneous water management services, and collaboration on regional recharge and augmentation studies (Santa Cruz Valley Water District, 1993).

SCVWD was funded by groundwater withdrawal fees for a 30-month study period. In December of 1993, although a majority of the board voted to continue, a veto from one member resulted in termination of the District, primarily because issues of governance could not be resolved. Some of the roles envisioned for SCVWD have been incorporated in Department and CAGRD programs.

8.4.5.5 Cooperative Efforts to Encourage Use of Renewable Supplies

The Department has also been actively involved in groups that have formed to facilitate use of renewable supplies within specific regions of the AMA. Department staff have participated in the Northwest Replenishment Program, which is a cooperative effort by multiple political jurisdictions, water districts, and water providers to use artificial recharge of CAP water and effluent for supply augmentation, wildlife and vegetation enhancement, recreation, and flood control. The Upper Santa Cruz Water Users Group (USCWUG) provides a forum to evaluate the feasibility of bringing CAP water to users in the southern part of the AMA, south of the CAP terminus. The regional recharge planning and effluent use planning efforts have also provided a means to share information, identify and resolve problems, and coordinate efforts. Section 8.7.4 provides information on continuing planning efforts.

8.4.6 Second Management Plan Objective 6: Identify Potential Augmentation Measures for Future Implementation

During the second management period, energy was focused on resolving conflicts related to CAP water and effluent use through regional recharge planning efforts and the attempt to establish a regional augmentation authority. The Department's focus has been on maximizing utilization and storage of CAP water, and efforts to take advantage of the surplus Colorado River water while it exists. The Department focused less on developing more remote, future alternative supply augmentation concepts such as cloud seeding or importing other water resources from outside the AMA.

8.4.7 The Second Management Plan Augmentation Assistance Program

The Second Management Plan contained specific criteria for evaluating augmentation grant applications and the Department's proposals for program expenditures. The Augmentation Assistance Program has since been expanded to include technical services contracts and intergovernmental agreements (IGAs) for monitoring of the AMA's water supply conditions. The Tucson AMA augmentation grants financed programs ranging from the Feasibility Study for the Rillito Recharge Project and the establishment of the

SCVWD, to staff support for the Regional Recharge Plan. In addition, a total of six grants supporting specific recharge projects, several IGAs, and three technical contracts have been issued. All of the grants, contracts, and IGAs have been written and managed by Tucson AMA staff. This program is described more specifically in Chapter 9, and the augmentation expenditures are listed in Appendix 9B.

8.4.8 Summary of Program Effectiveness

Overall, the implementation of the Second Management Plan Augmentation Program for the Tucson AMA has been effective. The most successful aspects of the program have been the legislative and rule changes that support the management goal, including: (1) the AWS Rules; (2) the passage of the Underground Storage, Savings and Replenishment Act; and (3) the establishment of the AWBA. In addition, activities supported by the Augmentation Fund have received substantial support from the public and the technical community. These activities include the development of the Regional Recharge Plan and of various specific recharge and feasibility studies. The Department has emerged as a major source of technical assistance and has put significant effort into coordination and facilitation of augmentation efforts.

However, utilization of renewable supplies has not progressed as quickly as was anticipated, due primarily to economic and institutional constraints. It is also not clear that the regulatory incentives included in the Second Management Plan have been effective in increasing use of CAP water and effluent.

8.5 AUGMENTATION AND RECHARGE ISSUES

The Department has planning tools and the regulatory authority to support achievement of safe-yield and the Tucson AMA's groundwater management objectives. The Department also has many opportunities to influence and/or contribute to the efforts of others to facilitate supply augmentation and management. However, the decisions and actions of many governments, institutions, and individuals are required to achieve safe-yield. Consequently, there are many factors affecting augmentation programs and implementation of programs that are beyond the control of the Department. Some of these factors are discussed in previous sections and Appendix 8A.

The programs developed for the third management period focus on elements of water-supply management problems and strategies that are within the authority of the Department and are feasible with the anticipated available agency resources. The program discussion and future directions sections of this chapter and Chapter 12 highlight some of the potential opportunities for the agency to acquire additional tools and authorities or to contribute indirectly to the efforts of others to address the water management problems facing this community. Major water supply augmentation challenges facing the Tucson AMA include:

(1) Existing grandfathered right allocations (irrigation, Type 1, and Type 2) exceed net natural recharge by a factor of about 2.8.

(2) Current failure to directly use or store the majority of the Tucson AMA CAP water allocations, the most important source of alternative supply available to the AMA.

(3) The local consequences of overdraft, including subsidence, decreases in well productivity, decreases in water quality, and loss of riparian habitat, are inadequately addressed by existing Code authorities, which focus on a basin-wide balance. Implications include difficulties for the City of Tucson in meeting the physical availability criteria for an assured water supply designation.

(4) Regional conflicts over water policy, including interjurisdictional conflict and factions that have evolved within the community, hinder appropriate use of renewable supplies.

(5) Inability to maximize the use of effluent in place of potable groundwater. If effluent discharges into the Santa Cruz River from the regional wastewater treatment plants continue to increase, this could result in eventual losses of effluent from the AMA through surface water or groundwater outflow.

(6) The effects of in-stream or "managed" effluent storage projects may require additional study.

(7) Lack of economic incentives to "do the right thing." Because groundwater pricing does not reflect the cost of the next available supply, and because the impacts of individual actions are obscured in long-term and regional effects, there is little sense of ownership of the consequences. Groundwater remains the cheapest, and in most cases, the highest quality source of supply.

(8) Local water supply management needs include delivery of alternative supplies to Tucson Water's Central Wellfield and to the rapidly developing portions of the AMA that are not directly adjacent to Tucson Water's reclaimed water system or a CAP delivery system. Distance from renewable supply sources increases the cost and difficulty of utilizing supplies.

(9) It is possible that the groundwater allocations provided through the AWS Rules and the Avra Valley groundwater credit provisions for the City of Tucson may provide too much flexibility for water providers and result in lower utilization of CAP water than would otherwise have occurred during the second and third management periods.

(10) There is a need to maximize the benefits of recharge by locating recharge facilities in places where multiple objectives can be achieved without jeopardizing the efficiency of the recharge component.

8.6 AUGMENTATION AND RECHARGE PROGRAM GOALS AND OBJECTIVES

Since the development of the Second Management Plan, new data about the distribution of water resources, hydrogeologic conditions, and subsidence potential have been published, and there have been significant changes in the institutional and regulatory setting for supply augmentation and recharge. The goals and objectives of the augmentation and recharge program in the third management period reflect an updated understanding of the scope of the AMA's groundwater management problems and the need to develop additional tools to address them.

The primary goals of the AMA's Third Management Plan augmentation program are to:

- Encourage and facilitate the replacement of groundwater use with the efficient use of renewable supplies throughout the AMA.
- Improve or maintain groundwater conditions in areas of the AMA experiencing or projected to experience significant negative impacts due to changes in water levels.
- Initiate a planning process to consider the "critical area" concept.
- Maximize storage of CAP water to offset future shortages.

During the third management period the Department will work to:

- Maximize the beneficial use of Colorado River water and effluent to reduce groundwater overdraft and ensure a safe, long-term, reliable water supply.

- Support efforts to utilize the CAP canal system to the fullest extent possible, to deliver "surplus" Colorado River water and other water to the AMA while these supplies are available, and develop opportunities to maximize interstate banking within the AMA through the AWBA.

- Support development of local water management, supply augmentation, and recharge plans consistent with groundwater management objectives.

- Develop groundwater monitoring programs, improve databases, and expand public information programs to support planning and management activities.

- Integrate water quality and quantity programs, and coordinate groundwater replenishment, AWBA activities, assured water supply activities, and related activities to facilitate achievement of groundwater management goals. These goals include ensuring that recharge activities protect the quality and storage capacity of the aquifer, and that facilities are sited in a manner that maximizes benefits and provides for future recovery as required.

- Resolve legal and institutional constraints that hinder comprehensive regional water management and inhibit the development and beneficial use of alternative supplies.

- Develop incentives for augmentation of water supplies, especially incentives that promote efficient use of renewable supplies.

- Continue to identify and assess feasibility of potential future water supply augmentation measures.

- Facilitate the settlement of Indian water rights claims, particularly the Southern Arizona Water Rights Settlement for the Tohono O'odham Nation.

- Evaluate the need for establishing a purchase and retirement program for groundwater rights in the AMA, and evaluate other possible incentives to retire existing groundwater rights.

- Develop programs and/or support new legislation and rules to reduce recovery in critical areas where water levels are declining rapidly. This is needed to mitigate existing and potential negative consequences including subsidence due to compaction of dewatered sediments, water quality problems, and increased costs to supply water.

- Develop new well-spacing rules that better protect existing land and water users and limit damage that can be caused by additional groundwater withdrawals.

8.7 THIRD MANAGEMENT PLAN AUGMENTATION AND RECHARGE PROGRAM

The Department is required to include in the Third Management Plan "a program for additional augmentation of the water supply of the active management area, if feasible, including incentives for artificial groundwater recharge." A.R.S. § 45-566(A)(6). "Augmentation" in this context is statutorily defined to mean "to supplement the water supply of an active management area and may include the importation of water into the active management area, storage of water or storage of water pursuant to chapter 3.1 of this title." A.R.S. § 45-561(2). As described in the introduction to this chapter, the Department must remain consistent with this statute, but for purposes of this chapter we have drawn a finer distinction: *augmentation* means increasing the availability and use of renewable supplies such as CAP water and effluent in lieu of groundwater; and *recharge* means storage of water pursuant to Title 45, Chapter 3.1, the Underground Water Storage, Savings and Replenishment Act. Therefore the augmentation program includes provisions addressing the development of additional water supplies for the

AMA, maximizing the use of renewable supplies, and for the storage of renewable water, either above ground or underground.

A.R.S. § 45-566(A) also requires the Third Management Plan to include a number of other provisions related to augmenting the AMA's water supplies. Paragraph 9 of that subsection provides that the Third Management Plan may include a plan for the purchase and retirement of grandfathered rights beginning no earlier than January 1, 2006. Paragraph 13 requires that the plan include recommendations to the AWBA regarding:

(a) Whether additional water storage in the AMA would help to achieve the management goal for the AMA.

(b) Where additional water storage in the AMA would be most useful to achieve the management goal for the AMA.

(c) Whether the extinguishment of long-term storage credits accrued or to be accrued by the AWBA would help to achieve the management goal for the AMA.

The Augmentation and Recharge Program for the third management period contains these required elements.

The principal responsibility for developing water supplies and for storing that water for future uses lies with the AMA's water users. The Department's responsibility under A.R.S. § 45-566(A) is to design an augmentation program that encourages and facilitates the efforts of those water users. The program should particularly encourage augmentation and storage of water where groundwater supplies are limited. However, the augmentation program must also allow the Department to use its authority to prevent unreasonable harm to third parties and to avoid exacerbating existing local water supply problems.

The Third Management Plan Recharge Program derives from A.R.S.§ 45-801.01, *et seq.*, the Underground Water Storage, Savings and Replenishment Act, which details the statutory requirements for storing and recovering water within an AMA. The key statutory provisions for storage facilities relate to hydrologic feasibility, A.R.S. § 45-811.01(C)(2); protection from unreasonable harm to land and other water users, A.R.S. § 45-811.01(C)(3); and avoidance of water quality impacts, A.R.S. § 45-811.01(C)(5). Although this Act contains requirements for water storage and recovery, it also includes requirements linking storage and recovery to the management plan goals. The provision that affects non-recoverable storage is found in A.R.S. § 45-833.01(A), with a requirement that non-recoverable water storage must be consistent with the AMA's augmentation program. The provisions that affect recovery are found in A.R.S. § 45-834.01. They include a requirement for consistency with the management plan in the case of recovery outside the area of impact (AOI) of the water storage. A.R.S. § 45-834.01(A)(2)(b).

The Department has developed the Augmentation and Recharge Program for the Third Management Plan based on the statutory authorities and tools available to it to address the goals and objectives identified in the previous section. The program components will be presented in the order listed:

- Recommendations to the AWBA (section 8.7.1)
- UWS Program (section 8.7.2)
- Regulatory Incentives for the Use of Renewable Supplies (section 8.7.3)
- Technical Assistance, Coordination, and Facilitation of Efforts (section 8.7.4)
- Financial Assistance (section 8.7.5)
- Purchase and Retirement of Grandfathered Rights (section 8.7.6)
- Resolution of Institutional and Legal Barriers (section 8.7.7)

8.7.1 Recommendations to the Arizona Water Banking Authority

As previously discussed in section 8.4.5.2, the AWBA was created in 1996 for the purpose of conveying and storing the unused part of Arizona's Colorado River water apportionment and surplus Colorado River water supplies. One of the stated purposes of the legislation is to "store water brought into this state through the CAP to fulfill the water management objectives of this state set forth in chapter 2 of this title." A.R.S. § 45-2401(F)(3). The AWBA is also required to coordinate with the director of the Department, who serves as chair of the AWBA Commission, in the "storage of water and distribution and extinguishment of long-term storage credits . . . in accordance with the water management objectives set forth in chapter 2 of this title [the Code]." A.R.S. § 45-2423(A)(3).

The statutory requirements to incorporate water management objectives in AWBA plans result in the need for the Department to provide specific advice to the AWBA as to how to incorporate such objectives in the AWBA's activities. The Code requires that the Department include in the Third Management Plan recommendations to the AWBA on whether additional storage in the AMA helps to achieve the goals of the AMA, where the storage would be most useful, and whether the extinguishment of credits would assist in achieving the goals. The Department provides the following recommendations to the AWBA for water storage in the AMA.

8.7.1.1 Advice to the AWBA on Additional Storage Needs in the AMA

In March of 1997, when the AWBA prepared its storage facility inventory for the Tucson AMA pursuant to A.R.S. § 45-2452, it was determined that the facilities available in the AMA were inadequate for the AWBA's needs for the following ten years. In making this determination, the AWBA was required to consider whether the facilities to be used by the AWBA promote the water management objectives of the AMA. In preparing the Facility Plan for the Tucson AMA as required by A.R.S. § 45-2453, the AWBA must consider the advice of the Department as to where storage would most contribute to meeting AMA water management objectives. The draft Facility Plan and each year's operating plan must be reviewed by the GUAC prior to adoption. A.R.S. §§ 45-2453(C)(1) and 45-2456(C)(1).

Evaluations of the storage capacity for CAP water in the Tucson AMA have been performed by both the RRC and the IPAG as part of the regional recharge planning process in the Tucson AMA (see section 8.4.5.3). Given current institutional limitations on the direct potable use of CAP water by the City of Tucson, as well as the need to utilize the subcontracts of various other entities that are not currently able to use CAP water directly, there is a substantial need for additional recharge facilities in the Tucson AMA. The IPAG report to the AWBA, using relatively conservative "high end" assumptions in the scenario development, concluded that the necessary storage capacity in the year 2000 could be 158,000 acre-feet, and by 2007, 173,500 acre-feet. Current permitted maximum annual capacity, counting both USFs and GSFs, is less than 100,000 acre-feet.

It is clear that there is a role for the AWBA to assist development of additional storage facilities, particularly those that would help meet water management objectives, through cooperative efforts as authorized by law.

8.7.1.2 Advice to the AWBA on the Location of Water Storage in the AMA

The location of recharge that is intended to firm up the supplies for municipal and industrial (M & I) subcontractors during periods of drought is extremely important, since it is imperative that the stored water be recoverable. In many cases, the AWBA may be able to select sites for recharge that are either in the vicinity of the subcontractor's wellfields, or that would hydrologically benefit such wellfields. The AWBA has evaluated recoverability issues. The key concept that should be incorporated in the AWBA's plans is that recharge siting decisions made annually and in the AWBA's ten-year Facilities Plan

must result in water being stored in locations that are consistent with the CAP subcontractor's long-range plans. Siting criteria are likely to be different, or at least weighted differently, to evaluate facilities that will serve different users and/or objectives. Optimal siting depends on the purpose of the recharge (e.g., for firming supplies for CAP M & I subcontractors, water management, Indian settlements, or interstate banking).

In many cases, it may be possible to store water to help meet local water management objectives as well as the AWBA's objectives. The AWBA may store water in an area that is experiencing, or is at high risk of experiencing, negative impacts from a rapid groundwater level decline rate, while developing a program to recover water in other parts of the basin that have more stable groundwater levels and are at less risk. The Department recommends close cooperation with AMA staff and local water users and distribution of draft facility and operation plans for review in advance of development of the AWBA's Annual Plan of Operation. This will maximize the opportunities to incorporate consideration of the AMA's water management objectives in the AWBA's actions. Furthermore, in any year in which Colorado River water supplies are limited, the AWBA should generate and distribute its storage credits in a manner that protects the interests of the water users in the AMAs.

The Tucson AMA has identified three geographic areas where additional storage may substantially increase the likelihood of attaining groundwater management objectives: (1) the Tucson Central Wellfield where historic groundwater declines have caused physical availability problems and where recharge could help mitigate the risk of subsidence; (2) the Cañada del Oro area where groundwater levels are relatively stable but significant increases in water demand are projected; and (3) the Sahuarita/Green Valley area where water levels are declining, increases in water demand are projected, and there are significant concerns associated with protecting the water supplies within the San Xavier District. The Department anticipates an ongoing exchange of planning information and advice with the AWBA. Additional critical areas may be identified in the future.

Although currently the most serious water management concerns in the AMA are associated with the City of Tucson's Central Wellfield, it is anticipated that a reduction in pumping in the Central Wellfield through the development of the CAVSARP, the development of proposed in-stream recharge projects, and ongoing conservation efforts will reduce these concerns. The AWBA's participation in CAVSARP indirectly contributes to the effort to address water management problems in the Central Wellfield. The AWBA could potentially store water supplies to offset future shortages in locations that would directly mitigate water level decline problems in the City's Central Wellfield. However, in the short term, it may be difficult for the AWBA to overcome political and jurisdictional considerations, and the logistical and cost issues related to the distance from the CAP canal to suitable recharge sites.

The AWBA could also help meet water management objectives in the Cañada del Oro area, a rapidly developing area of the AMA. There have been ongoing investigations of the feasibility and options for direct recharge in this area, primarily because of projected increases in demand. At this time, the groundwater table is largely stable, except in the lower reaches of the watershed. However, bringing "wet water" to the region is a top priority for MDWID and the Town of Oro Valley. Current investigations involve both CAP water and effluent (reclaimed water) deliveries. Both sources require significant capital investment because pumping stations and up to 16 miles of pipelines may be required. The AWBA could assist with financing through a long-term lease for recharge capacity in the proposed Cañada del Oro Recharge and Recovery project.

In the Green Valley/Sahuarita area, potential GSFs and USFs, in addition to the Pima Mine Road project, were evaluated by the USCWUG as part of a broader effort to develop a pipeline system from the CAP terminus to water users in the area. This area is generally up gradient from the majority of the pumpers in the AMA. There may be significant potential for AWBA activities in this location, including both GSFs and USFs. The most promising project in the short term may be the FICO GSF that is proposed for the

Sahuarita Farm. It may be possible for the AWBA to participate in recharge projects in the San Xavier District as well.

8.7.1.3 Advice to the AWBA on Water Storage and Storage Credit Extinguishment

Recharge of renewable supplies followed by extinguishment of the associated long-term storage credits is a key water management tool that is expected to assist with reducing overdraft in the Tucson AMA. Credits generated by the AWBA using groundwater withdrawal fees should be dedicated to reducing groundwater level declines in the AMA and stored in areas that provide other water management benefits, if possible. If this volume of water is recharged with consideration of water management opportunities and in critical areas, the AWBA could make a valuable contribution to stabilizing water levels and mitigating local water management concerns. Extinguishment of credits, which has the same effect as non-recoverable storage, would be most desirable in the Green Valley/Sahuarita area, Central Avra Valley, or Tucson's Central Wellfield.

It is recommended that the AWBA develop a program in cooperation with AMA water users and interested parties to store non-recoverable water and/or extinguish storage credits specifically in areas of ongoing overdraft that are likely to experience subsidence or other significant consequences of overdraft. This program could be incorporated in an amendment to the facilities plan.

8.7.1.4 AWBA Incorporation of Water Management Objectives

As discussed in the previous section, AWBA recharge and groundwater savings activities, particularly extinguishment of long-term credits using funding from either the general fund or the Tucson AMA withdrawal fees, can contribute to attainment of the AMA's water management objectives. There is also potential that the credits generated in an interstate water storage agreement could assist in meeting such objectives, if the forbearance plan is consistent with water management objectives. The following section addresses specific ways in which AWBA activities could further assist the Tucson AMA in meeting water management objectives.

It has been estimated by the AWBA Study Commission in the 1997 Interim Report of the Planning and Modeling Assumptions Subcommittee that 750,000 acre-feet of storage credits will be needed to firm up the predicted shortages for municipal CAP water subcontractors in the Tucson AMA over the next 100 years (AWBA, 1997). This is based on a series of assumptions regarding river operations; Upper Basin, Lower Basin, and Mexican demands; historic flows; 100-year projected deliveries to the CAP; and shortage criteria in the master contract and the 1983 Record of Decision regarding shortage sharing among subcontractors.

As of 1997, the AWBA had only recharged 3,100 acre-feet of CAP water in the Tucson AMA, for which the AWBA received 2,391.9 acre-feet of credits after adjustment for evaporation and the cut to the aquifer. In contrast, the AWBA had accrued hundreds of thousands of acre-feet of credits through direct recharge in USFs and indirect recharge in GSFs in the Pinal and Phoenix AMAs. The AWBA did not store as much water in the Tucson AMA primarily because of the lack of permitted storage capacity. It is imperative that more facilities be developed, so that sufficient capacity exists for local AMA recharge needs as well as for the AWBA. The AWBA could also increase indirect recharge quantities in the AMA by developing a pricing policy that makes groundwater savings in the Tucson AMA economically feasible. Current pricing policy and the lack of available capacity have, to date, precluded the AWBA's involvement in GSFs in the Tucson AMA.

It is imperative that the AWBA and others take advantage of the opportunity to store water in the early years while surplus volumes of CAP water and financial resources to pay for the storage are available.

This form of conjunctive management may cause local water levels to rise in early years, but this trend will be eliminated as stored supplies are used in the future during shortages.

8.7.2 Underground Water Storage, Savings, and Replenishment Program

Due to various factors that have been described in previous sections, underground water storage is an increasingly important tool for water management in the Tucson AMA. Underground storage provides an additional benefit of restoring or preserving groundwater in areas where groundwater levels have declined. The UWS Program is, therefore, a significant component of the Augmentation and Recharge Program.

Arizona's UWS Program is a regulatory program under which water may be stored underground and rights to recover may be accrued. The statutes and policies of the UWS or "recharge" program establish a number of objectives. The objectives include the following:

- to protect the general economy and welfare of the state by encouraging the use of renewable water supplies, especially Colorado River water, instead of groundwater through a flexible and effective regulatory program for the underground storage, savings, and replenishment of water;
- to allow the use of direct storage facilities to aid with filtration and to develop an accounting system which allows "recovery" of renewable supplies without the expense of expanding physical distribution systems;
- to further the conjunctive management of the water resources of this state to reduce the overdraft and achieve the management goals of the AMAs;
- to store water underground for seasonal peak demand use and for use during years of shortage; and
- to augment the water supply for future growth and development.

Since its inception in 1986, the recharge program has become increasingly flexible over time with regard to storage and recovery locations and the number and types of programs available. With the increased flexibility has come increased complexity and an increased potential for recharge projects to aggravate, as well as mitigate, local water problems. Water levels, water quality, physical availability, and third-party impacts are all conditions that can be impacted positively or negatively by recharge facilities. Thus, the regulation of the program to maximize benefits and minimize harm is crucial to an effective program.

This section includes: (1) a brief overview of the UWS programs; (2) the definition of what is, and what is not, considered a storage facility; and (3) the storage and recovery location criteria that determine whether a recharge project is considered "consistent with the management plan and achievement of the management goal" of the AMA.

8.7.2.1 Overview of the Underground Water Storage, Savings, and Replenishment Program

Persons who want to undertake recharge activities are required to obtain permits from the Department. There are three types of permits: (1) storage facility permits, which may be constructed USF permits, managed USF permits, or GSF permits; (2) water storage permits; and (3) recovery well permits.

8.7.2.1.1 Storage Facility Permits

Storage facility permits allow the holder to construct, develop and operate a storage facility. If storage is to occur at a facility that will use constructed basins or wells to add water to an aquifer, a constructed USF permit is required. If the storage will utilize the natural channel of a river or stream to add water to an

aquifer, a managed USF permit is required. At a GSF, a groundwater user who would otherwise have pumped groundwater is provided an alternative supply of water by a water storer. The alternative supply is then used in lieu of the groundwater, thus preserving the groundwater.

8.7.2.1.2 Water Storage Permits

Water storage permits are always affiliated with a particular storage facility where the storage will occur. The holder of the water storage permit is authorized to store water at the affiliated storage facility. Rights to recover water under the UWS Program always accrue to the holder of the water storage permit.

8.7.2.1.3 Recovery Well Permits

Recovery well permits allow the holder to recover water stored pursuant to the UWS Program. The storer of the water may always recover the water stored within the AOI of water storage. The AOI of water storage is defined as follows: "as projected on the land surface, the area where the stored water has migrated or is stored." A.R.S. § 45-802.01(2). Under a number of conditions, some of which are discussed in detail later in this chapter, recovery can also occur outside the AOI. Theoretically, if these recovery conditions are met, recovery of water stored in the Tucson AMA could occur anywhere within the AMA. Under no circumstance, however, can water be recovered in the AMA if it was stored outside the AMA.

8.7.2.1.4 Other Key Components of the Underground Water Storage, Savings, and Replenishment Program

There are a number of other key components of the UWS Program. Rights to recover water may be exercised annually or long-term. Almost any water stored can be recovered within the same year in which it was stored. If a number of conditions are met, stored water will be credited to a long-term storage account which allows the account holder to recover the water at any point in the future. These conditions assist the achievement of water management goals by preventing an entity from storing water and earning long-term storage credits if the water could be put to direct use. The statutes define which source waters cannot be put to direct use and therefore may be eligible for long-term storage credits. A.R.S. § 45-802.01(21). In general, if an entity stores effluent prior to 2025, it is determined that the effluent cannot be reasonably put to direct use, and is therefore eligible to earn long-term storage credits. Additionally, CAP water is considered water that cannot be put to direct use if the storer is *not* simultaneously mining groundwater. In other words, if the storer continues to mine groundwater, then credits may be earned only if the entity stores an additional amount of CAP water to offset the groundwater pumpage. (An exception is made for designated providers that are pumping groundwater pursuant to their assured water supply groundwater allocation.) The obvious intent of this provision is to discourage groundwater mining and avoid giving long-term storage credits in cases where there is no net storage in the aquifer. It should be reemphasized that while a given storer may not be eligible for long-term storage credits, the water stored is eligible to be recovered on an annual basis, and is treated as a direct use for all intents and purposes.

There is no time limit on the right to recover long-term storage credits. Long-term storage credits may be assigned to another entity, if that entity could meet the same provisions for earning credits as the storer. In addition, once the water is recovered, it retains the same legal characteristics it had before storage. For example, if CAP water is stored, the water, when recovered, may be used in any legal manner CAP water can be used, even if the recovery occurs outside the AOI of the stored water.

The UWS Program is also the mechanism by which the CAGRD replenishes water on behalf of its members. The CAGRD may store water and accrue long-term storage credits or obtain credits already accrued by other storers. At the CAGRD's request, the Department will transfer credits from the CAGRD's long-term storage account to its replenishment account, termed a "conservation district account"

by statute, to offset the CAGRD replenishment obligations. A.R.S. § 45-859.01. Once the credits are transferred to the replenishment account, they may not be recovered, assigned, or moved back to the long-term storage account.

8.7.2.2 Underground Water Storage, Savings, and Replenishment Program Issues

The Department must issue permits only to legitimate storage facilities. With regard to USFs, A.R.S. § 45-815.01 specifically lists a number of water-related facilities that are categorically excluded. These include aqueducts, irrigation canals and other man-made water conveyance systems. In addition, incidental recharge from any agricultural, municipal, or industrial use is precluded from qualifying for a USF permit.

A.R.S. § 45-815.01(1) also specifically references "body[ies] of water," stating that they do not qualify for USF permits unless they "have been designed, constructed or altered so that water storage is a principal purpose of the body of water." In addition, Arizona law generally prohibits artificial "bodies of water" constructed for landscape, scenic or recreational purposes, unless the body of water is "unsealed and an integral part of an underground storage facility." A.R.S. § 45-132(B)(6). Thus, the law does allow for a body of water to be both a USF and a recreational lake. The Department, however, will not issue a permit for a facility if the facility appears to be designed to evade the prohibition on recreational lakes by designating a facility as a USF. Thus, if the purpose of the facility is primarily recreational or aesthetic, it does not qualify as a USF. However, if the facility meets the goals and requirements of the USF Program while serving other uses as well, it may qualify for a USF permit.

Usually, the storage efficiency of a USF is related to its purpose. If a permit applicant's *primary* intent is to store water, achieving high efficiency at the facility is an important goal for the applicant, and the design and operation of the facility will minimize evaporation and transpiration. If storage is not a primary purpose, efficiency is likely to be less important.

As the AMA becomes more reliant upon renewable supplies, as is required under the AWS Rules, efficient storage and use of all water supplies will become even more important. The recharge program will continue to encourage efficient use of water. Every effort will be made in the future to retain the integrity of the program goals and to maximize the efficiency of recharge at permitted facilities. The Department examines projected efficiency of a USF as a part of its review to determine whether a project is hydrologically feasible, which must be established before a USF permit will be issued. A.R.S. § 45-811.01(C)(2). The less efficient a proposed project is, the more likely the Department will be concerned about its legitimacy as a USF. The Department will consider a number of factors when evaluating a facility for efficiency as a component of hydrologic feasibility, including the following:

- whether the facility has the *potential* to store water and the quantity of that potential storage;
- whether the facility is designed, constructed, or altered so that water storage is a principal purpose;
- whether other regulatory agencies apply standards to a facility that are inconsistent with the Department's program objectives (e.g., ADEQ containment standards in a treatment wetland);
- whether the facility will be maintained (e.g., wet-dry cycles, scraping, etc.) to ensure and/or enhance infiltration;
- if a facility serves multiple purposes, whether purposes other than recharge would not be legal or would be regulated if it was not associated with a recharge facility; and
- whether potential water storers at the facility are subject to conservation requirements and lost-and-unaccounted-for water limits under the management plan.

The Department is also concerned about potential abuses in applications for GSF permits. The statutes make clear that not every instance where groundwater use is replaced with a renewable water resource qualifies for a GSF permit. Therefore, the Department will not issue a GSF permit unless a legitimate "groundwater savings" will occur. Only where the use of the renewable resource would not have occurred

without the operation of the GSF and where there is no other reasonably available alternative source should a GSF be permitted. A.R.S. § 812.01(B).

The groundwater savings program is an important tool in achieving the water management objectives of increasing use of Colorado River water and preserving groundwater supplies. However, it should be noted that the recipients of the alternative supplies at GSFs retain their right to pump groundwater in the future. Therefore, the physical water that is saved at a GSF may be pumped once the recipient returns to using groundwater and the long term storage credits that are earned at the GSF may also be pumped. The groundwater savings program can be, in effect, a deferred groundwater pumping program and should not be confused with the conversion of an existing groundwater use to a renewable supply, which provides a permanent savings of groundwater and a direct contribution to the achievement of safe-yield. However, storage at USFs also result in long term storage credits that may be pumped in the future. Consequently, the benefits of any recharge facility must be evaluated on a case by case basis to determine whether the facility will result in water management benefits.

8.7.2.3 Need for Revised Storage and Recovery Criteria for the Third Management Plan

The Second Management Plan anticipated that CAP water utilization in the Tucson AMA would be met primarily through direct potable delivery. Water users' CAP water utilization plans have changed dramatically. The Third Management Plan assumes no direct potable use in the water budget scenarios in Chapter 11, and instead assumes all CAP water use will be through recharge and groundwater savings. Although there is no way of knowing how CAP water will actually be used in future years, this change from direct delivery to underground water storage and groundwater savings leads to new issues for the Department's recharge program. The potential for large amounts of water to be stored in some areas while the groundwater in other areas is seriously depleted has become a major concern in the Tucson AMA.

The siting criteria for storage of non-recoverable water and for recovery wells are currently one of the Department's few tools to address local groundwater management problems within the AMA. Stronger siting criteria are needed for the third management period to strategically address the negative consequences of further dewatering in critical areas of the AMA. Consequences of further dewatering may include: (1) loss of riparian habitat; (2) local increases in cost to supply groundwater due to decreasing well productivity, the need to drill deeper wells, and increasing pumping costs; (3) impacts on physical availability of supplies for future use; and (4) subsidence which can cause damage to structures and infrastructure (see sections 2.6 and 8.2.1.2).

In the Tucson AMA, the areas with high rates of aquifer dewatering are generally also areas at risk for subsidence and other negative impacts. The average rate of water level decline over a recent time period could serve as a proxy for the definition of "critical areas" within which additional withdrawals should be discouraged. Stricter recovery well average decline rate siting criteria may mitigate some of the local impacts of groundwater level declines while advancing progress on achieving AMA-wide safe-yield.

Recovery well siting criteria can be changed after recovery permits are issued, especially by adoption of new management plans. Although there is a need for the Department to be able to respond quickly to changing aquifer conditions, the Department recognizes there is also a need for regulatory certainty (including adequate noticing provisions) so that investments that are made in infrastructure to utilize or store renewable supplies are not reduced in value by subsequent changes in recovery permit criteria. Currently, recovery well permits can be reviewed at any time to ensure that wells listed on the permit continue to meet the recovery criteria. In theory, wells could lose their eligibility to be used for recovery and then regain this eligibility if the rate of water level decline in the area changes. To increase certainty regarding investments in recovery infrastructure, the Department may establish a period before a recovery well permit is subject to review.

The IPAG for the Regional Recharge Plan concluded that the storage and recovery siting criteria need to be strengthened as a step towards achieving safe-yield and addressing local groundwater supply problems. However, IPAG also recommended that stricter criteria be contingent on increasing the equity in applying the management plan siting requirements to both non-CAGRD and CAGRD pumpage. Water users who are storing and recovering CAP water themselves (non-CAGRD pumpage) are subject to the recovery criteria. Currently CAGRD members can pump groundwater, even in areas with high rates of decline, without being affected by the recovery criteria, because they are not recovering "stored" water as defined by current law. The CAGRD replenishes excess groundwater use with CAP water recharge, after the groundwater use has occurred. To require CAGRD pumpage to meet the same recovery siting criteria as those recovering stored water would require legislative action.

IPAG also supported the development of well spacing rules that incorporate concerns regarding localized areas of groundwater decline and supported the development of a critical areas program, including discussion of legislation to provide increased regulatory tools to address such areas.

8.7.2.4 Decline Rate Methodology

In evaluating an application for a proposed recovery well permit, the Department considers many factors in determining consistency with the average water-level decline rate recovery well siting criteria. The time frame for which the average is calculated may vary based on data availability and the hydrologic characteristics of the area. Major trends in water supply utilization over time, trends in precipitation, hydrogeologic data, and modeling of projected impacts may be factors in evaluating this rate. Other considerations may also be appropriate depending on the location of the proposed recovery well.

Typically, the Department examines the historic static water level data for the period of record for wells located in the section in which the proposed recovery well is located and in the adjacent eight sections. The specific area examined and the data that are used depend on the availability and quality of water level data and the hydrogeology of the area. Bedrock outcrops, large pumping centers, and other features may affect determination of which data are pertinent. Generally, wells which are screened in the aquifer of concern and regularly monitored using consistent methods for static water level data are good reference points (such as the Department's statewide network of regularly monitored index wells). The Department examines the well hydrographs (plots of static water levels over time) and evaluates the slope of the curve for the time period of interest. The slope indicates whether the static water level in the monitoring well has risen or fallen over time. A horizontal line indicates water levels remained stable over time. The Department identifies what activities may have caused any groundwater changes over time, to see whether the activity still exists, or has reduced or increased over time.

This approach provides more flexibility and protection of the groundwater resource than would be provided by a simplistic evaluation of water level decline rates calculated for all water level data within a set radius and the entire period of record. For example, if a recovery well is proposed for an area in which historically there was a rapid decline in groundwater levels due to activities that no longer exist (e.g., retirement of agriculture after heavy agricultural use in the 1940s and 1950s) and if the proposed area is not at high risk for subsidence, the proposed recovery well might be deemed consistent with the average decline rate criteria by looking at the period of time after the historic change in use. Similarly, if for decades water levels in the vicinity of the proposed recovery well were very stable but recently a new use has caused rapid rates of decline, the proposed recovery well may be deemed inconsistent with the criteria.

The Department's groundwater models may be used to regionally project future water levels and decline rates. Modeling may assist the permittee in evaluating recovery options. Where there are sufficient data, a model may give an indication of how long recovery within a region may remain permitable based on the current average decline rate criteria.

The most current procedures for establishing the average groundwater level decline rate in the vicinity of a proposed recovery well will be published in the Department's Recovery Well application packet.

8.7.2.5 Storage and Recovery Siting Criteria

The benefits to water management through the recharge program depend upon the location where water is stored and where it is recovered (unless the water stored is non-recoverable or the credits are extinguished). A.R.S. § 45-833.01(A) specifically states that non-recoverable water storage must be consistent with the AMA's augmentation program. To date, there has been very little water stored with a "non-recoverable" designation.

For storage and recovery, A.R.S. § 45-834.01(A) clarifies that unless stored water is recovered by the storer within the AOI of water storage, the recovery is only allowed "if the director determines that recovery at the proposed location is consistent with the management plan and achievement of the management goal for the active management area." Additionally, recovery of stored water within the AOI of the stored water is always considered consistent with the management plan.

Although the statute ties recovery outside the AOI to the consistency requirements of the plan, the locations of storage and recovery of water are inherently linked and must *both* be considered when determining whether the future recovery meets the consistency requirements and management goals of the AMA. Outside the AOI, it cannot be determined whether recovery is consistent with water management objectives of the AMA unless the storage location is also considered. Water management benefits to the AMA depend greatly on whether credits recovered from an existing well were accrued through storage in a remote area of the AMA or in a large pumping center of the AMA. Therefore, the criteria to determine whether a recovery location is consistent with the management plan and goal for the AMA must also consider where water was stored.

The locations of storage and recovery are important factors in addressing local and regional supply problems, particularly in critical areas, and attempting to balance the supplies in the AMAs during the third management period. For example, the useful water supplies of the AMA may be diminished if water storage occurs in a location where there is no future demand for the stored water and recovery occurs outside the AOI of storage. In addition, recovery away from the AOI of water storage could aggravate problems if the area of recovery was experiencing rapidly dropping groundwater levels or if the groundwater supplies were already fully committed under the AWS Program. On the other hand, if storage occurs in an area experiencing high water levels and recovery occurs away from the AOI, the water storage may cause damage through water logging. If dewatering is required as a *direct* result of water storage or savings, either the storage facility's operational plan should be adjusted to minimize impacts, which may include strategic recovery locations to mitigate impacts, or the storer may not be issued credits.

Thus, while the Second Management Plan siting criteria provided no protection of groundwater supplies already committed under the AWS Program, the new Third Management Plan criteria protect groundwater supplies that are already committed for an assured water supply from an entity who wishes to recover water *outside* of the AOI.

The Third Management Plan criteria also link future use benefits to determinations under the AWS Program. If storage occurs in a remote area, but one that has a committed and projected demand through a Designation or Certificate of Assured Water Supply, then it is deemed to contribute to groundwater supplies that will be used in the future. If the storage does not meet this criterion, it must otherwise be beneficial to the AMA if recovery is to occur outside the AOI of storage. If a storage facility does not meet the criteria, this concern would be incorporated in the permit as a notice to potential water storers that future recovery may only be allowed inside the AOI.

Recovery from within the AOI is not required to meet management plan consistency requirements. A.R.S. § 45-834.01(A) states that recovery may occur *outside* the AOI of the storage only if the director determines that the recovery location is consistent with the management plan. Therefore, recovery must continue to be consistent with management plan criteria, even after the recovery well permit has been issued. Existing, previously permitted recovery wells are subject to the criteria of the Third Management Plan and future management plans.

8-101. Storage and Recovery Siting Criteria

During the third management period, for the purposes of A.R.S. § 45-834.01(A)(2)(b), recovery of stored water at a location is consistent with the management plan and achievement of the management goal for the AMA:

A. *If recovery will occur within the area of impact (AOI), regardless of whether the recovery well permit applicant was the storer of the water; or*

B. *If recovery will occur outside of the AOI, all of the following three criteria are met:*

1. *The water storage that resulted in the right to recover water:*

   a. *Is contributing to groundwater supplies that are accessible to current groundwater users or that have been committed to establish a Designation, Certificate, or Analysis of Assured Water Supply pursuant to A.R.S. § 45-576 or rules adopted thereunder; or*

   b. *Is a component of a remedial action project under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) or Title 49, Arizona Revised Statutes, and the director has determined that the remedial action will contribute to the objectives of this chapter or the achievement of the management goal for the AMA; or*

   c. *Is otherwise determined by the director to have contributed to the objectives of this chapter or the achievement of the management goal for the AMA.*

2. *Either:*

   a. *At the time of the application, the maximum projected depth to water at the location of the recovery well after 100 years does not exceed the general 100-year depth-to-static water level for the AMA specified by A.A.C. R12-15-703 after considering: (1) the maximum proposed withdrawals from the recovery well; (2) withdrawals for current, committed, and projected demands associated with determinations made under A.R.S. § 45-576 that are reliant on the water which the recovery well will withdraw; and (3) withdrawals for other current or projected demands that are reliant on the water which the recovery well will withdraw; or*

   b. *The recovery will be undertaken within the applicant's service area and the applicant is a municipal provider designated as having an assured water supply.*

3. *The recovery well is:*

   a. *Located in an area experiencing an average annual rate of decline that is less than 4.0 feet per year for the years 2000 through 2004, and 3.0 feet per year for the years 2005 until any subsequent management plan provision. The three feet per year*

criterion will go into effect in the year 2005 only if all stored water withdrawals and groundwater reported as excess groundwater to a water conservation district serving as a groundwater replenishment district are subject to the same restriction, as established through a legislative amendment. Otherwise, the four feet per year criterion will continue until the effective date of any subsequent management plan provision; or

b. *A component of a remedial action project under CERCLA or Title 49, Arizona Revised Statutes, and the director has determined that the remedial action will contribute to the objectives of this chapter or the achievement of the management goal for the AMA; or*

c. *Likely to contribute to the water management objectives of the geographic area in which the well is located, as determined by the director.*

8.7.2.6 Criteria for Storage of Non-Recoverable Water

A.R.S. § 45-833.01(A) provides that "the director may designate a water storage permit as storing non-recoverable water. If the water storage occurs within an active management area, the water storage permit may be designated in this manner only if the storage is consistent with the active management area's augmentation program." Water that is stored under a non-recoverable water storage permit may not be recovered on an annual basis, may not be credited to a long-term storage account, and may not be used for replenishment purposes associated with the CAGRD. The same considerations discussed in the preceding section that shaped the criteria for recovery location have shaped the criteria for siting non-recoverable storage.

As of August, 1998, no applications for permits to store non-recoverable water had been filed in the Tucson AMA. During the third management period, non-recoverable water storage may result from enforcement actions for non-compliance with conservation requirements (see Chapter 10).

8-201. Storage of Non-Recoverable Water

During the third management period, water storage that is designated as non-recoverable is consistent with the AMA's augmentation program if one of the following criteria is met:

The water storage:

1. *Is contributing to groundwater supplies that are accessible to current groundwater users or that have been committed to establish a Designation, Certificate, or Analysis of Assured Water Supply pursuant to A.R.S. § 45-576 or rules adopted thereunder so long as the areas in which water is stored are not experiencing problems associated with shallow depth to water; or*

2. *Is a component of a remedial action project under CERCLA or Title 49, Arizona Revised Statutes, and the director has determined that the remedial action will contribute to the objectives of this chapter or the achievement of the management goal for the AMA; or*

3. *Is otherwise determined by the director to contribute to the objectives of this chapter or the achievement of the management goal for the AMA.*

8.7.3 Regulatory Incentives for the Use of Renewable Supplies

Provisions established in the Agricultural, Municipal, and Industrial Conservation Programs of this management plan provide incentives for water users to implement augmentation measures. The inclusion of augmentation incentives as a trade-off for conservation requirements is controversial. The program to increase the use of renewable water supplies should not be perceived as an alternative to conservation.

Although Arizona is not currently using its full Colorado River apportionment, and some municipal entities do not have enough annual demand to use their allotments, these conditions are likely to change in the relatively near future. Shortages are anticipated on the Colorado River system 35 out of the next 100 years. The Code (particularly through the assured water supply provisions) and the management plans require a long-term perspective on supply and demand. In the long-term, efficient use of *all* water supplies will be necessary. The distinctions that are now being made between sources of water, including incentives that allow increased use of certain renewable sources, may seem ill-advised in hindsight. In fact, shortages are anticipated on the Colorado River system 35 out of the next 100 years. It is important to build a conservation ethic into the structure of our communities even as we move towards the use of renewable supplies.

There are some uses of water that can be identified as "structural" and others that are "discretionary." Structural uses are part of the base water use requirement; for example, once a swimming pool is built, it is likely to be filled with water. However, the decision to overseed a lawn or a golf course in a particular year is discretionary. As incentives have been designed for inclusion in this plan, the Department has emphasized that increased utilization of renewable supplies should be for nonstructural purposes, so that the use can be scaled back as renewable supplies become more scarce.

Achievement of our water management goals over the long term is only possible in the context of serious, long-term conservation efforts and increased utilization of renewable supplies. The debate is not between conservation and augmentation, but rather, whether the concept of "efficient use" can be integrated into the regulatory system and the community ethic. Matching the demand to the supply in the context of a surface-water dominated water picture will require more sophisticated management, including conjunctive management of groundwater and surface water, than has been the norm in Arizona in the past. It is difficult to design incentives that are administratively workable without causing equity problems and weakening the conservation message.

Incentives should be limited to applications where the desired response, such as substitution of use of renewable supplies for groundwater use or improved water conservation, would not otherwise have happened.

Table 8-4 lists the Third Management Plan incentives to use alternative supplies. Some of these incentives were established in the Second Management Plan. Because many of these incentives encourage use of alternative supplies at the expense of conservation, the augmentation incentives may need to be scaled back in the future in order to achieve safe-yield.

Although the need to include specialized incentives to address subregional conditions has been identified, to date the only regulatory tool for addressing localized areas of decline is the limitation on recovery of recharged water if it is recovered outside the area of hydrologic impact. The compliance approach described in Chapter 10 may encourage recharge in specific locations to address local hydrologic concerns in critical areas.

Additional incentives to encourage use of remediated groundwater in lieu of high quality supplies are provided in the AWS Rules and through legislative requirements in the WQARF Program (see Chapter 7).

TABLE 8-4
RENEWABLE WATER SUPPLY USE INCENTIVES
TUCSON ACTIVE MANAGEMENT AREA

Municipal
Delivery of effluent by a municipal water provider does not count against the gallons per capita per day (GPCD) requirement, unless it is effluent that is recharged in one location and recovered outside the AOI. This is an incentive for municipal providers to invest in effluent systems (see section 5-103(A)). The Alternative Conservation Program removes the non-residential portion of the GPCD requirement for providers who have a Designation of Assured Water Supply or limit their groundwater use to the highest annual use between specific years, utilize renewable supplies for their remaining demand, and implement specific conservation measures for non-residential customers. This program also includes an incentive to extinguish existing grandfathered rights (see section 5-105). The Non-Per Capita Conservation Program removes the GPCD rate entirely as a regulatory tool in exchange for implementation of specified conservation measures. A "best management practices" approach is designed to achieve the same level of efficiency as the GPCD, but the point of compliance is implementation of the programs, not the level of water use. To qualify, water providers must phase out groundwater use or have a Designation of Assured Water Supply (see section 5-104). CAP water which is delivered by a municipal provider to a non-residential water user is excluded from the provider's total GPCD requirements for up to ten years if it is shown that the delivery will expedite the development of infrastructure to deliver reclaimed effluent to the user in the future (see section 5-103(E)).
Industrial
Turf-Related Facilities Effluent use is discounted when calculating compliance with the annual allotment for each facility. For the Third Management Plan, the incentive has been increased to a 30 percent discount (the Second Management Plan discount was a maximum of ten percent (see section 6-304(A))).
Large-Scale Cooling Facilities Cooling towers that recycle 100 percent of their blowdown water are exempt from meeting the blowdown concentration requirements (see section 6-702 (B)(1)). Cooling towers that convert to at least 50 percent effluent are exempt from the blowdown concentration requirements for one full year. If it is shown that they cannot meet the requirements if they use effluent, reduced blowdown concentration levels may be requested and approved (new incentive in the Third Management Plan (see section 6-702 (B)(2))).
Large-Scale Power Plants Electric power generating facilities that recycle 100 percent of their blowdown water are exempt from meeting the blowdown concentration requirements (see section 6-607). Electric power generating facilities that convert to at least 50 percent effluent are exempt from the blowdown concentration requirements for one full year. If it is shown that they cannot meet the requirements if they use effluent, reduced blowdown concentration levels may be requested and approved (new incentive in the Third Management Plan (see section 6-605)).

TABLE 8-4
RENEWABLE WATER SUPPLY USE INCENTIVES
TUCSON ACTIVE MANAGEMENT AREA

Agricultural
Pursuant to A.R.S. § 45- 467, effluent use cannot contribute to a farm exceeding its allotment in any year. In determining whether a farm exceeds its maximum annual groundwater allotment for a year, total water use, including groundwater, effluent, and surface water, is counted. Then any effluent used that year is subtracted from the amount of water that otherwise would have exceeded the farm's allotment (see section 4.7.1).
All Users
The Department's compliance approach for the third management period may allow regulated groundwater users, under certain specified conditions, to voluntarily enter a stipulated agreement to extinguish recharge credits or store non-recoverable water in specified locations to offset their overuse prior to the end of the year in which the over utilization occurred. This program cannot be used to offset a permanent, structural increase or for any other long-term physical changes (see section 10.7.3). If 100 percent of the water used at a facility is legally non-groundwater, the user is not subject to compliance with management plan conservation requirements.

In response to comments received during the development of the Third Management Plan, the Department will be establishing one or more task forces to address incentive development in the context of local water management objectives. The task force concept is developed more fully in Chapter 12.

8.7.4 Technical Assistance, Coordination, and Facilitation of Efforts

The Department will continue to support augmentation project construction, planning, modeling, and research activities during the third management period. Technical assistance will be provided to water users in assessing the need for augmentation projects, determining project feasibility, and reviewing project impacts. Department staff will participate on oversight committees, provide data, and review planning and feasibility study reports. To facilitate research projects, the Department will assist users by initiating research activities, assisting in study design, providing data, reviewing results, and disseminating information.

The Department's current Technical Services Contract provides for a facilitated contracting process to address technical issues associated with recharge. The focus of this effort is to evaluate technical concerns associated with developing recharge projects, and to facilitate construction of projects that are consistent with the AMA's management goals. A similar contract may be developed during the third management period. In addition, the Department may assess opportunities for additional funding.

Cooperative efforts among many government agencies, water users, and other groups will allow the development of larger, more effective projects and studies. The Department will continue to work with water utilities, government agencies, and other organizations to coordinate and facilitate augmentation activities. For example, during the second management period, the Department: (1) conducted studies in 1992 and 1993 on the underutilization of CAP water in the state for the Governor's CAP Advisory Committee, (2) coordinated the assessment of the feasibility of weather modification along the Mogollon Rim, (3) assisted in establishing the SCVWD, and (4) initiated the Regional Recharge Planning Process in the Tucson AMA. The Regional Recharge Planning Process (further described in section 8.4.5.3) has established a means for the sharing of information and coordination of efforts. As technical coordinator for

recharge permit applications, AMA staff assist in streamlining the permitting process and ensuring timely processing and good communication within the Department and between agencies and applicants.

The Tucson AMA staff will also continue to provide planning support and technical assistance to facilitate the following local efforts: the SAWRSA negotiations; the Regional Effluent Planning Process; the City of Tucson Pilot Membrane Filtration Study; the USCWUG, which is investigating the feasibility of CAP water delivery to the Green Valley-Sahuarita area; the Northwest Replenishment Study; and the Southern Arizona Regional Water Management Study. The Department will participate in other water supply augmentation-related projects as they arise.

8.7.5 Financial Assistance

The Department's Augmentation Assistance Program is described in Chapter 9. This is a significant program that provides funding for augmentation and recharge projects through grants, contracts, and IGAs.

Funds for the Augmentation Assistance Program, the Conservation Assistance Program, and monitoring activities are provided to the Department through the groundwater withdrawal fee which is levied within the AMAs pursuant to A.R.S. § 45-611 which provides in part that:

> The director shall set the actual amount of the fee as follows:
>
> 2. Through 2016, for augmentation of the water supply of the active management area, conservation assistance to water users within the active management area and monitoring and assessing water availability within the active management area, an amount of not more than fifty cents per acre-foot per year, and after 2016, an amount of not more than two dollars per acre-foot per year.
>
> 4. For purchasing and retiring grandfathered rights, an amount of not more than two dollars per acre-foot per year. The initial fee for purchasing and retiring grandfathered rights shall be levied in the first year in which the director develops and implements a program for the purchase and retirement of grandfathered rights as part of the management plan for the active management area, but not earlier than January 1, 2006.

Additional funds may be received for augmentation and conservation assistance and for purchase and retirement of grandfathered rights through fees assessed for the temporary use of groundwater in artificial lakes as described in A.R.S. § 45-133(E). The Department may seek additional funding and cooperative efforts for water supply monitoring and assessment.

8.7.6 Purchase and Retirement of Grandfathered Rights

A.R.S. § 45-566(A)(9) authorizes the Department to develop a program for the purchase and retirement of grandfathered rights to begin no earlier than January 1, 2006. An annual groundwater withdrawal fee of up to $2.00 per acre-foot can be collected for this program; however, the fee cannot be levied until the management plan contains a program for the purpose of purchase and retirement. A.R.S. § 45-611(C)(4). If the management plan were modified to include a grandfathered rights purchase and retirement program, it would provide the Tucson AMA with another method to reduce groundwater overdraft and to achieve the management goal. The purpose of this section is to evaluate the feasibility of developing and implementing a purchase and retirement program in the Tucson AMA.

8.7.6.1 Program Concept

The focus of this analysis is on the purchase and retirement of Irrigation Grandfathered Rights (IGFRs). Although a purchase and retirement program could also legally include Type 1 and Type 2 grandfathered rights, these rights may be more expensive to retire, and purchase and retirement of these rights could possibly be offset by increases in general industrial use permits, thereby defeating the objective of reducing groundwater demand. At a minimum, the program should be limited to those IGFRs that use groundwater exclusively and do not lie in the path of urban development. In addition, IGFRs that would be targeted for purchase and retirement should be required to meet one or more of the following secondary criteria: (1) high water duties, (2) recent history or current use of high consumptive use crops, (3) recent history or current use of high proportion of cropped acres, or (4) located in areas historically exhibiting high groundwater decline rates.

8.7.6.2 Potential Groundwater Savings

To analyze the potential groundwater savings that could be realized from an IGFR purchase and retirement program in the Tucson AMA, an estimate was first made of the total withdrawal fees that could be collected by the Department in 2006 assuming: (1) use of a $2.00 per acre-foot withdrawal fee for purchase and retirement, and (2) groundwater and in-lieu water use equivalent to the AMA's average annual groundwater and in-lieu water use from 1990 through 1996. An estimate was next made of the amount of farmland that could be purchased by the Department assuming: (1) use of all of the collected fees, and (2) a purchase cost for farmland equivalent to the representative 1996-1997 price for an acre of farmland in those areas of the AMA that best meet the proposed minimum program criteria. The groundwater savings were then estimated by assuming: (1) a historic groundwater use for the retired farmland equivalent to the representative annual groundwater use per acre for those IGFRs in the AMA that grow high consumptive use crops and have high land utilization rates, and (2) a 20-year benefit period for the groundwater savings, beginning in 2006 and lasting through the end of the fifth management period in 2025. It should also be noted that the potential groundwater savings assumes that the farmland would not be offset by inactive IGFRs in the AMA being brought back into production. While this information, which is shown in Table 8-5, is useful for analytical purposes, it is unrealistic to assume that the Department would implement an IGFR purchase and retirement program for just one year. Therefore, using the same basic assumptions, the potential groundwater savings that could be realized from continued IGFR purchase and retirement programs implemented for 5, 10, 15, and 20 years were also analyzed.

As shown in Table 8-5, the potential groundwater savings for a five-year program, which would be implemented in 2006 and terminated at the end of the third management period in 2010, are estimated to average 2,201 acre-feet per year, and the average cost associated with the groundwater savings is estimated to be $65 per acre-foot. It should be noted that this cost reflects only the Department's costs for purchasing farmland and assumes that: (1) 163 acres of farmland would be purchased each year using $572,000 of withdrawal fees that were collected during that year, and (2) the 489 acre-feet of groundwater savings resulting from the purchase would continue to accrue on an annual basis from the year of purchase through 2025. Adding the accrued groundwater savings from each year's purchase of farmland results in total groundwater savings of 44,010 acre-feet by 2025. The total costs from 2006 to 2010 for purchasing the farmland equals $2,860,000 (or $572,000 x 5 years). Therefore, the average cost of groundwater savings is $65 (or $2,860,000 ÷ 44,010 acre-feet).

While possible, it is unlikely that the Department would terminate a purchase and retirement program at the end of the third management period. A more realistic assumption is that the program would be continued for the fourth and fifth management periods. Assuming no change in the price for farmland or the amount of withdrawal fees collected, the potential groundwater savings for a 20-year purchase and retirement program are estimated to average 5,135 acre-feet per year, with purchase costs averaging $111 per acre-foot.

TABLE 8-5
POTENTIAL GROUNDWATER SAVINGS AND ASSOCIATED IMPACTS
IGFR PURCHASE AND RETIREMENT PROGRAM
TUCSON ACTIVE MANAGEMENT AREA

Program Duration (Years)	Total Withdrawal Fees Collected [1]	Total Farmland Purchased and Retired [2] (Acres)	Total Groundwater Savings [3] (Acre-feet)	Average Groundwater Savings[4] (Acre-feet per year)	Cost of Groundwater Savings [5] (Per acre-foot)
1	$572,000	163	9,780	489	$58
5	$2,860,000	815	44,010	2,201	$65
10	$5,720,000	1,630	75,795	3,790	$75
15	$8,580,000	2,445	95,355	4,768	$90
20	$11,440,000	3,260	102,690	5,135	$111

[1] Assumes a $2.00 per acre-foot withdrawal fee for purchase and retirement and 286,000 acre-feet per year of groundwater and in-lieu water use.
[2] Assumes purchase of the farmland in the year the fees are collected and a $3,500 per acre purchase cost.
[3] Assumes 3.00 acre-feet per acre of historic groundwater use and groundwater savings accruing annually through 2025.
[4] Annual savings equals total groundwater savings divided by 20 years.
[5] Average cost equals total withdrawal fees collected divided by total groundwater savings.

It is likely, however, that the price for farmland will increase and the amount of withdrawal fees collected will decrease before 2025. Changing the assumptions used above has a significant impact on the conclusions that can be drawn about the effectiveness of the program. If the volume of groundwater and in-lieu water used declines incrementally from 286,000 acre-feet in 2006 to 187,000 acre-feet in 2025 (as is projected in the TMP scenario water budget in Chapter 11, Table 11-12), the total water savings from a twenty year program is 85,774 acre-feet. If the purchase price of farmland increases incrementally from $3,500 per acre in 2006 to $7,000 per acre in 2025, the total water savings from a twenty year program is 79,891 acre-feet. Under a scenario where both of these variables change simultaneously, a twenty year program will result in a total groundwater savings of 71,914 acre-feet by 2025 and an annual average savings of 3,596 acre-feet. The total cost of the program is $9,460,000 and the average cost of groundwater savings is $132 per acre-foot.

8.7.6.3 Land Management and Maintenance Issues

Before a purchase and retirement program could be developed and implemented in the Tucson AMA, issues involving land management and maintenance would need to be addressed. These issues include, but are not limited to, the following:

- Funding for staff and other resources needed to manage the retired farmland
- Liability claims
- Impacts of removing the land from the county and local property tax base
- Control of noxious weeds and dust on the land

8.7.6.4 Program Development Decision

Even without considering the costs to manage and maintain the retired farmland, it is clear that saving groundwater in the Tucson AMA through the purchase of irrigated land and retirement of the irrigation rights would be expensive. Other augmentation or demand reduction measures may be more cost effective

to implement. Although at this time the Department has decided to not develop an IGFR retirement program, the Third Management Plan can be modified in the future to incorporate such a program if the concerns listed in the section above are addressed. Many issues could be avoided if a program were developed that extinguished the water right without purchasing the land.

8.7.7 Resolution of Institutional and Legal Barriers

The Department will continue to work with interested parties in the AMAs and around the state to draft rules and propose legislation that will resolve legal and institutional barriers to water supply augmentation projects. Among the barriers are difficulties with the permitting process, jurisdictional issues, and conflicting objectives of various regulatory programs. There are some problems that the Department can address with existing tools and authorities, such as revision of well-spacing and impact rules. The Department can indirectly influence progress in some areas through support of legislation, education, and the regional planning process. For some issues, new tools and authorities may be necessary, as described at the end of this chapter and Chapter 12.

8.8 FUTURE DIRECTIONS

There are a number of issues that will have to be addressed in order to facilitate achievement of safe-yield and other objectives discussed in this chapter. There is a growing recognition that the regulatory and non-regulatory tools that are available may not be sufficient to meet the AMA management objectives. As has been discussed, there are numerous factors that impact water use patterns, many of which are not affected by the Department's programs. Although some Code provisions are directly linked to achieving the management goal, there are many ways in which water management tools could be improved. An evaluation of the roles and responsibilities of all groundwater users in reducing groundwater mining will be initiated as described in Chapter 12. A key consideration in evaluating the need for stronger regulatory programs is whether economic conditions alone can substantially reduce groundwater use in the agricultural and copper mining sectors. If these sectors reduce their groundwater pumpage substantially, the need to offset their groundwater pumpage will diminish.

Critical area management strategies are being considered for formulation during the third management period to attempt to move beyond the AMA-wide goal and address water management problems in specific geographic areas of the AMA. If a critical area program is developed, it will focus on problems associated with groundwater pumping, such as large cones of depression, subsidence, earth fissures, reduction in aquifer storage capacity, and the reduced physical availability of supplies. These efforts will require partnerships with entities from the areas in question who are willing to make necessary changes, and support more stringent requirements to improve groundwater conditions.

It may be necessary to reexamine the AWS Rules provision that allows groundwater up to 1,000 feet below the land surface to be determined physically available. Allowing groundwater levels to fall this much will exacerbate subsidence, water quality problems, and problems with well productivity. Evaluation of the results from the subsidence monitoring and gravity studies conducted by the Department and the USGS in the context of the AMA groundwater flow model will provide information that can be used to amend the AWS Rules if changes are warranted. The total volume of allowable mined groundwater under the AWS program may also need to be reevaluated in order to reach physical safe-yield. See Chapter 11, section 11.5 for further explanation of the effect of allowable mined groundwater on the water budget.

Further examination of the purchase and retirement of grandfathered rights will be conducted. Issues such as whether the current withdrawal fee would be sufficient to successfully carry out this program will be evaluated and whether or not the Department will consider the extinguishment of rights separately from the lands will be considered.

Community support is the key component to developing new programs. The quality and quantity of the water supply is a major concern for the citizens of the Tucson AMA. Changes to the water rights system and the relative responsibilities of various water use sectors will require substantial public input and opportunities for comment. If larger public policy issues are included in the evaluation, such as quality of life, water quality objectives, riparian habitat, and wetland treatment opportunities, the public input effort may require significant staff resources.

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APPENDIX 8
REGULATORY AND INSTITUTIONAL FACTORS AFFECTING RECHARGE AND/OR WATER SUPPLY AUGMENTATION

The following policies, programs, and regulations have a significant impact on the Department's water supply augmentation program.

8A.1 CENTRAL ARIZONA WATER CONSERVATION DISTRICT POLICIES

The CAWCD was established to contract with the federal government for the repayment of the CAP. CAWCD operates the CAP and repays the federal construction debt for the project. In addition to these responsibilities, CAWCD has been assigned recharge-related functions, including operation of State Demonstration Projects (A.R.S. § 45-891.01) and replenishment projects. The CAWCD is directed by a fifteen-member elected board from the three member counties (Pima, Pinal, and Maricopa). Pima County has four members. The Board sets policy for the CAP, which the CAWCD implements. CAWCD policies regarding CAP water pricing, use of State Demonstration Project monies, and delivery scheduling priorities may affect the direct use of CAP water as well as the development and operation of some recharge projects in the Tucson AMA.

8A.1.1 Central Arizona Project Water Pricing

The CAWCD charges a "postage stamp rate" for all CAP water delivered to subcontractors in the CAP service area. This pricing policy is critical to the Tucson AMA's augmentation efforts, since higher delivery costs in the Tucson AMA would make CAP water utilization far less attractive.

The price of CAP water affects utilization rates. In particular, the cost of CAP water for the AWBA has a direct effect on augmentation in the Tucson AMA. The amount of money available to finance the AWBA's activities is limited, so higher water costs will reduce the amount of water recharged. The postage stamp rate is a key consideration in AWBA cost, and it is hoped that the AWBA will continue to be subject to this pricing policy. Also, decisions regarding participation in GSFs will affect the volume of water that can be recharged in the Tucson AMA.

In 1993, CAWCD established an agricultural pool pricing program as an incentive to keep the agricultural sector participating in the CAP and increase its use of CAP water. This pricing program has had little impact in the Tucson AMA because the majority of agricultural CAP water use has been through GSFs. CAWCD also offers incentive priced water for recharge to municipal and industrial subcontractors. This is excess water that is priced below subcontract water to supply permitted recharge projects only. CAWCD has approved this program only through 1999. CAWCD will need to reevaluate the program and pricing for future years. See section 8.2.2.1.3 for further discussion of CAP water pricing and agriculture. A schedule for annually increasing capital charges for municipal and industrial CAP water allocations has been established by CAWCD.

8A.1.2 State Demonstration Fund

Funding for State Demonstration Projects or recharge of excess CAP water was provided from ad valorem taxes levied by CAWCD at a rate of four cents per $100 secondary assessed valuation in Maricopa and Pima Counties between 1991 and 1996. Monies are no longer being added to the fund for state demonstration projects, and most of the fund for the Tucson AMA has been encumbered. In 1996, new legislation established the AWBA. The monies raised from the tax are now provided to the AWBA to recharge excess CAP water in the county from which the monies originated, unless CAWCD determines that it must be used to support CAWCD's repayment obligation to the federal government.

Three projects in the Tucson AMA have, or will, receive State Demonstration Project funds for construction: the Pima Mine Road Recharge Project, Avra Valley Recharge Project, and Lower Santa Cruz Replenishment Project. After completion, these State Demonstration Projects can be used by CAWCD, CAGRD, AWBA or others to store water for various purposes.

8A.1.3 Delivery Policy

As operator of the CAP, the CAWCD established an administrative system to take orders, schedule deliveries, collect charges and handle contingencies. Each year the CAWCD estimates the amount of water that will be available to customers and accepts orders on the basis of that estimate. As long as more CAP water exists than is ordered by subcontractors, the CAWCD will schedule orders for excess water. Orders for scheduled water deliveries must be made by October 1 for the next calendar year. Additional water may be purchased on demand as long as excess CAP water supplies and excess canal capacity exist. The CAWCD maintains an informal working relationship with its CAP water customers for flexibility in meeting system needs.

Annual priorities for delivery of CAP water, as established in law, assign the highest priority to Indian and municipal subcontractors. The lowest priority is assigned to non-Indian agriculture. This means that if scheduled deliveries must be curtailed in any year, deliveries to non-Indian agricultural subcontractors will be cut first. The priority of daily deliveries is assigned by CAWCD taking into account the operational flexibility of its customers. As currently implemented, daily operating priorities place direct municipal uses first, but place agricultural uses before municipal recharge projects, on the rationale that timing of deliveries is more important to agriculture than to recharge. This policy may be revisited due to the concerns of some municipal subcontractors that it could shift the burden of supply reliability away from agriculture and towards municipal and industrial users.

8A.2 CENTRAL ARIZONA GROUNDWATER REPLENISHMENT DISTRICT

Legislation enacted in 1993 established the CAGRD as an operating unit of CAWCD. As currently constituted, the CAGRD exists solely to provide municipal providers or subdivisions a means to replenish groundwater that is withdrawn in excess of the amount of groundwater that is allocated to them under the Department's AWS Rules. Membership in the CAGRD is voluntary. The CAGRD may offer economic benefits to members through the collective bargaining power of the district and the economies of scale in development of cooperative regional projects.

The CAGRD service area includes those portions of Maricopa, Pinal, and Pima Counties which are located within the Phoenix, Pinal, and Tucson AMAs. The CAGRD provides replenishment services to members who agree to the terms of a membership contract. The CAGRD may meet its replenishment obligations using CAP water or any other source of water except groundwater withdrawn within an AMA. In addition, the CAGRD may construct and operate recharge projects, enter into leases or water exchanges, purchase and retire water rights, and levy and collect fees from its members to finance replenishment activities.

The amount of excess groundwater reported can vary at the discretion of the provider from a minimum, calculated on the basis of a formula in the replenishment statute, to the total amount of groundwater delivered in any year. The contractual minimum replenishment obligation formula begins in 1999 at 1/30 of the groundwater delivered in that year and increases by 1/30 each year until 2014 for most member service areas in the Tucson AMA. A special contract was negotiated with Tucson Water because under the standard contract Tucson's demand for replenishment could have varied from near zero to over 100,000 acre-feet from one year to the next. The special contract addresses uncertainty and costs of maintaining redundant recharge capacity.

The CAGRD maintains a replenishment account for each member. It computes each member's replenishment obligation yearly based on the member's annual report and debits the account by the calculated amount. Members can build limited credit in the account by purchasing replenishment services. Members' accounts are balanced annually, and members with a debit balance must pay the CAGRD to replenish the amount of over-drafted groundwater and bring the balance at least to zero. A member also may transfer to the CAGRD storage credits accrued or purchased elsewhere to offset a debit balance. The CAGRD has three years to replenish excess groundwater used by a member.

Because of the flexibility of the system, it is difficult to predict the volume of replenishment which will be provided by the CAGRD in any given year beyond the statutory minimum replenishment obligation. Because the minimum replenishment obligation increases over time, the impact of the CAGRD's activities on the Tucson AMA's water supply will increase over time.

The water used for replenishment may be acquired by the CAGRD or a member. According to the CAGRD's first 20-year plan of operation adopted in 1994 in the Tucson AMA, the CAGRD intends to fulfill contractual obligations using excess CAP water.

8A.3 DEPARTMENTAL REGULATIONS AND PROGRAMS RELATED TO AUGMENTATION

8A.3.1 Augmentation and Conservation Assistance Fund

The Department's Augmentation Assistance Program is one of the ways in which the Department provides technical assistance to the community. Conveyance, storage, and/or direct use of alternative water supplies are facilitated through grants and contracts for feasibility studies, monitoring studies, routing studies, and other projects. Fund monies may be used to advance development of specific projects, or to resolve technical issues with broader applications. Chapter 9 describes the Augmentation Assistance Program more fully, including a summary of specific grants and projects completed during the second management period.

The Department's augmentation and conservation assistance activities are funded by groundwater withdrawal fees. The potential of the program to affect the Tucson AMA's augmentation activity depends on the amount of funds available and how strategically the funds are used. In 1996, when most of the available augmentation funding was diverted to the development and support of the AWBA, the Department initiated a proposal and contracting process to target high priority groundwater management issues and information needs with the remaining funds. In 1997, to help reduce the time required to procure technical consultants for augmentation projects, the Department developed a general technical services contract that is renewable for up to three years. Cost-sharing projects broaden the effectiveness of the program.

8A.3.2 Water Protection Fund Grants

Legislation establishing the AWPF was passed in 1994. The purpose of the AWPF is to provide grant monies for implementing projects to protect or restore the state's rivers and streams, including the purchase of CAP water or effluent for riparian enhancement. The Legislature appropriated $4 million for the AWPF from the state general fund in 1994 and $6 million in 1995. The Commission awarded 53 AWPF grants totaling $12,289,923 in the 1995 and 1996 funding cycles.

AWPF grants could impact future augmentation activities in the Tucson AMA by providing funds to develop riparian enhancement projects which would utilize excess CAP water or effluent. AWPF grants issued for the City of Tucson's Atturbury Wash Project and the San Xavier District's Arroyos Project are

associated with recharge facilities. However, few of the applications filed to date in the Tucson AMA have proposed acquisition of renewable supplies.

8A.3.3 Assured Water Supply Program

In February of 1995, the Department adopted the Assured and Adequate Water Supply Rules. These rules are a primary tool in achieving the AMA's management goals and ensuring sufficient water supplies for new development. The rules require that developers of new subdivisions demonstrate the availability of renewable, non-mined groundwater supplies that are sufficient to meet the demand of the development for 100 years, either by obtaining a Certificate of Assured Water Supply or by receiving service from a water provider with a Designation of Assured Water Supply. While new subdivisions and designated providers must limit their overall use of mined groundwater, a specified amount of mined groundwater is allocated to them. Any groundwater use above the mined groundwater allocation must be replenished. If a certificate applicant or water provider does not have access to a renewable water supply, the development or service area may be enrolled in the CAGRD to satisfy its replenishment obligation. If a municipal provider is a member service area, or a subdivision is a member land of the CAGRD, any groundwater withdrawn in excess of the mined groundwater allocation must be replenished within the AMA by the CAGRD within three years.

Municipal water use accounts for nearly half of all water used in the Tucson AMA. In addition, a significant portion of the population falls within service areas that have assured water supply designations. Once a provider has joined the CAGRD, the CAGRD is committed in perpetuity to replenish the demand that existed within that service area during the membership period in addition to the demand of new developments. Therefore, the AWS Program should significantly influence the use of renewable water supplies in the AMA.

Most private water companies have chosen not to be designated. Vail Water Company (formerly Del Lago) and Spanish Trail Water Company are the only private water companies in the Tucson AMA with designations as of December 1999. Several companies which formerly held assured water supply designations have decided not to reapply (see Chapter 5). New developments in undesignated providers' service areas must have a Certificate of Assured Water Supply, but undesignated water providers are expected to continue to pump groundwater to serve their existing customers. This ongoing use of mined groundwater jeopardizes the ability of the AMA to reach safe-yield.

Table 8A-1 shows the status of provider assured water supply designations. Tucson Water, the largest municipal provider in the AMA, has applied for and received a designation under the AWS Rules. In order to maintain a designation under the new requirements, Tucson Water needs to resolve some of the limitations on municipal CAP water use described in section 8.2.2.1.2 because there are limits to the amount of groundwater physically available within their service area. All of the designated providers listed below are, or will be, members of the CAGRD.

As of December 1999, there were 19 large (serving more than 250 acre-feet) and approximately 132 small undesignated providers in the Tucson AMA. Some of these undesignated providers could be targets for augmentation efforts; their current groundwater use is 23,600 acre-feet. Efforts to encourage use of renewable water supplies in this sector merit further attention as a component of the augmentation program in the Tucson AMA.

TABLE 8A-1
ASSURED WATER SUPPLY STATUS
TUCSON ACTIVE MANAGEMENT AREA

Provider	1996 Population	1996 Water Use (acre-feet)	Assured Water Supply Status
Marana Municipal Water System	533	88	Designation granted
Metropolitan Domestic Water Improvement District	42,861	9,109	Designation granted
Spanish Trail Water Company	551	133	Designation granted
Town of Oro Valley (formerly Canada Hills and Rancho Vistoso Water Companies)	23,229	6,457	Designation granted
Tucson Water	599,602	114,548	Designation granted
Vail Water Company (formerly Del Lago Water Company)	1,275	202	Designation granted
TOTAL DESIGNATIONS	**668,051**	**130,537**	
Community Water Company of Green Valley	12,819	2,145	Expired
Farmers Water Company	686	280	Expired
Forty-Niner Water Company	872	862	Expired
Green Valley Water Company	4,203	2,355	Expired
New Pueblo Water Company (purchased by Community W.C. of Green Valley)	841	122	Expired
Ray Water Company	4,617	667	Expired
TOTAL EXPIRED	**24,038**	**6,431**	
TOTAL OTHER UNDESIGNATED PROVIDERS	**80,788**	**17,180**	
GRAND TOTAL	**772,877**	**154,148**	

8A.3.4 Well Spacing Rules

The Code states that the director shall adopt rules governing well locations (A.R.S. § 45-598(A)) and may adopt rules governing pumping patterns (A.R.S. § 45-601) to minimize damage to adjacent land and water users. The Department is currently operating under temporary well-spacing and well-impact rules (A.A.C. R12-15-830 adopted in 1983) and intends to develop new rules to address this complex program. These rules could be developed not only to address the statutory requirements of protection but also as a management tool in conjunction with recharge and augmentation programs to better control localized aquifer conditions.

8A.4 ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY REGULATIONS AND PROGRAMS RELATED TO AUGMENTATION

ADEQ activities and regulations that affect supply augmentation and/or recharge include Aquifer Protection Permits (APP), disinfection rules, Aquifer Water Quality Standards (AWQS), and the Wastewater Reuse Rules. For further information on ADEQ programs and regulations, contact the ADEQ Southern Regional Office (520) 628-6734.

8A.4.1 Aquifer Protection Permits

ADEQ has responsibilities for protecting the quality of water resources in the state. Unless otherwise exempted, discharge that has the potential to degrade water quality in an aquifer must receive an APP from ADEQ certifying that specified measures have been or will be taken to prevent pollution of the aquifer.

The APP rules include special provisions for underground storage and recovery. They also require ADEQ to advise the Department of permit applications received for individual APPs for facilities which are recharge projects. An APP is not required for recharge projects using CAP water. However, ADEQ statutorily is required to review applications for USF permits regardless of their exemption from APP requirements. ADEQ assesses whether a facility is in a location that will promote either the migration of a contaminant plume or the migration of a remediated groundwater area so as to cause unreasonable harm, or is in a location that will result in pollutants being leached to the groundwater table so as to cause unreasonable harm. A.R.S. § 45-811.01(C)(5). The Department, after consultation with ADEQ, may include in its permit any requirements deemed necessary to protect aquifer water quality.

Recharge projects using effluent must be issued an APP by ADEQ. In general, effluent must meet primary drinking water quality standards before an APP will be issued for its discharge to the aquifer, although other standards and exceptions can apply. Recharge projects employing spreading basins, stream channels or injection methods would all be considered discharge to the aquifer. To discharge CAP water to a river bed, an entity must have either an APP or a recharge permit.

APP rules include numeric and narrative water quality standards. There are numeric AWQSs for certain inorganic and organic chemicals, radionuclides, and microbiological pollutants which may not be exceeded within the aquifer. These standards are generally the same as the Maximum Contaminant Levels (MCL) set by the EPA for drinking water. ADEQ has one year to adopt a new AWQS after EPA adopts an MCL for a groundwater constituent. Sometimes when EPA eliminates an MCL standard, ADEQ retains the correlating AWQS for that constituent. ADEQ narrative standards include that a discharge shall:

- Not cause a pollutant to be present in an aquifer classified for a drinking water protected use in a concentration which endangers human health.

- Not cause or contribute to a violation of a surface water quality standard established for a navigable water of the state.

- Not cause a pollutant to be present in an aquifer which impairs existing or reasonably foreseeable uses of water in an aquifer.

Changes or additions to the numeric standards list and interpretation of the narrative standards could significantly affect future augmentation activities in the Tucson AMA. For example, the recharge of effluent could become constrained if numeric standards for TDS were added to the list. Conversely, this could lead to increased direct use of effluent.

8A.4.2 Groundwater Under the Direct Influence of Surface Water Disinfection Requirements

The ADEQ is the designated agency of the state to administer the federal Safe Drinking Water Act. In this capacity, ADEQ must promulgate rules for determining on a case-by-case basis whether water recovered from CAP water recharge projects is considered "groundwater under the direct influence of surface water." Such water must be treated according to the drinking water rules that apply to surface water, while groundwater need not be treated unless it fails to meet primary drinking water standards. (A national groundwater disinfection rule is currently being contemplated which could change this.) If water recovered from a recharge project is determined to be "groundwater under the direct influence of surface water," filtration and disinfection could be required before the water enters the distribution system. This treatment could add significantly to project costs. Rules on this subject were adopted effective April 19, 1999.

For public water systems using a well within 500 feet lateral distance from a surface water body, the ADEQ requires a determination of whether the well is pumping "groundwater under the direct influence of surface water." ADEQ's Drinking Water Program currently regards recharge basins, in-channel recharge facilities, injection wells, or virtually any other mode of discharge of CAP water into wells or an aquifer as a "surface water body." Thus, if a recharge facility is designed with recovery wells that are within 500 feet, or utilizes existing wells within 500 feet of the facility, a determination would be required. ADEQ will first try to assess the vulnerability of the well to the direct influence of surface water using existing hydrogeologic and well construction data. ADEQ may determine that the groundwater source is sufficiently separated from the surface water source and is, therefore, not under the direct influence of surface water. However, if there is insufficient data available or it is determined that the groundwater source has a high vulnerability to influence the surface water source, then the water system will be required to determine through testing whether it is pumping "groundwater under the direct influence of surface water."

While a recharge project's recovery wells may qualify for testing, they do not need filtration and disinfection treatment unless the tests confirm a direct surface water influence. The required test is Microscopic Particulate Analysis (MPA), which looks for insect fragments, leaf parts, etc., that have not been filtered out by aquifer materials.

This is a new and evolving program. Because ADEQ is currently reviewing and revising procedures and requirements for this program, the Department recommends contacting ADEQ for the latest information on this rule.

8A.4.3 Aquifer Water Quality Standards

Under Title 49, ADEQ has adopted rules (A.A.C. R18-11-401, *et seq.*) which set both numeric and narrative AWQSs as well as Health Based Guidance Levels (HBGL). Numeric AWQSs are equivalent to the Federal primary drinking water standards while narrative standards may be set on a "case by case" basis utilizing HBGLs or other technical information to protect human health or current and future aquifer use.

Although recharge of CAP water and other non-effluent waters is exempt from APP requirements (A.R.S. § 49-250(B)(12) and (13)) if a permit to operate is secured under Title 45, any discharge must still comply with AWQSs. This exemption from the APP program should expedite recharge permitting of non-effluent water while still providing ample protection to the aquifer through the Department's permit and monitoring requirements.

8A.4.4 Wastewater Reuse Permits

Wastewater reuse is an important component of the Tucson AMA augmentation program. Direct use of treated wastewater (effluent and industrial wastewater) may occur only if a wastewater reuse permit is granted by ADEQ. A wastewater reuse permit is intended to ensure that the use of treated wastewater will not adversely affect human health, water supplies, or the environment. For example, a wastewater treatment plant operator or the user of the effluent must apply for a permit from ADEQ before effluent can be released from the treatment plant for reuse. The treatment plant operator or the user of the effluent is responsible for meeting the conditions of the wastewater reuse permit, as set forth in a legally enforceable contract between them.

The reuse rules specifically prohibit the use of treated wastewater for direct human consumption. However, there are reuse standards established for orchards, fiberseed and forage, pastures, livestock watering, processed food, landscaped areas, food consumed raw, incidental human contact and full body contact uses, gray water uses, wetlands marshes, and industrial reuse. Depending upon the use and disposal of the wastewater, an APP, or a National Pollutant Discharge Elimination System (NPDES) permit may also be required.

The ADEQ is currently revising the reuse rules, A.A.C. R18-9-701, *et seq.* The revised rules may impact augmentation activities in the Tucson AMA by expanding the options for direct use of effluent.

In the Tucson AMA, Tucson Water holds a reuse permit for its reclaimed water system. Individual reclaimed water customers who agree to operate within the criteria set forth in the City's blanket reuse permit are not required to obtain individual permits from ADEQ.

8A.5 STATE HISTORIC PRESERVATION ACT

Recharge projects are frequently located along riverbeds, which are the areas where archaeologic sites are most frequently identified. Under Arizona's State Historic Preservation Act, an archaeologic survey is required wherever the land surface will be excavated and/or inundated for a storage project. The survey is done to ensure that no historic or prehistoric sites will be disturbed. If no archaeologic remains are found, a clearance is issued. If archaeologic or paleontologic items are found on state, county, or municipal lands, it is necessary to contact the director of the Arizona State Museum. It also is necessary to contact the director of the Arizona State Museum if funerary remains are found on private lands. Other agencies that should be contacted if archaeologic remains are found include the Tucson Historic Preservation Office and/or the Pima County Historic Preservation Office.

8A.6 FEDERAL REGULATIONS PROGRAMS AND ISSUES

Federal activities affecting supply augmentation and/or artificial recharge include compliance with: the NPDES and dredge and fill sections of the Clean Water Act, the Endangered Species Act (ESA), the Reclamation Reform Act (RRA), Colorado River Law, and SAWRSA.

8A.6.1 National Pollutant Discharge Elimination System Permits

Pursuant to section 402 of the Clean Water Act, ADEQ administers the certification of NPDES permits for the EPA. The NPDES Permit for Point Sources of Pollution, as defined by ADEQ, protects the waters of the state from pollutants discharged from a point source. The waters of the state include all perennial or intermittent streams, lakes, ponds, impounding reservoirs, marshes, watercourses, waterways, wells, aquifers, springs, irrigation systems, drainage systems, and other bodies or accumulations of surface, underground, natural, artificial, public, or private water situated wholly or partly in or bordering on the state.

A NPDES storm water permit may also be required for certain industrial and construction activities that discharge storm water. NPDES permits are usually required for effluent or industrial wastewater being disposed of by discharge to the waters of the state. However, when wastewater is proposed for a reuse application, such as recharge, the ADEQ wastewater reuse and APP rules are applied.

8A.6.2 Section 404 Clean Water Act Dredge and Fill Permits

Section 404 (Wetlands) of the Clean Water Act requires that the United States Army Corps of Engineers, with the concurrence of EPA, issue or deny permits for activities that result in the discharge of dredge or fill material into the waters of the United States. For the purposes of this section, waters of the United States include most streams, stream channels, and wetlands in Arizona. Intended to prevent the unlawful filling of wetlands, this section would apply to most channel modifications made for in-channel recharge projects. Section 404 permits must be certified by ADEQ, under section 401 of the same Clean Water Act. Certification depends on a review "solely to determine whether the effect of the discharge will comply with the water quality standards for navigable waters . . . ." A.R.S. § 49-202(C).

8A.6.3 Endangered Species Act

The ESA could have a major impact on siting and developing recharge facilities in the Tucson AMA. The United States Fish and Wildlife Service (USFWS) must be consulted when a recharge project involving a federal government action is planned. The USFWS issues a Biological Opinion on whether a project is likely to jeopardize endangered or threatened species. If the USFWS determines the project is likely to jeopardize such species, the project's sponsors must consult with the USFWS on ways to avoid or mitigate the project's negative impact. In the Tucson AMA, projects that involve the USBR, rights-of-way on federal land, or similar federal participation may require consultation with the USFWS.

The mitigation requirements can be extensive. In 1994, USFWS released a Biological Opinion under section VII of the ESA identifying the potential of the CAP delivery system to transport, introduce, and spread non-native aquatic species to the Gila River Basin. Although this 1994 Gila River Basin Biological Opinion did not consider CAP impacts to most of the Santa Cruz River Subbasin, it provides precedents that may affect other federal agency decisions and indirectly the development of recharge projects in the Tucson AMA. The Reasonable and Prudent Alternatives developed to minimize potential jeopardy to endangered native species included: (1) construction of physical fish barriers and maintenance of existing electrical fish barriers, (2) development and implementation of a program to monitor fish populations in the CAP aqueduct and selected contiguous waters, (3) funding for threatened and endangered fish conservation, (4) funding for control activities of non-native fishes, and (5) development and implementation of an information and education program on non-native species introductions into native aquatic communities.

As of 1999, GSFs using CAP water have gone forward in the Santa Cruz River Basin without formal USFWS consultation based on an agreement between the USFWS and the USBR on protective measures. The USFWS mitigation requirements for the Santa Cruz River sub-basin included construction of fish

barriers. However, because the CAWCD requested that 1996 and subsequent funds for endangered species mitigation be deleted from the congressional appropriation, protective structures were not built; and several issues disputed by the USBR, the USFWS, and the CAWCD are being resolved through litigation.

Currently it is unclear if the construction of the CAP system itself can be considered the federal action used as a basis for applying certain provisions of the ESA to recharge projects involving use of CAP water, even though the recharge project has no other direct federal involvement.

Many areas along rivers and washes in the Tucson AMA have been identified as potential ferruginous pygmy owl habitat. Construction in and near the owl habitat may be affected by this determination. ESA compliance may block or inhibit development of some of the proposed in-channel and off-channel recharge projects located within or near critical owl habitat.

Determination of the applicability of USFWS formal consultation and mitigation requirements under the ESA to recharge projects involving CAP water may range from limited to extensive impact on the cost of development and operation of many proposed recharge projects in the Tucson AMA. If resolution of the dispute results in requirements for formal consultation with the USFWS on endangered species protection and addition of protective structures to recharge project designs for all CAP water recharge projects located in or near the Santa Cruz River bed and tributaries, ESA compliance could become a significant disincentive to recharge.

The ESA may also affect recharge projects in the Tucson AMA if an endangered species should come to depend on habitat created or sustained by a project. The Southwest Center for Biological Diversity has filed suits requesting that Hoover and Roosevelt Dams be operated in a way that protects the habitat of the endangered southwestern willow flycatcher, which exists around the margins of the reservoirs created by the dams. If a facility can be compelled to protect habitat it incidentally creates or sustains, then the design and operation of some recharge projects may be legally constrained for endangered species protection. Injection recharge projects and basin recharge projects operated to maximize recharge through wet/dry cycles and disking are less likely to create incidental habitat than multi-purpose projects incorporating riparian features and recreation.

8A.6.4 Reclamation Reform Act

The RRA was passed by Congress in 1982. The RRA established strict limits on the amount of acreage that landowners may irrigate with reclamation water delivered by irrigation districts which have water service contracts with the USBR. In most cases, the limit is 960 acres, including leased lands. Land owned in excess of 960 acres must be put under recordable contract with the Secretary of Interior and disposed of within 10 years of the date of first water service to the land. Excess lands not placed under recordable contract must pay full cost for reclamation water.

The Impact of the RRA on CAP water use in the Tucson AMA was initially thought to be significant; however, the groundwater savings program has provided an avenue to avoid the RRA CAP water use restrictions for agriculture.

8A.7 INDIAN WATER RIGHTS SETTLEMENTS

Indian water rights claims involve a large portion of the water supplies available in the state. Through an initial allocation by the Secretary of the Interior in 1982 and subsequent water rights settlements, Indian CAP water allocations totaled approximately 455,600 acre-feet by 1996, or 483,800 acre-feet if the 28,200 acre-feet of SAWRSA exchange water is included. Recent CAP repayment proposals affect the

distribution of CAP water between Indian and non-Indian users. It is expected that Indian water rights settlements will play a major role in water supply availability within the AMAs.

In the Tucson AMA, amendments to the SAWRSA being proposed as settlement to pending litigation may have significant water supply management implications. The Tohono O'odham Nation, the United States, and two Indian allottees initiated a lawsuit in 1975 suing the City of Tucson and other water users in the AMA claiming damages and seeking to enjoin pumping of groundwater. Although a settlement was reached in 1982, most provisions have not been implemented because an ongoing dispute between the Nation and the San Xavier District allottees regarding distribution of assets included in the settlement thwarted dismissal of the pending litigation. In 1993, the allottees filed two new lawsuits. All three lawsuits are in abeyance during ongoing negotiations for a legislative solution. Settlement negotiations are ongoing. The 1996 version of the proposed SAWRSA Amendments settlement is summarized in Table 8A-2.

TABLE 8A-2
INDIAN WATER SUPPLIES IF SAWRSA AMENDMENTS ARE ENACTED
TUCSON ACTIVE MANAGEMENT AREA

	San Xavier District	Eastern Schuk Toak District	Total
CAP water	27,000 AF	10,800 AF	37,800 AF
Groundwater	10,000 AF	3,200 AF	13,200 AF
Additional CAP water (effluent exchange)	23,000 AF	5,200 AF	28,200 AF
Initial Groundwater Credits	50,000 AF	16,000 AF	66,000 AF
Annual Maximum Credit Recovered*	10,000 AF	3,200 AF	13,200 AF
10 Year Maximum Credit Recovered*	50,000 AF	16,000 AF	66,000 AF

*The annual maximum recovered credit would be in addition to the annual groundwater allotment. This means the San Xavier District Allottees could pump up to 20,000 acre-feet per year, as long as there were credits in their account, and they did not exceed the 10-year maximum. Because they could recover a maximum of 50,000 acre-feet of credits in any 10-year period, they could potentially pump an average of 15,000 acre-feet per year in any 10-year period.

AF = acre-feet

The USBR is responsible for executing the federal government's responsibilities (other than trust responsibilities) in the SAWRSA. The USBR has assisted the San Xavier District of the Tohono O'odham Nation by helping to deliver CAP water to the Arroyos Project.

The SAWRSA amendments are anticipated to resolve the Tohono O'odham Nation's "Winters Doctrine" water claims in the Tucson AMA, as well as claims for damages resulting from groundwater overdraft. In separate efforts, the Tohono O'odham Nation is also seeking water rights for the Sif Oidak District located within the Pinal AMA.