3. PLANNING AREA DESCRIPTION

3.1. NATURAL SETTING

The natural setting in Pima County is diverse with respect to many parameters, especially elevation. Pima County is approximately 9,200 square miles in area, with land surface elevations ranging from 1,200 feet to more than 9,000 feet above mean sea level (PAG, 2003). The lower elevations of Pima County lie within the Sonoran Desert, which covers 86,000 square miles in southern Arizona, southeastern California, most of the Baja Peninsula and the Mexican state of Sonora (Nature Conservancy, 2005). Near Tucson, the Santa Catalina, Rincon, and Santa Rita Mountains are the highest mountain ranges in the county, with deciduous woodlands, coniferous forests and perennial streams. The wide elevation span leads to diverse climate regimes and ecosystems.

3.1.1. Planning area and watershed boundaries

Although PAG's DPA legally encompasses all of Pima County, the Tohono O'odham Nation opted to produce its own 208 Plan for its lands. Therefore, PAG's 208 Plan only addresses non-tribal lands including the City of Tucson, the Town of Oro Valley, the Town of Marana, the City of South Tucson, the Town of Sahuarita, and unincorporated Pima County, which includes Green Valley, Ajo and Summerhaven (Figure 3-1). Because the majority of the DPA falls within eastern Pima County (as well as the majority of the population, water resources, and wastewater treatment plants), it is the geographic focus of this chapter.

Watersheds in Pima County include large alluvial basins separated by mountain ranges. The Santa Cruz River watershed encompasses most of eastern Pima County, whereas a portion of the Lower Gila River watershed covers the western third of Pima County (Figure 3-1). The eastern Pima County drainage network generally runs north to northwest, while the western Pima County drainage network runs west to southwest. A portion of the Lower San Pedro River watershed is in the northeast corner of Pima County. All of Pima County ultimately drains to the Colorado River. The majority of the watercourses in Pima County are ephemeral, with some intermittent and perennial watercourses located in eastern Pima County.

Pima County intersects the ADEQ-defined Colorado-Lower Gila, Santa Cruz-Magdalena-Rio Sonoyta, and San Pedro-Wilcox Playa-Rio Yaqui watersheds. The following bulleted list and Figure 3-1 indicate which Hydrologic Unit Code (HUC) watersheds intersect Pima County.

COLORADO-LOWER GILA

- San Cristobal Wash
- Tenmile Wash

SANTA CRUZ-MAGDALENA-RIO SONOYTA

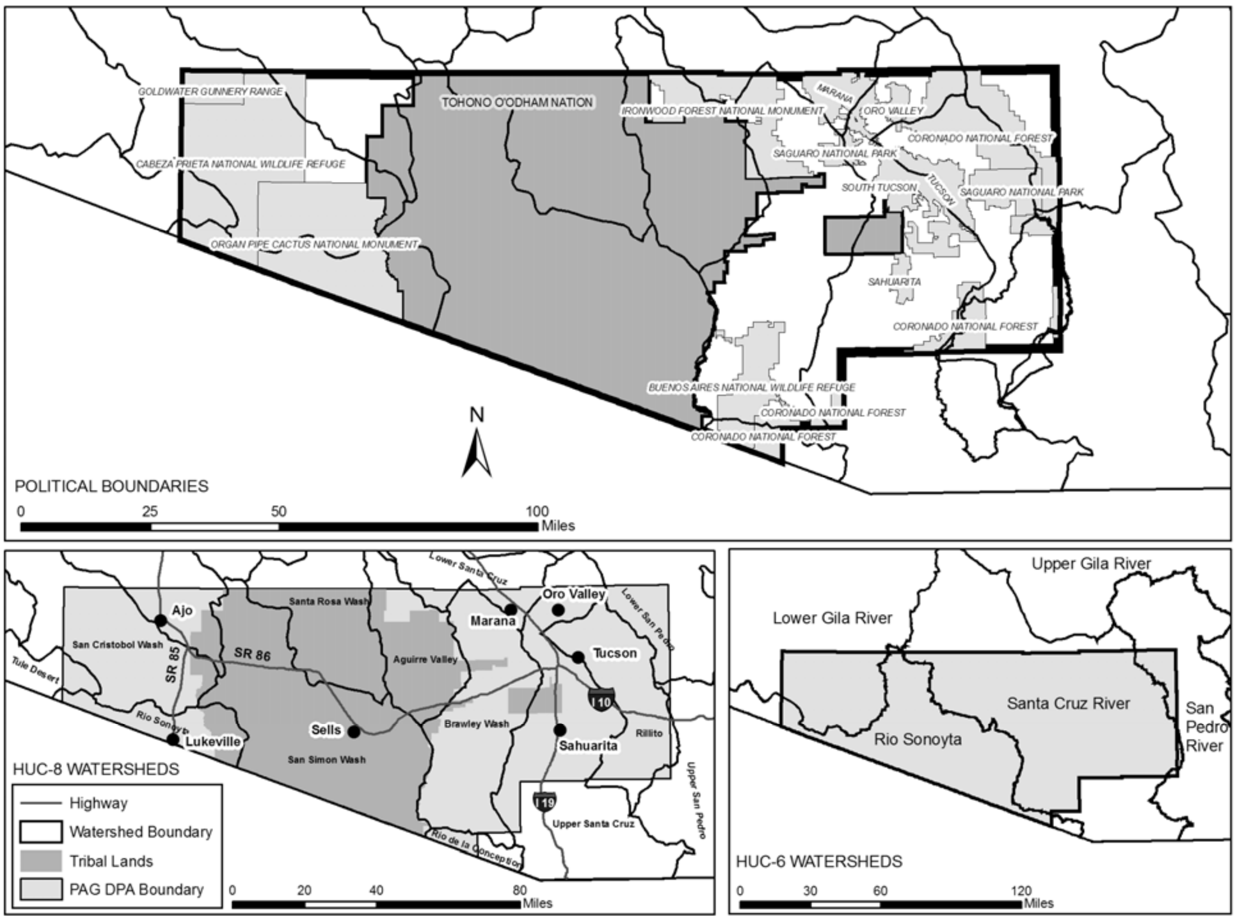
- Aguirre Valley
- Brawley Wash
- Rillito (also known as the Cienega Creek and Pantano)
- Lower Santa Cruz
- Rio de la Concepcion
- Rio Sonoyta

- San Simon Wash
- Santa Rosa Wash
- Tule Desert
- Upper Santa Cruz River

SAN PEDRO-WILCOX PLAYA-RIO YAQUI

- Lower San Pedro River
- Upper San Pedro River

Figure 3-1. PAG 208 Planning Area: Political and Watershed Boundaries



Data sources: PCLIS, 10/2004; Arizona Electronic Atlas, 2004

<u>3.1.2. Climate</u>

Southeastern Arizona is known for its low annual precipitation, clear skies, and year-round warm weather; however, climate variability is very pronounced in the Southwest, with relatively dry, wet, cool, and warm periods fluctuating on time scales from seasons to centuries due to changes in oceanic and atmospheric circulatory patterns (Sheppard et al., 1999). For example, the U.S. Southwest has been in an aggressive drought for the last five to seven years. Reservoir levels and stream flows are down, and some climatologists suggest that the U.S. Southwest has entered an abnormally dry period. According to paleoclimatology records, such dry periods have occurred in the past, notably during the 1890s and the 1950s (Sheppard et al., 1999).

Seasonal precipitation patterns are evident in Pima County. Summer precipitation is due to intense, localized convective thunderstorms associated with the North American monsoon. Winter precipitation is due to the remnants of tropical storms or frontal storms that are tracking more southerly than usual. In both cases, winter precipitation tends to be in the form of widespread, soaking rains, with snow in the upper elevations. In the Santa Catalina Mountains, snowfalls averaged 75.37 inches per year between 1965 and 1980 (WRCC, 2004a). A quasi-permanent subtropical high-pressure ridge over the Southwest can be attributed for the warm and dry periods in between.

Between 1971 and 2000, summer (June - August) high temperatures averaged 99 degrees Fahrenheit (ºF), winter (December – February) high temperatures averaged 66.6 ºF, and annual precipitation averaged 12.19 inches in Tucson (WRCC, 2004).

3.1.3. Geology

Pima County is in the Basin and Range physiographic province, which extends from eastern California to central Utah and from southern Idaho to the Mexican state of Sonora. Characterized by northwest trending mountain ranges separated by alluvial valleys, the basin and range physiography was created by volcanic activity and normal faulting in areas where the earth's crust underwent lateral extension. Along the north/south trending faults, mountains uplifted and valleys down-dropped. Vertical relief between the valley floor and mountain peaks regularly exceeds 6,000 feet. Rock types in Pima County span from acidic volcanic and intrusive rocks to limestone, basalt, andesite and metamorphic schists (USGS, 2001).

Eroded sediments from the mountains created deep basins in the valleys. Basin units consist of (from oldest to youngest) mountain bedrock, moderately to highly consolidated pre-basin and range sediments, consolidated lower basin fill, less consolidated upper basin fill and unconsolidated stream alluvium (Anderson et al., 1990).

3.1.4. Hydrology

3.1.4.1. Groundwater hydrology

Most aquifers in Pima County exist in the unconsolidated units such as the Pleistocene Fort Lowell Formation in the Tucson basin and the upper Tinaja beds in the Avra Valley basin (Figure 3-2). Although large aquifers are laterally separated from each other by mountain piedmonts (Anderson et al., 1990), faults and fractures create vertical conduits between saturated units. Perched aquifers exist in some areas where a clayey layer acts as an aquitard between the main aquifer and the perched aquifer.

From youngest to oldest, the three sedimentary units in the Tucson basin are the Pleistocene Fort Lowell Formation, the Tertiary Tinaja beds, and the Tertiary Pantano Formation (Davidson, 1973). The saturated portion of the Fort Lowell Formation and the upper Tinaja beds compose the most productive part of the aquifer (CH2M Hill, 1988). The Fort Lowell Formation unconformably overlies the Tinaja beds, which consist of upper, middle, and lower units. The Tinaja beds range from a few feet thick near the edge of the basins to more than 5,000 feet thick near the center of the Tucson basin (Davidson, 1973). The Tinaja beds unconformably overlie the Pantano Formation. The thickness of the Pantano Formation is unknown, but may be thousands of feet thick in the Tucson basin (Anderson, 1987). Quaternary alluvial deposits can be found in alluvial fans, terrace deposits and stream channels. Groundwater generally flows in a north to northwest trending direction, and exits the Tucson basin at the Rillito narrows (Davidson, 1973). The groundwater basins in Eastern Pima County are shown on Figure 3-2.

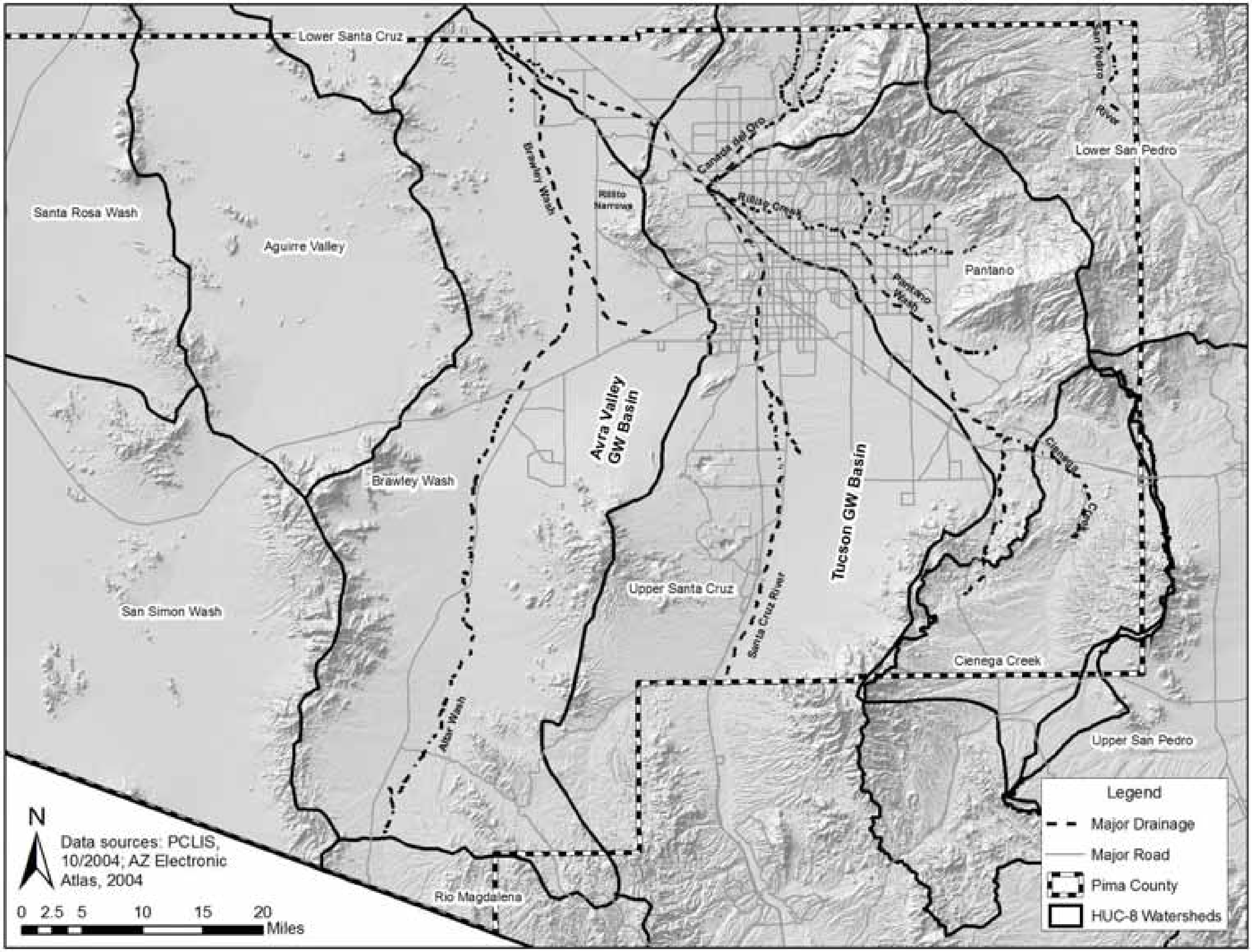
Primary inputs and outputs to the aquifer include recharge and groundwater withdrawal, respectively. Precipitation naturally recharges the aquifers through infiltration of streamflow, mountain front recharge and underflow. Recharge also occurs via anthropogenic projects. In the Tucson basin, groundwater pumpage since the mid-20th century has dewatered much of the shallow and highly unconsolidated portions of the quaternary alluvium and upper Fort Lowell Formation. Depths to water in the Tucson basin range from less than 20 feet to greater than 500 feet (Tucson Water, 2000).

3.1.4.2. Surface water hydrology

The Santa Cruz River originates in the San Rafael Valley, flows southward and enters Mexico. During its 25-mile course through Mexico, the river continues its southward flow for a short distance and then bends northward and enters Arizona five miles east of Nogales (ADWR, 1999a). From the International Border, the Santa Cruz River continues northward for 105 miles to the confluence of the Gila River (ADWR, 1999 and ADWR, 1999a). Mostly ephemeral, there are two effluent-dependent reaches downstream of Nogales, Arizona, and Tucson, Arizona. Significant tributaries to the Santa Cruz River include Cienega Creek, Pantano Wash, Rillito Creek, Julian Wash, Rincon Creek, Tanque Verde Wash, Sabino Creek, and Canada del Oro Wash. Brawley Wash is a tributary to the Lower Santa Cruz River (Figure 3-2).

The majority of surface water courses in Pima County are currently ephemeral, flowing only in response to runoff events. In a 2000 report, only 32 perennial streams were identified in Pima County (PAG, 2000a). Surface water sources are discussed in more detail later in this chapter.

Figure 3-2. Groundwater Basins in Eastern Pima County



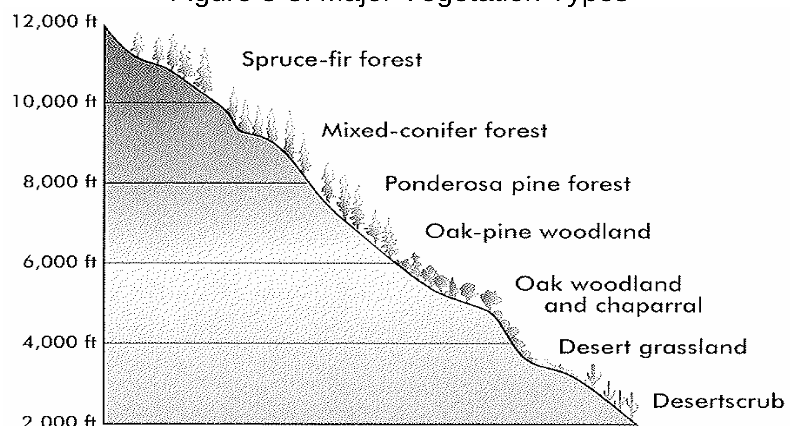
3.1.5. Biology

3.1.5.1. Vegetative communities and habitat

Categorized based on elevation ranges, there are six native vegetative communities in Pima County (Figure 3-3). Sonoran desert scrub and desert grasslands exist between 2,000 and 4,000 feet above mean sea level. Creosote bush, saltbrush, palo verde trees, saguaro and other succulents are present at this elevation range. Lower temperatures and increased precipitation in the mountains support mid-elevation oak and juniper woodlands, and at the highest elevations, coniferous forests (PAG, 2003).

Along riparian reaches, native cottonwood, willow, and velvet mesquite can be found. However, non-native species such as Lehmann lovegrass, salt cedar (tamarisk), Johnson grass, and giant reed are displacing native vegetation in riparian areas (PAG, 2003a) as well as in desert areas. Escaped landscape plants have been identified in wild areas (Pima County, 2002).

Figure 3-3. Major Vegetation Types



From *Mount Lemmon – Map Road Guide and Checklists*
Arizona-Sonora Desert Museum Guide Series

In addition to the proliferation of non-native vegetative species, habitat destruction stemming from other causes is also occurring. Urban growth in eastern Pima County, border traffic in western Pima County (Organ Pipe National Monument, 2004), recent upper elevation fires, and drought conditions have displaced animal and plant species. Over the last few years, fires of differing magnitudes have burned in the mountains surrounding Tucson, namely the 2003 Aspen Fire and 2002 Bullock Fire in the Santa Catalinas. Although natural events, fires can lead to increased sediment discharge, flood potential, and water quality changes in associated valleys (Woodhouse, 2004; Meixner and Wohlgemuth, 2004).

The Pima County Sonoran Desert Conservation Plan was developed in the early 2000s to mitigate habitat loss. It designates priority habitat areas for identified, vulnerable species and general biodiversity purposes, and directs urban growth into other areas. Priority habitat areas include the Altar Valley, Baboquivari Mountains, Cienega Creek, Eastern Tucson Riparian Complex, Organ Pipe/Goldwater Complex, Sabino Canyon, San Pedro River, Santa Rita Mountains, Silverbell Mountains, Tortolita Mountains and the Tucson Mountains (Pima County, 2004). The City of Tucson and Town of Marana are also developing habitat conservation plans. The local governments' habitat conservation efforts tend to focus on areas that serve as wildlife corridors to publicly protected lands such as national parks or forests and cover several aquatic and riparian-based ecosystems. The diverse vegetative communities present on mountain ranges support a variety of vulnerable species and habitats, especially for animals with large home ranges. In addition, some of the last remaining perennial streams are located in the upper elevations.

3.1.5.2. Wildlife

The extensive elevation range in Pima County yields a diversity of animals and plants in the Sonoran Desert and surrounding mountains. Common year-round mammals include bobcats, javelinas and coyotes. Most native amphibians, reptiles (including many rattlesnakes), and rodents hibernate over the winter and emerge in the spring. Common Sonoran desert reptile species include the Gila monster, desert iguana, gopher snake and banded gecko. Native avian species include the cactus wren, Gila woodpecker, Gambel's quail, roadrunner and Harris hawk. Many species of butterflies, bats and birds migrate through the desert washes, riparian woodlands or pine forests between their wintering areas in the subtropics to their nesting areas. Over the last 30 years scientists observed that non-native aquatic species, such as bullfrogs, green sunfish, and crayfish have displaced native species such as leopard frogs, gila topminnow and gila chub.

3.1.5.3. Endangered species

As of 2002, there are 17 species on the U.S. Fish and Wildlife Service's (FWS) Endangered Species List, four species on the Threatened Species List, and three species on the Candidate List in Pima County (Table 3-1). According to the U.S. FWS (2004), species on the Endangered list are in danger of extinction throughout all or a significant portion or their range, species on the Threatened list are likely to become endangered in the foreseeable future, and species on the Candidate list are proposed for possible addition to the other two lists.

Table 3-1. Endangered and Threatened Species in Pima County (Pima County, 2002a)

Species Name (common)	*Endangered*	*Threatened*	*Candidate*
Acuna cactus			X
Bald eagle		X	
Cactus ferruginous pygmy-owl	X**		
Chiricahua leopard frog		X	
Desert pupfish	X		
Gila chub	X*		
Gila topminnow	X		
Huachuca water umbel	X		
Jaguar	X		
Jaguarundi	X		
Kearney's blue star	X		
Lesser long nosed bat	X		
Masked bobwhite	X		
Mexican gray wolf	X		
Mexican spotted owl		X	
Mountain plover		X*	
Nichol turk's head cactus	X		
Northern aplomado falcon	X		
Ocelot	X		
Pima pineapple cactus	X		
Sonoran pronghorn	X		
Sonoyta mud turtle			X
Southwestern willow flycatcher	X		
Western yellow-billed cuckoo			X

*Proposed listing **Recent court decisions indicate this species could be de-listed

The City of Tucson and the Town of Marana are in the process of developing Habitat Conservation Plans (HCP) to mitigate incidental takes of listed species. Pima County is also developing an HCP as part of the Sonoran Desert Conservation Plan.

3.1.5.4. Aquatic species in the Santa Cruz River watershed

There are several native aquatic species in the Santa Cruz River watershed. In general, many aquatic species are listed as vulnerable species in the Sonoran Desert Conservation Plan due to the decrease in perennial surface waters, most notably the Santa Cruz River and Rillito Creek. Native species include the Chiricahua leopard frog, Sonoran desert toad, Great Plains toad, Great Plains narrow-mouthed toad (Tucson Herpetological Society, 2004), Southwestern Woodhouse toad, narrow-mouthed toad, canyon tree frog, lowland leopard frog (PAG, 2001), longfin dace, desert sucker, Sonora sucker, desert pupfish, gila chub, gila topminnow, Quitobaquito pupfish, Sonoyta mud turtle, Tarahumara frog, and speckled dace (Pima County, 1999).

3.2. POPULATION

Almost all of the incorporated and many of the unincorporated areas of Pima County increased in population between 1980 and 2000, with the exception of the City of South Tucson. Between 1990 and 2000 the populations of Arizona and Pima County have grown by 39.9 percent and 26.5 percent respectively, to make Arizona the second fastest growing state in the nation. Based on 2000 Census data, the population of Pima County is approximately 840,000; the population of Tucson, the largest incorporated city, is approximately 490,000. The City of Tucson grew from 158 square miles to 225 square miles during this time frame, and the Towns of Oro Valley and Marana also annexed additional lands. The towns of Marana and Oro Valley were the fastest and second-fastest growing towns in Arizona in the 1990s. The town of Sahuarita was incorporated in 1994 with a population of 2,159. The Pascua Yaqui population living on the reservation was 3,315 in 2000 (PAG, 2003).

Table 3-2. Population Growth in Pima County – 1980 to 2000 (PAG, 2003)

Year	*Arizona*	*Pima County*	*Unincorporated Pima County*	*Tucson*	*South Tucson*	*Marana*	*Oro Valley*	*Sahuarita*
1980	2,716,546	531,443	191,179	330,537	6,554	1,674	1,489	*
1990	3,665,228	666,880	247,540	405,390	5,093	2,187	6,670	1,629*
2000	5,130,632	843,746	305,059	486,699	5,490	13,556	29,700	3,242
Change 1990-2000	1,465,404	176,866	57,519	81,309	397	11,369	23,030	1,613*
Percent Change 1990-2000	39.9%	26.5%	23.2%	20.1%	7.7%	519.8%	345.3%	99.0%*

* Sahuarita incorporated in 1994. 1990 population estimated from census tracts approximate to the incorporation limits of the town.

The 1978 208 Areawide Wastewater Management Plan accurately projected the actual Pima County population for 2000. It published a population range of 675,000 to 879,300 to use in projecting future wasteloads. The actual 2000 Pima County population was 843,746.

3.3. Local governments

There are eight local governments in Pima County: the City of Tucson, City of South Tucson, Pascua Yaqui Tribe, Tohono O'odham Nation, Town of Marana, Town of Oro Valley, Town of Sahuarita, and Pima County. Each jurisdiction is governed by an elected board (i.e., city or tribal council, board of supervisors), and the cities and towns also directly elect a mayor and appoint management staff. Department staff for publicly provided services (i.e., transportation, human resources, planning, police) are appointed in each jurisdiction. One elected official from each jurisdiction serves on the PAG Regional Council, which acts on regional transportation, environmental and planning issues.

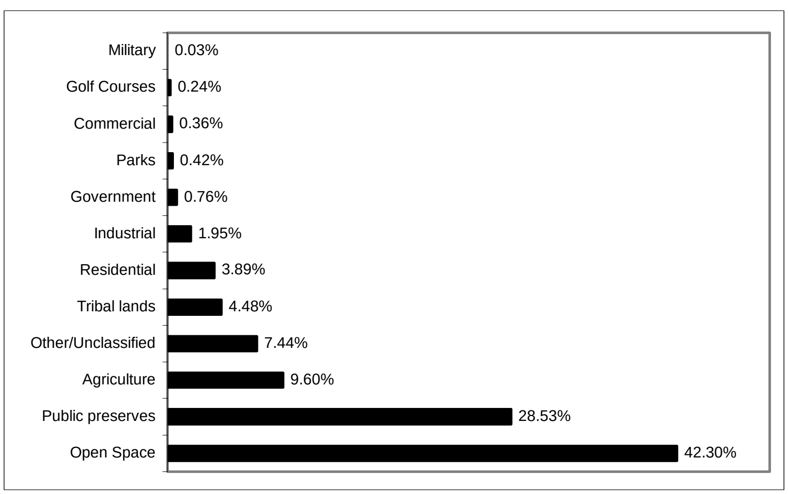
There are two Congressional Districts for the 108th Congress in Pima County, 7 and 8. Currently, Raúl M. Grijalva (D) is the U.S. Representative for District 7, and Jim Kolbe (R) is the U.S. Representative for District 8. Each was re-elected in November 2004 for two-year terms. There are six State Legislative Districts in Pima County: 25, 26, 27, 28, 29, and 30. There is one State Senator and two State Legislators elected per district to two-year terms.

In August 2004, legislation was passed to allow a Regional Transportation Authority (RTA) governed by the PAG Regional Council to plan and fund regional transportation projects in eastern Pima County. It also allows the RTA to propose an excise tax to voters and use the generated income, if approved, to fund approved projects. The excise tax is expected to be voted on in May 2006.

3.4. Land use / ownership

Approximately 86 percent of Pima County consists of land owned by the federal and state governments and tribal nations. Tribal nations account for 42 percent of the total land area, primarily in central Pima County. The State of Arizona owns 15 percent, and the U.S. Government owns 29 percent, which consist of national parks, monuments, forests, wildlife refuges, and an Air Force range. Individual and corporate ownership account for the remaining 14 percent (PAG, 2003).

Figure 3-4. Land Uses in Eastern Pima County in 2002 (PAG, 2003)



Land uses in Pima County are diverse, with sometimes quite disparate land uses occurring in the same geographic area. In western Pima County, small, unincorporated communities and open space cover the landscape. In contrast, eastern Pima County consists of urbanized areas, especially around the Tucson metropolitan area, croplands along the I-10 corridor from Marana to the southern outskirts of Phoenix, and open space and ranching in the southeastern, northeastern and eastern corners of the county. Incorporated areas in eastern Pima County continue to expand as open space and settled areas are annexed. Figure 3-4 indicates the land uses in eastern Pima County in 2002.

3.5. WATER RESOURCES

Five principal water resource categories are present in Pima County (Table 3-3). These are mapped on Figures 3-5.

Table 3-3. 2003 Water Resources in Eastern Pima County

Resource
Groundwater
Central Arizona Project (CAP) water
Treated wastewater
Surface water
Stormwater runoff

Coordinated planning and management of these water resources is necessary, because they are not always physically isolated from one another. For example, groundwater is the original source of most of the perennial and intermittent natural surface water sources in Pima County. Groundwater is also the original source for the treated wastewater that is discharged to the Santa Cruz River. Stormwater runoff recharges groundwater naturally, and CAP water is used to recharge groundwater artificially. Treated wastewater in the Santa Cruz River also recharges groundwater. Thus, in many instances the quality and quantity of one water source can affect the quality and quantity of another.

Although these resources can be hydrologically linked, they are not necessarily managed as such. For example, surface water use and groundwater use are treated as two separate entities by the legal method used to allocate surface water in the Western United States. In addition, water management tools consider groundwater, CAP water, and effluent as direct water resources, whereas harvested stormwater is not. Instead, it is factored into the net natural recharge of aquifers. Runoff that does not recharge groundwater is subject to surface water rights.

3.5.1. Groundwater

Historically, groundwater has been the most extensively used water resource in Pima County. Most of the groundwater development has occurred in eastern Pima County, in the Upper Santa Cruz Basin and Avra Valley. Groundwater in these areas is used for public drinking water supply, landscape and crop irrigation, and industry (including mining). Figure 3-5a shows the locations of all of the registered production wells in the Tucson AMA that are not exempt from reporting requirements. Throughout most of the county, groundwater is drawn from wells that tap deep aquifers found in the alluvial basins. Elsewhere, groundwater is drawn from shallow wells tapping comparatively localized sources, such as fractured bedrock, flood plain aquifers, or perched aquifers. Depths to groundwater in eastern Pima County currently range from less than 20 feet to greater than 500 feet below land surface (Tucson Water, 2000).

Groundwater pumpage totaled more than 316,000 acre-feet in 2003 in the Tucson AMA, which includes most of eastern Pima County and part of Pinal County (ADWR, 2004). This greatly exceeds the volume of groundwater recharge (ADWR, 2004), resulting in water-table declines of over 200 feet (Tucson Water, 1998) over decades. In 2003, it is estimated there was an overdraft of more than 100,000 acre-feet between aquifer gains (i.e., groundwater inflow and recharge) and aquifer losses (i.e., groundwater outflow, pumping, riparian evapotranspiration) (ADWR, 2004). In general, water level declines can lead to lower well productivity, increased pumping costs, declining water quality, and land subsidence (WRRC, 1999; WRRC, 2001). For these and other reasons, there is widespread interest in developing and using other renewable water sources instead of relying entirely on groundwater.

3.5.2. CAP water

Construction of the Central Arizona Project aqueduct started in 1973, and completed 20 years later south of Tucson. The CAP aqueduct is 336 miles long and transports Colorado River water from Lake Havasu to cities, towns, and farmers in central and southern Arizona, including Tucson. Some of the water is stored along the way in Lake Pleasant, which is impounded by the New Waddell Dam on the Agua Fria River northwest of Phoenix. CAP water allocations in Pima County are shown on Table 3-4.

Table 3-4. Central Arizona Project Contracts in the Tucson AMA (CAP, 2005)

A. Non-Indian Municipal and Industrial Subcontracts

Entity	*Annual Entitlement (acre-feet)*
Community Water Co. of Green Valley	1,337
Flowing Wells Irrigation District	4,354
Green Valley Domestic Water Improvement District	1,900
Metropolitan Domestic Water Improvement District	8,858
Spanish Trail Water Co.	3,037
Town of Marana	47
Town of Oro Valley	6,748
Tucson Water	135,966
Vail Water Co.	786
TOTAL	163,033

B. Indian Contracts

Entity	*Annual Entitlement (acre-feet)*
San Xavier (Tohono O'odham Nation)	27,000
Schuk Toak (Tohono O'odham Nation)	10,800
Pascua Yaqui	500
TOTAL	38,300

It has recently become a priority for CAP contractors in Arizona to use or store their full CAP allocations in underground storage facilities (USFs) or groundwater savings facilities (GSFs). USFs are constructed basins or natural streambeds where CAP water is allowed to percolate into the aquifer for current or future recovery, and GSFs are agreements between agricultural irrigators and CAP contractors to use CAP water for irrigation instead of groundwater. These facilities are designed to offset groundwater pumping elsewhere in the TAMA. There are four permitted USFs recharging CAP water and six permitted GSFs in the Tucson Active Management Area, as indicated on Table 3-5 and Figure 3-5b.

Figure 3-5a. Non-Exempt Water Production Wells in Eastern Pima County

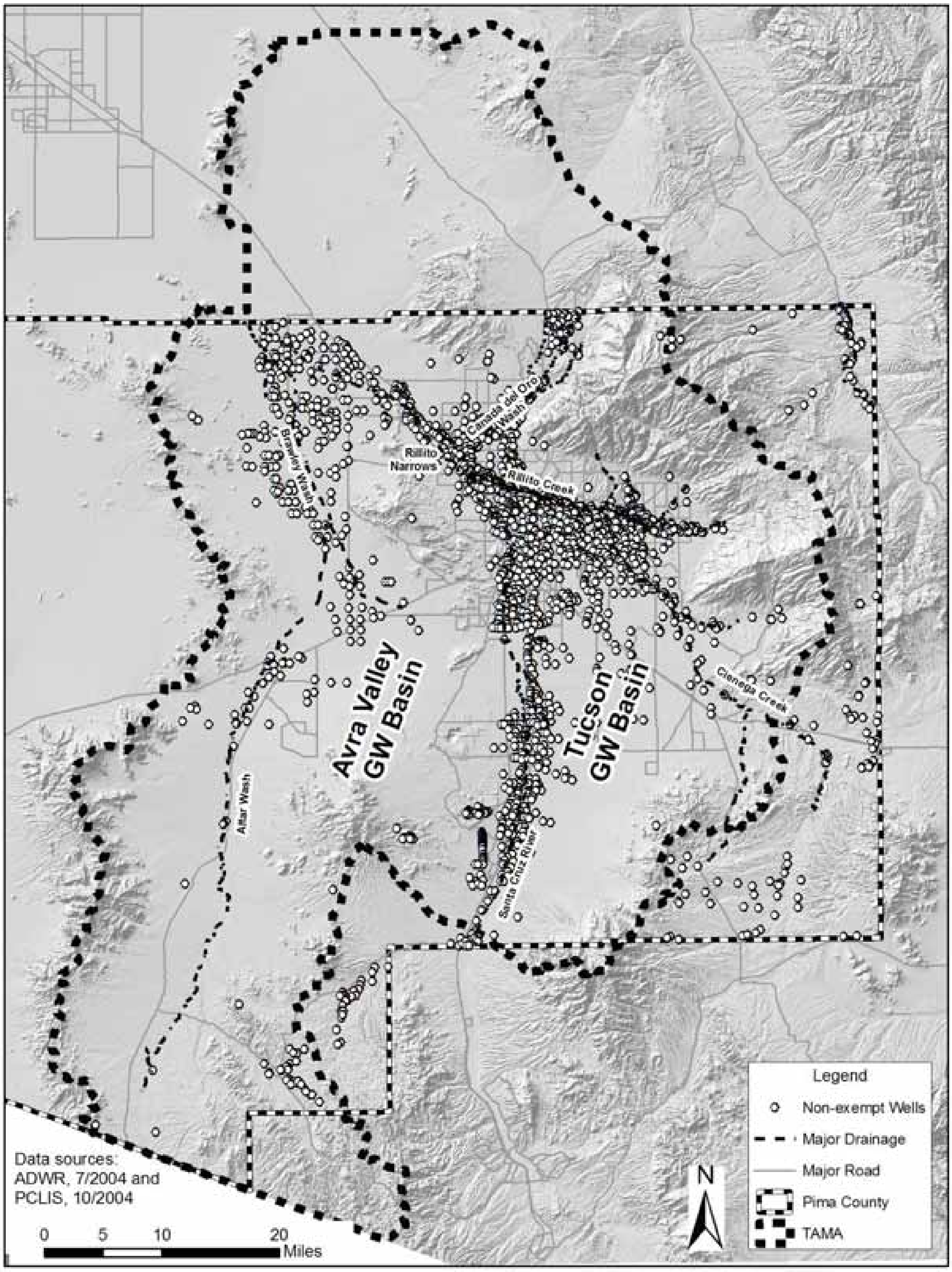


Figure 3-5b. CAP Water Resources in Eastern Pima County

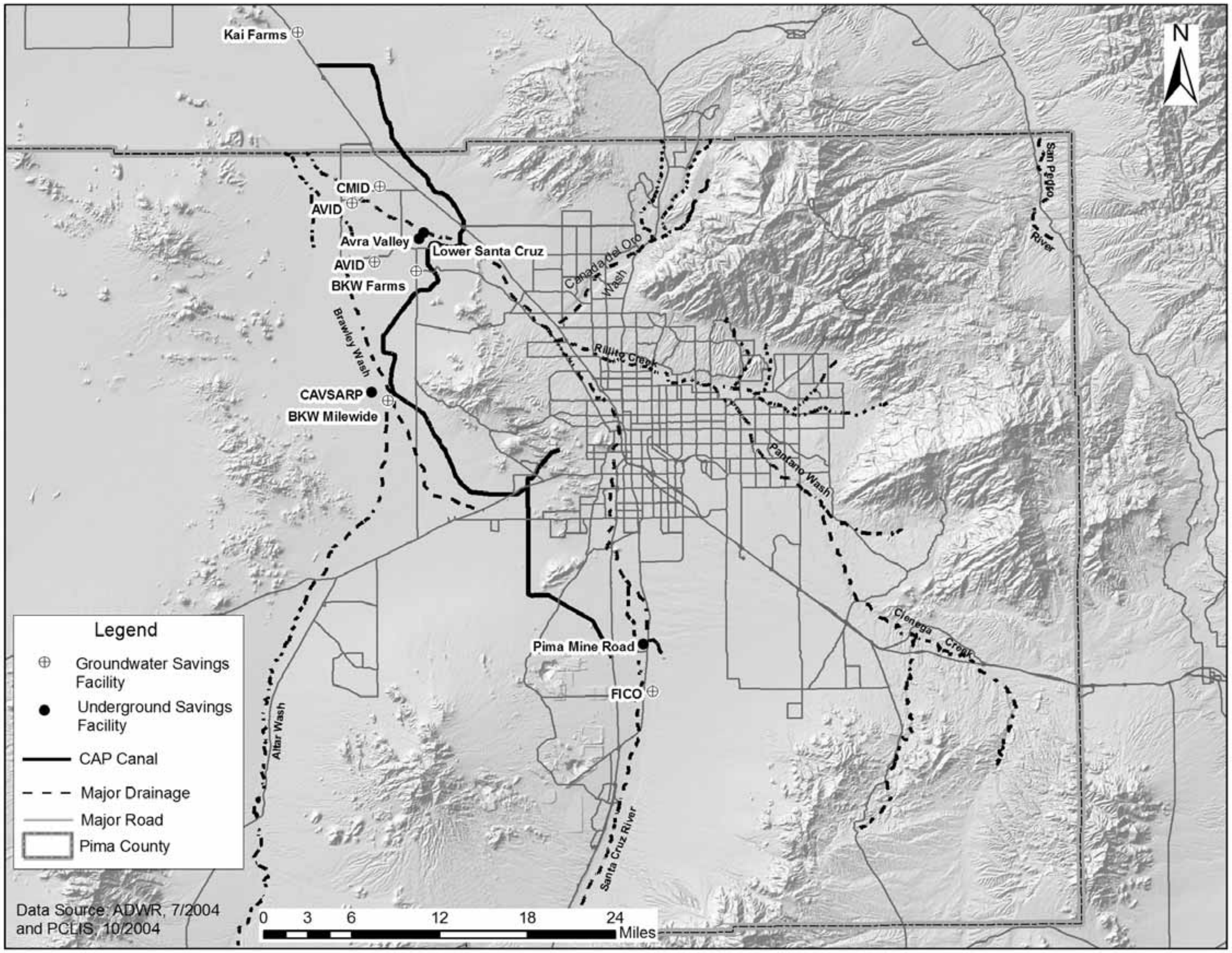


Table 3-5. Permitted USFs and GSFs Using CAP Water in the TAMA
(ADWR, 2003; Kusel, 2005)

Facility Name	*Facility Location*	*Facility Operator(s)*	*Organizations that are permitted to recharge at this facility*	*Permitted Annual Recharge Volume (acre-feet)*	*Cumulative Recharge through December 2003* (acre-feet)*
Lower Santa Cruz Replenishment Project (USF)	Northwest Tucson metro area, west of Tangerine and I-10	CAWCD, Pima County Flood Control District	CAWCD, AWBA, MDWID, Robson Communities, Town of Marana	50,000	108,455
Central Avra Valley Storage and Recovery Project (CAVSARP) (USF)	Avra Valley, west of Saguaro National Park West	City of Tucson	City of Tucson, AWBA	80,000	126,238.0
Avra Valley Recharge Project (USF)	Northwest Tucson metro area, NE of Avra Valley/Sanders Rd Intersection	CAWCD	CAWCD, MDWID, AWBA, Town of Marana	11,000	42,699.2
Pima Mine Road Full-Scale Recharge Project (USF)	South of Tucson metro area, between Santa Cruz River and Old Nogales Highway	CAWCD	CAWCD, City of Tucson, AWBA, Green Valley Water Co.	30,000	82,637.0
Cortaro Marana Irrigation District (GSF)	Western Marana	CMID, conveyed from CAWCD	CAWCD, City of Tucson, Spanish Trail Water Company, Community Water Company of Green Valley, MDWID, Town of Marana, Flowing Wells Irrigation District	20,000	59,347.0
BKW Farms (GSF)	Southwest Marana, near Twin Peaks and Sandario Rds	CAWCD	City of Tucson, AWBA, MDWID	~16,000	64,288.0
Kai Farms – Picacho (GSF)	Southern Pinal County, near Picacho Peak	Herb Kai	MDWID, CAWCD, Spanish Trail Water Company, Town of Oro Valley, City of Tucson, Vail Water Company, AWBA	~11,000	57,371.0

Facility Name	*Facility Location*	*Facility Operator(s)*	*Organizations that are permitted to recharge at this facility*	*Permitted Annual Recharge Volume (acre-feet)*	*Cumulative Recharge through December 2003* (acre-feet)*
Milewide/BKW Farms (GSF)	CAWCD	West of Saguaro National Park West	CAWCD, City of Tucson	~600	1,412.0
Avra Valley Irrigation District (GSF)	Herb Kai	Between Trico and Sanders Rds	MDWID, AWBA, City of Tucson	~12,500	0
Farmers Investment Company (GSF)	Farmers Investment Company	East of I-10/Sahuarita intersection	None	22,000	0

*Does not include the volume of water recovered (if any) from each facility.
*ADWR has not verified 2003 delivery volumes.

While many non-agricultural entities are storing water, Tucson Water is the only CAP contractor in the Tucson AMA currently recovering and using CAP water for potable supply. Through its Central Avra Valley Storage and Recovery Project (CAVSARP), which is a component of the Clearwater Project, Tucson Water recharges CAP water into groundwater basins, recovers the blended water through groundwater wells and distributes it.

3.5.3. Treated wastewater

Treated wastewater, also known as effluent, is used in several ways in Pima County in an effort to conserve groundwater and other potable supplies for uses that require higher quality water. It is used directly, recovered and treated from ongoing recharge projects, and also recharged without any ongoing associated wet-water recovery. Table 3-6 lists the wastewater treatment plants that are permitted to directly re-use effluent for landscape irrigation or construction dust control either onsite or within the associated service area.

Table 3-6. Effluent Use in Pima County (Source: Individual permits, ADEQ, 2005; Pima County WWM, 2002; Chavez, 2005)

Reuse Site/Provider	*Permitted use(s)*
Ina Road Treatment Plant/Tucson Water Service Area	Commercial and residential turf irrigation, agricultural irrigation. Construction dust control. Cooling towers. Public toilet flushing.
Roger Road WWTF	Turf and onsite irrigation
Green Valley Wastewater Treatment Facility/PC	Onsite irrigation
Marana Riparian Habitat Restoration Site/PC	Riparian landscape irrigation
Marana Publicly Owned Treatment Works/PC	Onsite construction dust control and irrigation

Avra Valley Wastewater Treatment Facility/PC	Onsite irrigation
UA Science and Technology Park/IBM Corp	Turf and landscape irrigation. Fire suppression. Toilet flushing. Onsite construction dust control.
Mt. Lemmon Wastewater Treatment Plant/PC	Spray irrigation

In addition to direct use, effluent is recharged into USFs at the Sweetwater Recharge Facilities, Santa Cruz River Managed Underground Storage Facility Project, Lower Santa Cruz River Managed Recharge Project, Marana High Plains Effluent Recharge Project, Robson Ranch Quail Creek, and the Lower Santa Cruz Recharge Project. Refer to Figure 3-5c for their locations. Tucson Water operates the Sweetwater Recharge Facilities on the west and east banks of the Lower Santa Cruz River. The U.S. Bureau of Reclamation and the City of Tucson jointly operate the Santa Cruz River Managed Underground Storage Facility, where effluent-dependent surface water is recharged in-channel to diverse riparian habitat along a river reach that would otherwise be ephemeral. The effluent originates from upstream wastewater treatment facilities. Marana High Plains is a pilot effluent recharge project located northwest of the Marana Airport. It is permitted to recharge up to 600 acre-feet of effluent-dependent surface water per year into off-channel constructed basins. Robson Ranch Quail Creek is located along the Upper Santa Cruz in the southern half of the Tucson AMA. It is permitted to recharge up to 2,240.3 acre-feet of effluent per year in basins. The Lower Santa Cruz River Managed Recharge Project is an in-channel recharge project permitted to recharge up to 43,000 acre-feet of effluent per year. Table 3-7 indicates the cumulative volume of effluent stored at each USF as of December 2003. In the Sweetwater Recharge Facilities entry, the reported volume does not reflect recovery volumes.

Table 3-7. Cumulative Effluent Recharge Volumes in Tucson AMA USFs, December 2003 (Kusel, 2005)

Recharge Facility	*Total Recharge Volume* (acre-feet)*
Sweetwater Recharge Facilities	50,121.9
Santa Cruz Managed	24,718.8
High Plains	277.4
Robson Quail Creek	103.5
Lower Santa Cruz Managed	2,074.5

*Does not include the volume of water recovered (if any) from each facility.
*ADWR has not verified 2003 delivery volumes.

Table 3-8 lists the entities and their rights to effluent that is discharged from the large, metropolitan wastewater treatment plants (i.e., Roger Road Wastewater Treatment Plant, Ina Road Water Pollution Control Facility and Randolph Park Wastewater Reclamation Facility), as outlined in the 2000 IGA between the City of Tucson and Pima County. Pima County and the City of Tucson are currently discussing the interpretation of the IGA with regard to the definition of what constitutes a metropolitan wastewater treatment plant. There have also been subsequent IGAs between the City of Tucson and other entities regarding effluent rights.

Figure 3-5c. Treated Wastewater Resources in Eastern Pima County

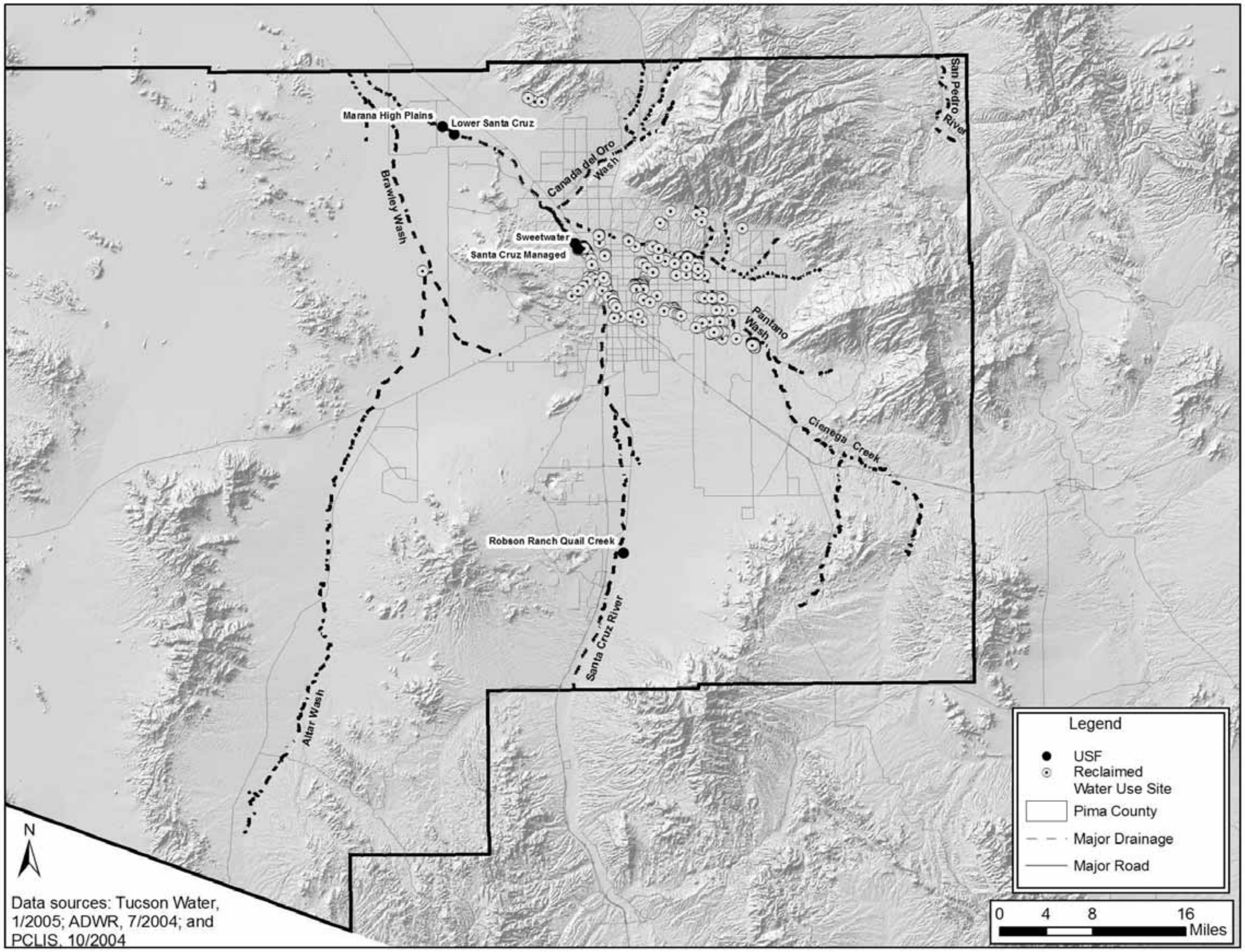


Table 3-8. Annual Effluent Rights to Wastewater Discharged from Tucson Metropolitan Wastewater Treatment Plants (City of Tucson and Pima County, 2000)

Entity	*Volume (acre-feet)*
Secretary of Interior (SAWRSA settlement)	28,200
Conservation Effluent Pool*	5,000
Pima County	10% of remaining effluent
Tucson Water	Remaining effluent

*Can increase to 10,000 acre-feet and above if negotiated.

Table 3-9 indicates the actual effluent distribution volume from metropolitan facilities in 2003, and the entities entitled to use it. Effluent produced by the metropolitan treatment plants that is not used directly or for recharge, is discharged into the Santa Cruz River.

Table 3-9. Local Effluent Entitlements in 2003 (Tucson Water, 2004)

Entity	*Volume (acre-feet)*
Tucson	30,739
Secretary of Interior	28,200
Pima County	3,986
Metropolitan Domestic Water Improvement District	3,074
Oro Valley	2,062
TOTAL Produced by metropolitan treatment plants	68,061

3.5.4. Surface water

There is currently very little perennial surface water in Pima County. The vast majority of the watercourses in Pima County are ephemeral, where flows consist solely of stormwater runoff. In contrast, the number of perennial[1] and intermittent[2] watercourses is relatively small, but the surface water in these water bodies is very important habitat for terrestrial and aquatic species.

The identified perennial and intermittent streams of Pima County are in a variety of locations and environments, and most are located in eastern Pima County as indicated in Figure 3-5d. Thirty-eight streams that had perennial or intermittent reaches had flows that originated in the Santa Catalina, Rincon or Santa Rita Mountains (PAG, 2000a). Forty-six perennial stream reaches and 97 intermittent stream reaches from a total of 86 different streams have been identified in Pima County.

Table 3-10. Perennial Streams in Pima County

Reach Name	*Reach Name*
Apache Spring	Montosa Canyon
Arivaca Creek	Nogales Spring
Bingham Cienega	Posta Quemada
Buehman Canyon (3 reaches)	Quitobaquito Spring
Bullock Canyon	Romero Canyon
Canada del Oro	Ruelas Canyon
Cienega Creek (9 reaches)	Sabino Creek (3 reaches)
Cinco Canyon	San Pedro River (2 reaches)
Davidson Canyon	Santa Cruz River

[1] A perennial stream is one that flows continuously, except possibly during times of severe drought.
[2] An intermittent stream is one that flows only at certain times of the year when it receives water from springs or from some surface source such as melting snow in mountainous areas.

Reach Name	*Reach Name*
Edgar Canyon	Scholefield Spring
Empire Gulch (2 reaches)	Simpson Spring
Espiritu Canyon (2 reaches)	Tanque Verde (upper)
Honey Bee Canyon	Wakefield Canyon (3 reaches)
Lemmon Creek	Wild Burro Canyon (4 reaches)
Little Nogales Spring	Wild Cow Spring
Mattie Canyon	Youtcy Canyon (2 reaches)

Two of the perennial stream reaches, Cienega Creek (from I-10 to the USGS gauge station at Pantano Wash) and Buehman Canyon (from headwaters, 9.8 miles downstream), are classified as “Unique Waters” by ADEQ, which means they are outstanding state resource waters and subject to stricter water quality regulations. Both reaches are indicated on Figure 3-5d. Downstream of the Unique Waters reach of Cienega Creek, water is diverted for golf course turf irrigation.

Table 3-11. Intermittent Streams in Pima County

Reach Name	*Reach Name*
Agua Caliente Wash	La Milagrosa Canyon
Agua Verde Creek	Madera Canyon
Alder Canyon	Madrona Canyon
Arivaca Creek (2 reaches)	Mattie Canyon
Ash Creek	Miller Creek
Atchley Canyon	Molino Canyon
Barrel Canyon	Mud Spring Canyon
Batamote Wash	Oro Blanco Wash
Bear Canyon (2 reaches)	Paige Creek (2 reaches)
Bear Creek	Palisade Canyon Creek
Bear Grass Tank	Peck Basin
Bolt Canyon	Pima Canyon
Bootlegger Spring	Rincon Creek
Box Canyon (Rincon)	Romero Canyon (2 reaches)
Brown Canyon	Rose Canyon Creek
Buehman Canyon (2 reaches)	Sabino Canyon
Bullock Canyon (3 reaches)	San Luis Wash
Canada Agua Canyon	San Pedro River (3 reaches)
Canada del Oro	Santa Cruz River (2 reaches)
Cargodera Canyon	Shaw Canyon
Chiminea Canyon	Smitty Spring
Chimney Canyon	Soldier Canyon
Cienega Creek (8 reaches)	Sutherland Wash
Davidson Canyon (3 reaches)	Sycamore Canyon
Deer Creek	Tanque Verde Creek (5 reaches)
Distillery Canyon	Thomas Canyon
East Fork Sabino Canyon	Turkey Creek
Enchanted Hills Wash	Unnamed Spring

Reach Name	*Reach Name*
Espiritu Canyon	Unnamed Spring
Finger Rock Canyon	Unnamed Springs
Fish Canyon	Unnamed tributary to Ash Creek
Florida Canyon	Ventana Canyon (3 reaches)
Gardner Canyon	Wakefield Canyon (2 reaches)
Geesaman Wash	West Fork Sabino Creek
Kings Canyon	Youtcy Canyon (2 reaches)

The primary surface water drainage in eastern Pima County is the Santa Cruz River. The river, which is approximately 60 miles long within Pima County, flows north through the Upper Santa Cruz Valley Subbasin and then northwest into the Avra Valley Subbasin. The river is mostly ephemeral in Pima County (ADWR, 1999).

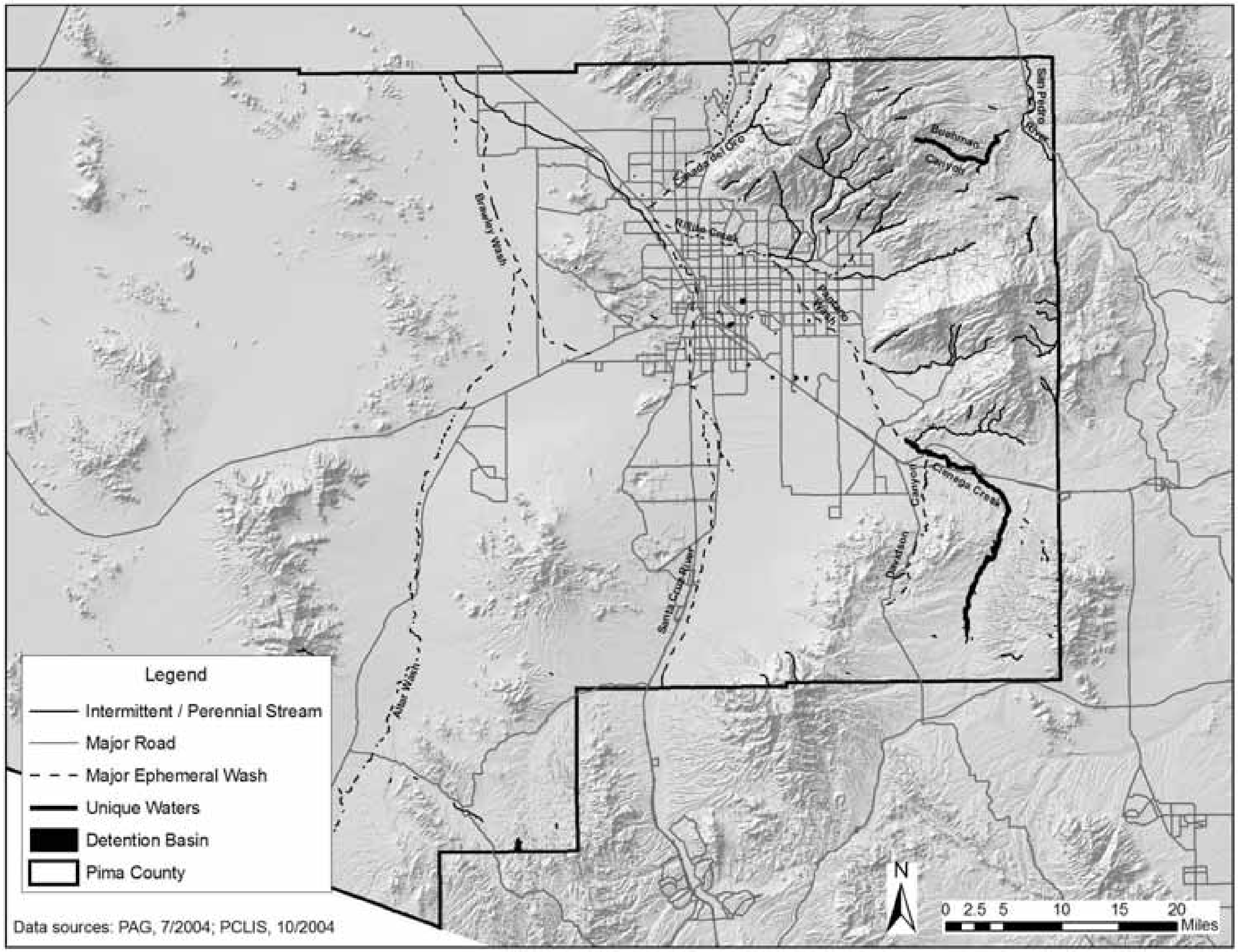
Major tributaries of the Santa Cruz River in the Upper Santa Cruz Valley Subbasin include the Canada del Oro, which drains the northern part of the Upper Santa Cruz Valley Subbasin, and Rillito Creek and its tributaries, which drain the area north and east of Tucson. Tributaries to Rillito Creek include Pantano Wash and Tanque Verde Creek. Pantano Wash receives flow from Rincon Creek and Cienega Creek. Tanque Verde Creek receives flow from Sabino Creek. In the Avra Valley Subbasin, Altar Wash originates in the southern part of the valley and flows north to become Brawley Wash. Brawley Wash flows to the north and northwest through Avra Valley to its confluence with the Santa Cruz River southwest of Red Rock.

The San Pedro River is a tributary of the Gila River and drains 4,485 square miles of Arizona and Mexico. The San Pedro River enters the northeastern corner of Pima County in what is considered the Lower San Pedro Basin. The river is fed by flow from the northeast side of the Santa Catalina Mountains and by two significant drainages from the Galiuro Mountains. Most of the stream reaches on the San Pedro are intermittent, but in the area around Bingham Cienega there is perennial flow (Royayne and Maddock III, 1996).

Tributaries to the Lower Gila River flow south to north to drain the western third of Pima County. These include Alamo Wash, Cherioni Wash, Chico Shunie Arroyo, Cuerda de Lena, Daniels Arroyo, Darby Arroyo, Gibson Arroyo, Growler Wash, Gunsight Wash, Kuakatch Wash, Rio Cornez, San Cristobal Wash, Sikort Chuapo Wash, and Tenmile Wash.

The San Simon Wash watershed drains the Tohono O'odham Nation, and runs northeast to southwest.

Figure 3-5d. Surface Water Resources in Eastern Pima County

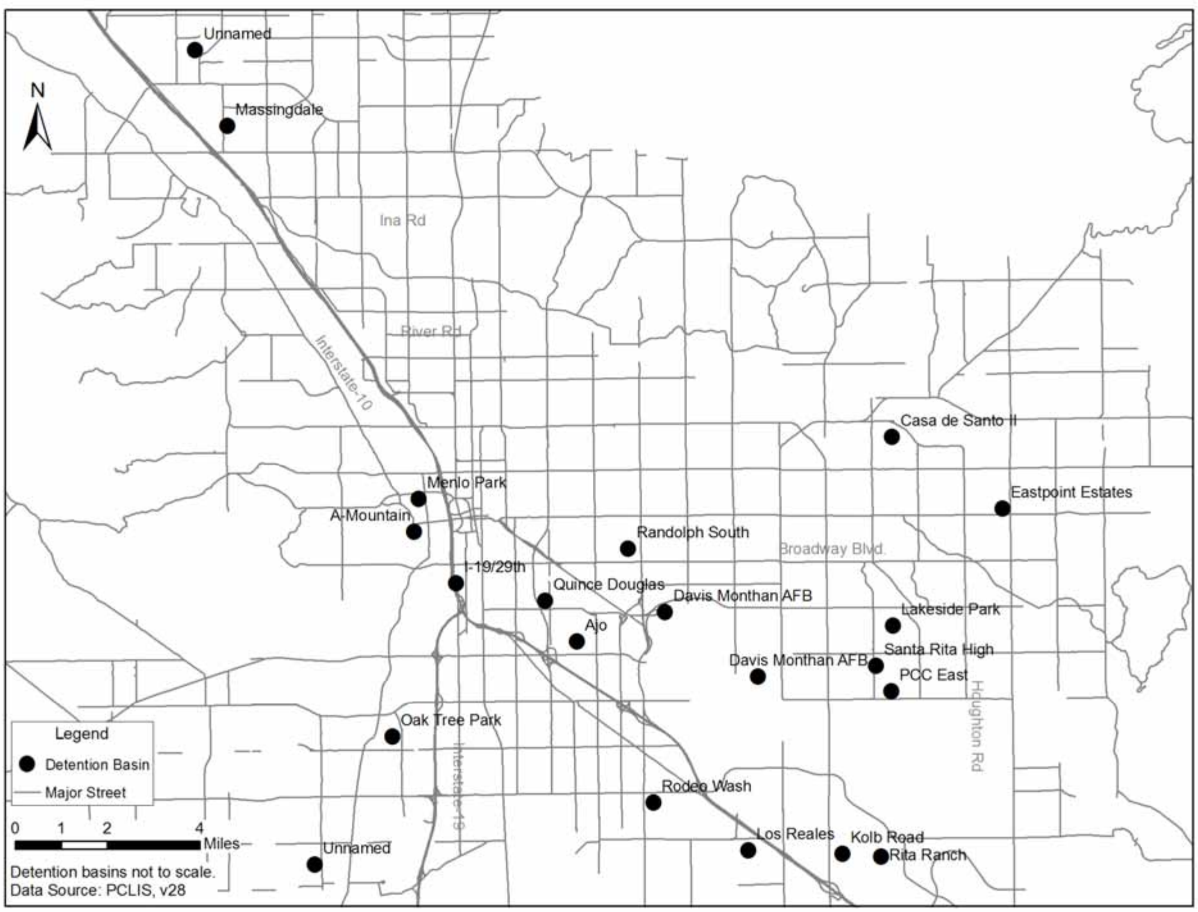


3.5.5. Stormwater runoff

Overland flow from winter precipitation events is an important source of recharge to the aquifers in Pima County. Groundwater conditions can be greatly affected by occasionally large overland flow events in the Santa Cruz River and its tributaries. Surface water flows recharge the shallow groundwater system as water infiltrates through stream channel sediments to the underlying aquifer. Stream channel recharge in the Upper Santa Cruz Valley Subbasin is estimated at 31,000 acre-feet per year and in the Avra Valley Subbasin at approximately 6,700 acre-feet per year (ADWR, 1999).

In addition to aquifer recharge, stormwater serves other purposes as well. It supports riparian vegetation along washes, and can support aquatic habitats in retention basins. For example, the Ajo Detention Basin recently has been reconfigured to utilize stormwater for onsite turf irrigation and wetland habitat. The City of Tucson and Pima County maintain several other detention basins, as indicated on Figure 3-5e. In addition, stormwater has been considered a potential source water for artificial groundwater recharge projects in Pima County. Since 1999, the City of Tucson Land Use Code requires rainwater harvesting to supplement outdoor irrigation for new and expanding commercial developments and City projects (City of Tucson, 2004).

Figure 3-5e. Stormwater Detention Basins in Eastern Pima County



3.6. WATER QUALITY

3.6.1. Groundwater quality

In general, groundwater in the Tucson AMA is of acceptable quality for most uses. In most cases, the minimum detectable level of a constituent is well below the U.S. EPA's regulatory limit for that constituent (Tucson Water, 2000a). A review of water quality data from Pima County drinking water providers for the 1998-2000 sampling years indicated the most common regulated constituents detected were nitrate, fluoride, arsenic and chromium (PAG, 2002a). Though these constituents were detected in drinking water supplies, none were seen at levels that exceeded the established drinking water maximum contaminant levels (MCL). Groundwater withdrawals from wells within these identified areas have been discontinued or are in the process of remediation. Other areas of known contamination not currently under remediation are monitored to ensure that contaminants do not spread (ADWR, 1999).

3.6.1.1. Water quality data from water providers and other sources

Most existing groundwater quality data for Pima County is representative of eastern Pima County, because more groundwater development has occurred there. Concentrations of selected constituents in eastern Pima County groundwater are shown on Table 3-12. The data are from Tucson Water's wellfields, which encompass large areas of the Tucson and Avra Valley basins. Groundwater quality data from the Upper Santa Cruz River basin are on Table 3-13.

Table 3-12. Concentrations of Selected Constituents In Tucson-Area Groundwater, 2003-2004 (Tucson Water, 2004a)

Parameter	*Tucson Supply Source*				
	Clearwater	*Avra Valley Wells*	*Santa Cruz Wells*	*Central Wells*	*South Side / TARP*
Fluoride, mg/L F	0.52	0.41	0.85	0.26	0.61
Hardness, mg/L CaCO3	119	77	216	125	175
Nitrate as Nitrogen, mg/L N	1.34	1.91	4.02	1.92	2.03
Sodium, mg/L Na	50	37	46	37	57
Total Dissolved Solids (TDS), mg/L	298	209	435	305	In Progress
pH, Std. Units	7.79	7.69	7.45	7.49	7.76

"In Progress" indicates that the data is under development and will be included on the table as the data becomes available.

Table 3-13. Upper Santa Cruz Basin Groundwater Quality Data Summary (PAG, 2002)

Constituent	*No. of Samples*	*Maximum*	*Minimum*	*Mean*	*No. Exceeding Standard*[1]
TDS (mg/L)	65	2000	170	580	30 (*500 mg/L)
Sulfate (mg/L)	70	1100	3.5	230	13 (*250 mg/L)
Nitrate (mg/L)	76	20	ND	4.4 [2]	7 (10 mg/L as N)
Arsenic (mg/L)	49	0.046	ND	n/a [3]	10 (0.01 mg/L) [4]
Hardness (mg/L)	67	1317	27	283	(no standard)

1 National Primary and Secondary Drinking Water Standards are shown in parentheses. Secondary standards are unenforceable guidelines and are noted with an *.
2 Calculation of mean included one non-detect treated as zero mg/L.
3 Mean not calculated due to numerous non-detect values and varying minimum detection levels.
4 Standard is not in effect yet.

Arsenic in groundwater in the Tucson Water well fields was measured during 2000. Six of the 162 points of entry (POE) tested had maximum arsenic concentrations greater than or equal to 9.0 μg/l, with the highest maximum value of 24 μg/l found at one site. Fifty-six of the POEs had maximum arsenic values of less than 2.0 μg/l (Tucson Water, 2004b). Public water systems must comply with a new arsenic drinking water standard of 10 μg/l beginning January 23, 2006

In the 1970s and 1980s groundwater studies were conducted in western Pima County by the USGS (Carruth, 1996). Samples from three groundwater sources, Bonita Well, Pozo Salado Well, and Quitobaquito Spring, all located within the Organ Pipe Cactus National Monument, indicated that the major-ion chemistry is similar to chemistry of groundwater in other alluvial basins in southern Arizona (Robertson, 1991). The upgradient well, Bonita Well, had dissolved solids measured at 338 mg/L and fluoride at 0.4 mg/L. Readings for pH ranged from 7.4 in the upgradient well to 8.4 in the downgradient well. Dissolved solids and fluoride also increased from the upgradient well to the downgradient site and ranged from 338 mg/L to 1,500 mg/L and 0.4 mg/L to 5.4 mg/L respectively (Carruth, 1996).

3.6.1.2. Areas of groundwater quality degradation

Land uses that have reportedly led to historic groundwater contamination in eastern Pima County include landfills and disturbed areas, irrigated agriculture, animal impoundments, underground storage tanks, surface impoundments, wastewater treatment facilities, mines, and industry and commerce (PAG, 1994a). Common groundwater contaminants in Tucson area groundwater include volatile organic compounds (VOC), nitrates, petroleum hydrocarbons, and heavy metals.

Federal and state programs have been established to remediate contaminated groundwater and soil.

3.6.1.2.1. Federal Superfund/CERCLA sites

The Tucson International Airport Area (TIAA) is the only federal Superfund site in Pima County. It was listed in 1983. The TIAA project is made up of several smaller projects, including the Raytheon/Air Force Plant 44, Tucson Airport Remediation Project (TARP), Airport Property Soils and Shallow Groundwater Zone, Arizona Air National Guard 162nd, Texas Instruments (formerly Burr-Brown), West Cap Property, and the West Plume B (ADEQ, 2004b). Groundwater in the area is primarily contaminated with trichloroethylene (TCE). Other contaminants include tetrachloroethylene (PCE), dichloroethylene (1,1-DCE), chloroform, benzene and chromium (EPA, 2004). Several pump and treat remediation systems has been in operation, and have cumulatively removed approximately 25,000 pounds of VOCs as of September 2004 (EPA, 2004).

3.6.1.2.2. State WQARF sites

The Arizona Water Quality Assurance Revolving Fund (WQARF) was created under the Environmental Quality Act of 1986 to support hazardous substance cleanup efforts in the state. ADEQ identifies sites that are most in need of cleanup and adds them to the WQARF Registry. Sites on the Registry receive first consideration for distribution of funds for water quality monitoring, health and risk assessment studies and remediating hazardous substances that may impact state waters. There are several groundwater and subsurface contamination sites in Pima County that are currently monitored or remediated under the State WQARF program. The following table details WQARF sites in Pima County. Soil and groundwater monitoring is ongoing at all of the WQARF sites.

Table 3-14. WQARF Sites in Pima County (ADEQ, 2004b)

Site	*Location*	*Registry Date*	*Primary Contaminants*	*Contaminant Sources/Land Use*	*Remedial Actions*
7th Street and Arizona Avenue	Downtown Tucson	2000	PCE, TCE, cis-1,2-dichloroethene (cis-1,2-DCE)	Former solvent, heating oil, waste oil USTs; former dry cleaning business (1957-1989)	Site assessments
Broadway-Pantano	East-Central Tucson	1998	PCE, TCE, cis-1,2-dichloroethene, vinyl chloride, and methylene chloride, arsenic	Former municipal landfill (1960-1971), buried metal waste	Soil vapor extraction system, fenced off dross site, pump and treat with granular activated carbon and reinjection
El Camino del Cerro	Northwest Tucson	1998	PCE, TCE, 1,1-dichloroethene (1,1-DCE), vinyl chloride, and benzene	Former municipal landfill, former oil recycling plant	Landfill gas extraction systems
Los Reales Landfill	Southeast Tucson	1999	PCE, TCE	Active municipal landfill	Pump and treat via air stripping, soil vapor extraction, use of landfill gas as TEP energy source, reinjection and reuse of treated water
Miracle Mile	West Tucson	1998	TCE, chromium	Unknown	Site assessment, remedial system design
Park-Euclid	Downtown Tucson	1999	Diesel free product, PCE, TCE, cis-1,2-DCE	Dry cleaning facilities	Soil vapor extraction
Shannon Road-Rillito Creek	West Tucson	1999	PCE and other VOCs	Possibly former landfill (El Camino del Cerro)	Wellhead treatment, on-going site assessments
Silverbell Landfill	West Tucson	1999	PCE, TCE, cis-1,2-DCE, vinyl chloride	Former landfill (1966-1977)	Air injection, soil vapor extraction

3.6.1.2.3. Other areas

In addition to the above sites, there are a number of sites where land uses have impacted the local groundwater. For example, groundwater under downtown Tucson is contaminated with diesel fuel (PAG, 1992). Also, an area encompassing 42 square miles in the upper Santa Cruz River area, which extends from two miles south of the Tucson City limit to just north of Green Valley, contains seven public supply wells that have exceeded the MCL for nitrate. Historical data indicate the high nitrate concentrations in this area occurred between the late 1940s and the mid-1960s, apparently as a result of irrigated agriculture, sewage effluent, septic tanks and animal feed lots (PAG, 1992). Sampling conducted between 1997 and 2002 indicated high

TDS, sulfate, and hardness concentrations near tailings ponds associated with mining activities southwest of the Tucson metropolitan area (PAG, 2002). Groundwater and soil contamination at the Davis Monthan Air Force Base results from a 1985 jet fuel spill. A soil vapor extraction system was installed in 1994, and continues to remove VOCs. Soil and groundwater monitoring is on going at the on-site former landfill and at the off-site former Titan Missile Silo (ADEQ, 2004c).

3.6.2. CAP water quality

The CAP water delivered to the Tucson area is a mixture of mostly water from the Colorado River, with some water from the Bill Williams River and the Agua Fria River. It is a sodium-sulfate water type meeting all primary drinking water standards established by the EPA and ADEQ with the exception of turbidity and total coliform bacteria (Tucson Water, 2000b). Analytical results for common constituents for all CAP water samples collected at the pump station at the CAP aqueduct (Tucson Water sample point 713) between October 1997 and April 2000 are summarized on Table 3-15. The data were collected by Tucson Water, which conducts extensive monitoring of CAP water delivered to CAVSARP.

Table 3-15. Summary of Water Quality for Untreated CAP Water at the Clearwater Site, October 1997-April 2000 (Tucson Water, 2000b)

Constituent	*Mean*	*Std. Dev.*	*Min.*	*Max.*	*MCL*	*No. of samples*
Calcium (mg/L)	66	4.53	56	75	-	14
Magnesium (mg/L)	28	3.05	26	38	-	14
Potassium (mg/L)	5.0	0.76	4.5	7.5	-	14
Sodium (mg/L)	92	12.8	85	135	-	14
Bicarbonate* (mg/L)	133	24.4	70	156	-	18
Bromide (mg/L)	@0.015	0.041	<0.1	0.14	-	13
Chloride (mg/L)	82	13.2	72	123	-	13
Sulfate (mg/L)	248	30.5	227	348	-	13
Nitrate (as Nitrogen) (mg/L)	@0.0077	0.0277	<0.025	0.1	10	13
Fluoride (mg/L)	0.313	0.051	0.24	0.44	4	13
Orthophosphate (as Phosphorus) (mg/L)	<0.3	0	<0.3	<0.3	-	11
Bicarbonate alkalinity (as mg/L $CaCO_3$)	109	20	57	128	-	18
Total Alkalinity, calculated (as mg/L $CaCO_3$)	129	16.6	84	148	-	11
TDS (mg/L)	603	48	566	712	-	14
Hardness, calculated (as $CaCO_3$)	280	12.6	261	303	-	13
pH	8.34	0.43	7.70	9.37	-	16
Electrical Conductivity at field temp (µmho/cm)	949	58.6	880	1010	-	4
Temperature (Celsius)	22.6	5.1	10.6	32.1	-	16
Aluminum (mg/L)	<0.1	0	<0.1	<0.1	-	5
Arsenic (mg/L)	@0.0023	0.0015	<0.002	0.0057	0.05	14
Barium (mg/L)	0.105	0.0102	0.095	0.13	2	14
Boron (mg/L)	0.131	0.0213	0.12	0.2	-	14
Iron (mg/L)	@0.072	0.120	<0.02	0.38	-	9
Lead (mg/L)	@0.0051	0.017	<0.002	0.064	0.015	14
Selenium (mg/L)	<0.005	0	<0.005	<0.005	0.05	12
Silicon (mg/L)	3.9	0.71	2.5	5.2	-	13

Constituent	Mean	Std. Dev.	Min.	Max.	MCL	No. of samples
Zinc (mg/L)	@0.052	0.093	<0.02	0.31	-	10
Total Trihalomethane (ug/L)	<0.5	0	<0.5	<0.5	100	17
Haloacetic acids (ug/L)	<3	0	<3	<3		5
Total Coliform MPN-CFU/100mL	@60	101	<2	300	-	8
TOC (ug/L)	3.3	0.32	2.7	3.81	-	18
Radon (pCi/l)	<22	-	<22	<22	-	1
Perchlorate (ug/L)	@0.0066	0.005	<0.004	0.014	-	6

Source: Sample point 713 (CAP Aqueduct M.P. 308.175)
*Bicarbonate concentration- 1.22 times the results of bicarbonate alkalinity reported above.
µmho/cm- micromhos per centimeter
MPN/100 ml- most probable method; results given in colony forming units (CFU) per 100 milliliters
< less than; constituent not detected above the laboratory reporting limit
@- Constituent was not detected above the laboratory reporting limit in some or all of the samples included in calculation

CAP water quality is also monitored at the Pima Mine Road Recharge Project. Analytical results of the source water samples did not indicate the presence of any analyte at concentrations exceeding the Arizona Aquifer Water Quality Standards (AWQS). No pesticides or herbicides were detected above the laboratory reporting limits. Results of the general minerals, and physical parameters (except temperature), were remarkably consistent among the three sampling periods conducted in 2000 (CAWCD, 2001). Results of the source water samples for mineral and physical parameters are shown on Table 3-16.

Table 3-16. Pima Mine Road Recharge Project Source Water Quality Monitoring Results (CAWCD, 2001)

Parameter	Units	AWQS limit	01/06/2000 Results	03/03/2000 Results	10/19/2000 Results
Alkalinity, total	mg/L		109	110	104
Alkalinity, Bicarbonate	mg/L		133	133	126
Alkalinity, Carbonate	mg/L		0.864	1.72	1.30
Chloride	mg/L		76.3	72.2	88.7
Fluoride	mg/L	4	0.32	0.31	0.36
Nitrate (as N)	mg/L	10	ND	ND	ND
pH	Std unit		8.0	8.3	8.2
Specific Conductance	Us/cm		915	855	905
Sulfate	mg/L		253	236	267
Total Dissolved Solids	mg/L		530	530	650
Temp (field)	°F		65.5	74.1	nm
Aluminum, dissolved	mg/L		ND	ND	ND
Antimony, dissolved	mg/L	0.006	ND	ND	ND
Arsenic, dissolved	mg/L	0.05	0.0045	0.0025	0.004
Barium, dissolved	mg/L	2	0.066	0.091	0.105
Beryllium, dissolved	mg/L	0.004	ND	ND	ND
Cadmium, dissolved	mg/L	0.005	ND	ND	ND
Calcium	mg/L		120*	68	62
Chromium, dissolved	mg/L	0.1	ND	0.0041	ND
Copper, dissolved	mg/L		ND	0.0037	0.021
Iron, dissolved	mg/L		ND	ND	ND
Lead, dissolved	mg/L	0.05	0.019	ND	0.66
Magnesium	mg/L		18.1*	29	31
Mercury, dissolved	mg/L	0.002	ND	ND	ND

Parameter	Units	AWQS limit	01/06/2000 Results	03/03/2000 Results	10/19/2000 Results
Nickel, dissolved	mg/L	0.1	ND	0.005	ND
Potassium	mg/L		3.5*	4.1	5.5
Selenium, dissolved	mg/L	0.05	ND	ND	ND
Silver, dissolved	mg/L		ND	ND	ND
Sodium, dissolved	mg/L		51.5*	84	100
Thallium, dissolved	mg/L	0.002	ND	ND	ND
Zinc, dissolved	mg/L		0.14	0.015	0.088
TOC	mg/L		0.9	2.8	3

nm=not measured

* results are questionable for these analytes, laboratory results appear to have been switched with another sample but could not be confirmed by the laboratory.

3.6.3. Treated wastewater quality

The Roger Road Wastewater Treatment Facility and the Ina Road Water Pollution Control Facility (WPCF) are required to monitor wastewater discharge (i.e., secondary effluent) for a number of parameters to comply with NPDES (1999) and Aquifer Protection Permits (2001). The data collected from the County's monitoring have been summarized in several previous studies, including those by PAG (1994, 1996) and Malcolm Pirnie (1994). In addition, more recent monitoring data included on Tables 3-17 and 3-18 indicate that the effluent water quality is well within the current NPDES and APP permit limits.

Table 3-17. Roger Road Wastewater Treatment Facility Discharge Monitoring Report, 2000 (Pima County WWM, 2001)

Constituent (Units)*	Permit Limit	1st Quarter Averages Jan- Mar	2nd Quarter Averages Apr-June	3rd Quarter Averages July-Sept	4th Quarter Averages Oct-Dec
Flow (MGD)	Up to 41	26.3	23.2	28.0	29.2
Suspended Solids (Kg/day)	4,654	2,217	2,090	1,470	2,247
Suspended Solids (mg/L)	45	25	30	16	23.5
Fecal Coliform (#/100ml)	200	4	16	35	12
pH	6.5 - 9.0	7.6	7.6	7.6	7.6
Disinfectant Residual (mg/L)	0.5	0.22	0.07	0.15	0.09

Table 3-18. Ina Road Water Pollution Control Facility Discharge Monitoring Report, 2000 (Pima County WWM, 2001)

*Constituent (Units)**	*Permit Limits*	*1st Quarter Averages Jan- Mar*	*2nd Quarter Averages Apr-June*	*3rd Quarter Averages July-Sept*	*4th Quarter Averages Oct-Dec*
Flow (MGD)	Up to 25	22.5	23.1	22.1	24.3
Suspended Solids (Kg/day)	2,839	1,516	1,398	1,151	2103
Suspended Solids (mg/L)	45	19	18	16	31
Fecal Coliform (#/100ml)	200	5	14	31	28
pH	6.5 - 9.0	7.1	7.1	7.2	7.2
Disinfectant Residual (mg/L)	0.5	0.30	0.44	0.15	0.35

Tables 3-19 and 3-20 list compounds that were detected in the quarterly monitoring during 2000.

Table 3-19. Quarterly Priority Pollutant Organic Compounds Detected in Effluent from Ina Road WPCF, 2000 (Pima County WWM, 2001)

Parameter	*Detected Samples*	*Mean – Max. µg/L*
Chloroform	4 of 4	1.6- 2.0
1,4-Dichlorobenzene	4 of 4	4.0-6.4
Methylene Chloride	4 of 4	<1.0-1.02
Tetrachloroethylene	1 of 4	<0.5
Toluene	2 of 4	<0.32-<0.5
Diethyl phthalate	1 of 4	<5
Bis(2-ethylhexyl)phthalate	4 of 4	14.7-34.8

Table 3-20. Quarterly Priority Pollutant Organic Compounds Detected in Effluent from Roger Road WWTF, 2000 (Pima County WWM, 2001)

Parameter	*Detected Samples*	*Mean-Max. µg/L*
Chloroform	4 of 4	<0.81-1.32
1,4-Dichlorobenzene	2 of 4	<1-<5
Methylene Chloride	4 of 4	<1.41-1.63
G-BHC(gamma)	1 of 4	0.38
Toluene	3 of 4	<0.41-<0.5
Bis(2-ethylhexyl)phthalate	2 of 4	<7.1-16.3
Pentachlorophenol	1 of 4	<10.0

Table 3-21 shows results from effluent sampling for metals at the Roger Road and Ina Road wastewater treatment facilities in 2000.

Table 3-21. Priority Pollutant- Metals, Quarterly Sampling for 2000 (Pima County WWM, 2001)

Parameter (mg/L)	*Ina Road WPCF 12 month mean*	*Ina Road WPCF 12 month max*	*Roger Road WWTP 12 month mean*	*Roger Road WWTP 12 month max*
Antimony	<0.0021	<0.0037	<0.0021	<0.0037
Arsenic	<0.0039	<0.0080	<0.0081	<0.0100
Beryllium	<0.0009	<0.0013	<0.0007	<0.0013
Cadmium	<0.0006	<0.0008	<0.0018	<0.0050
Chromium	<0.0054	0.0134	<0.0065	0.0188
Copper	0.0256	0.0270	0.018	0.025
Cyanide	<0.008	<0.015	<0.005	<0.005
Lead	<0.0019	<0.0050	<0.0019	<0.0050
Mercury	<0.000026	<0.000026	<0.000026	<0.000026
Molybdenum	<0.0066	<0.0079	0.0207	0.0251
Nickel	<0.0029	<0.0050	0.0050	0.0058
Selenium	<0.0022	<0.0038	<0.0022	<0.0038
Silver	<0.0015	<0.0019	<0.0036	<0.0050
Thallium	<0.0017	<0.0047	<0.0017	<0.0047
Zinc	0.0377	0.0434	0.0346	0.0394

Under a state wastewater reuse permit the reclaimed water produced at the Ina and Roger Road wastewater treatment plants is monitored for flow, turbidity, fecal coliform, pH, enteric virus and *Ascaris lumbricoides* (Dotson, 2001). Water is sampled at a point that is representative of the quality of water received by the reclaimed water customers. The reclaimed water has a higher TDS concentration than secondary effluent. This is due in part to mixing with groundwater at the Sweetwater Underground Storage and Recovery facility, where background TDS levels are higher than most Tucson Water wellfields (PAG, 1994). Tables 3-22 and 3-23 present data provided by Tucson Water for this sample point. All of the data are within permitted limits.

Table 3-22. Tucson Water Reclaim System Water Quality, January – July 2001 (PAG, 2002a)

Constituent	*Average*	*No. of Samples*
Total Dissolved Solids	657 mg/L	6
Total Kjeldahl Nitrogen	10.09 mg/L	6
Total Organic Carbon	7.75 mg/L	6
Total Suspended Solids	1.6 mg/L*	7
Turbidity	3.28 NTU	6
Ammonia as N	6.29 mg/L	6
Nitrate as N	3.87 mg/L	7
Chloride	107.43 mg/L	7
pH	7.7 su	6
Conductivity	1012.66 umhos/cm	6
Fluoride	0.9	7
Potassium	8.2 mg/L	2
Phosphate as P	1.52 mg/L	6
Sulfate	120.8	7
Calcium	59.5	2
Total Alkalinity	247	3
Sodium	130 mg/L	2

*- This value calculated using a value of zero for one sample with a result of <1.

Samples collected on January 4, 2001, and April 12, 2001, also were analyzed for VOCs and metals. In general these constituents were only detected at levels less than the lowest standard or quantification limit of the method. Aluminum, arsenic, barium, boron, copper, iron, magnesium, nickel and zinc were all present at detectable levels, but below permit limits. The results of the two samples are listed on Table 3-23.

Table 3-23. Analytical Results for Reclaimed Water Quality (PAG, 2002a)

Constituent (mg/L)	*1/4/01*	*4/12/01*
Aluminum, Total	<.1	0.12
Arsenic, Total	0.0038	0.0055
Barium, Total	0.033	0.031
Boron, Total	0.3	0.29
Copper, Total	0.015	<0.01
Iron, Total	0.11	0.084
Magnesium, Total	10	9.9
Nickel, Total	0.013	<0.01
Zinc, Total	0.026	0.039

3.6.4. Surface water quality

ADEQ conducts long-term, statewide water quality monitoring, while other agencies and organizations conduct water quality monitoring at smaller spatial and temporal scales. Surface water quality monitoring in Pima County is limited because there are very few perennial surface water bodies. Where surface water is impaired, it is often due to natural processes like fires or chemical weathering of bedrock, or human activities like urbanization or chemical use associated with mining or agriculture. Common constituents of concern in Pima County are suspended sediments/turbidity, dissolved oxygen, nutrients, metals and pathogens.

3.6.4.1. Surface water quality data

Required by the Clean Water Act Section 305(b), ADEQ compiles periodic reports detailing surface water quality in Arizona. Surface water bodies, including stream reaches and lakes, are sampled for different parameters and assessed as to whether or not they attain the water quality standards associated with the designated use of the water body. ADEQ-defined designated uses are as follows:

- Aquatic and Wildlife
  - Coldwater Fishery
  - Warmwater Fishery
  - Ephemeral Stream
  - Effluent Dependent Water
- Full Body Contact (i.e., swimming)
- Partial Body Contact (i.e., nonswimming recreation)
- Fish Consumption
- Domestic Water Source
- Agricultural Irrigation
- Agricultural Livestock Watering

Assessment categories include Attaining All Uses (Category 1), Attaining Some Uses (Category 2), Inconclusive (Category 3), Not Attaining (Category 4), and Impaired (Category 5). Category 1 waters meet the water quality standards for all designated uses. Category 2 waters attain the water quality standards for at least one designated use, while the other uses are deemed inconclusive. The inconclusive category indicates the sampling data do not show a clear result or no credible data is available. Category 4 waters are not attaining at least one designated use, and a Total Maximum Daily Load has been completed for the reach or the reach is expected to attain all designated uses by the next listing cycle. Impaired waters do not attain water quality standards for any designated use and require development of a TMDL plan in an effort to restore surface water quality.

ADEQ assessed seven stream reaches and four lakes in Pima County for the 2004 305(b) report. Of these, one stream reach was designated attaining all uses and one lake was assessed impaired relative to certain pollutants. The remaining assessed water bodies were inconclusive or attaining some uses (ADEQ, 2004). Appendix D lists all of the water quality results for monitored surface water bodies in Pima County.

<u>Attaining All Uses (Category 1)</u>
Cienega Creek (Gardner Canyon - USGS gage (Pantano Wash)

<u>Attaining Some Uses (Category 2)</u>
Kennedy Lake
Sabino Canyon Creek (tributary at 32E23'28"/110E47'00" - Tanque Verde Wash)
Santa Cruz River (Canada del Oro - HUC boundary 15050303) - Chlorine

<u>Inconclusive (Category 3)</u>
Chimenea Creek (headwaters – Rincon Creek)
Loma Verde Wash (headwaters – unnamed tributary to Tanque Verde Wash)
Madrona Creek (headwaters - Rincon Creek)
Santa Cruz River (Roger Road WWTP outfall - Rillito Creek)

Not Attaining (Category 4)
Arivaca Lake – Mercury, dissolved oxygen, pH, selenium

Impaired Waters (Category 5)
Lakeside Lake – Dissolved oxygen, ammonia, turbidity
Rose Canyon Lake* – pH
*EPA addendum is pending.

In addition to ADEQ's monitoring, several perennial or intermittent water bodies that are potentially very important aquatic habitat in Pima County have been sampled for studies conducted as part of the Sonoran Desert Conservation Plan. These include Cienega Creek, Bingham Cienega and the San Pedro River.

A portion of Cienega Creek has been designated by the state as a "Unique Water," which means it qualifies for site-specific water quality standards established to maintain and protect the existing water quality. Fonseca, et al. (1990) concluded that the water quality of base flows in the reach nominated for Unique Water status met designated uses standards, including aquatic and wildlife (warm-water). The lowermost reaches of Cienega Creek were sampled more recently (in the late 1990s) as part of a two-year study by PAG and Pima County Flood Control District to determine the source of the water. The results are summarized on Table 3-24.

Bingham Cienega is a perennial wetland located approximately 2,000 feet west of the lower San Pedro River, and ¼ mile north of the settlement of Redington. PAG and the Pima County Flood Control District sampled Bingham Cienega, the San Pedro River, and Edgar Canyon (a tributary to the San Pedro) in the late 1990s, in order to identify the water source of the cienega. The results are summarized on Table 3-24.

Table 3-24. Average Values, Water Quality Data for Selected Streams in Pima County, September 1998-June 2000 (PAG, 2000; PAG 2001a)

Analyte (mg/L)	*Cienega Creek*	*Bingham Cienega*	*San Pedro River*	*Edgar Canyon*
Ca dissolved	109	64	64	64
Mg dissolved	32	12	16	15
Na dissolved	61	40	55	24
K dissolved	5.9	1.7	2	1.1
Alkalinity $CaCO_3$	252	219	222	238
SO_4 dissolved	257	55.8	90.2	18.6
Cl dissolved	14	11	18	6.9
F dissolved	0.57	1.14	0.92	0.39
Arsenic dissolved	0.0006	0.0043	0.0022	0
TDS	737	280	344	287

0 = constituent was not detected at the Practical Quantitation Limit (PQL).

3.6.4.2. Water quality limited waters and TMDLs

For waters that are designated Impaired, ADEQ is required to calculate a TMDL of a water quality parameter that will not cause an exceedance of surface water quality standards. They are also required to implement the TMDL by tracking pollutant sources, and managing them in such a way that water quality standards are met. Table 3-25 lists all TMDL projects in Pima County (ADEQ, 2004; ADEQ 2004a).

Table 3-25. Historical and Current Impaired Waters in Pima County (ADEQ, 2004; ADEQ, 2004a)

Impaired Water	*Pollutant(s)*	*Year First Listed*	*Status*
Arivaca Lake	Mercury	TMDL approved by EPA in 1999.	TMDL complete.
Lakeside Lake	Dissolved oxygen, pH, ammonia	2004	City of Tucson installed new aeration system on 06/25/02. City and ADEQ will monitor lake water quality for first year as part of implementation plan. The draft TMDL is available for review as of May 2004. High Priority. An AZPDES permit revision is pending for a discharge to this lake. Low dissolved oxygen and elevated ammonia are related to historic fish kills at this lake, and the lake is an important urban recreational area. Low dissolved oxygen and elevated ammonia may be related to seasonal activities. Reclaimed water and storm water inputs make this TMDL complex. Ongoing monitoring and investigation.

3.6.5. Stormwater runoff water quality

Stormwater runoff water quality data collection is often limited to urbanized areas in Pima County, especially the Tucson metropolitan area. Several agencies, including ADEQ, USGS, the City of Tucson and Pima County monitor stormwater quality data in metro Tucson. Table 3-26 indicates the City of Tucson's stormwater quality data for the 2003-2004 fiscal year. Stormwater was monitored at five locations representing different land uses typical to Tucson. They include: single family residential (Sfr), multi-family residential (Mfr), commercial (Com), industrial (Ind), and mixed-use (Mxu). The 2003-04 sampling results, similar to the results submitted in the previous annual report, indicated that Tucson stormwater was essentially free of sampled contaminants.

Table 3-26. FY 2003-2004 Monitoring Results for City of Tucson Stormwater (City of Tucson, 2004)

DATE	*7/12/2003*	*11/12/2003*	*7/25/2003*	*1/22/2004*	*7/18/2003*	*11/12/2003*	*7/12/2003*	*11/12/2003*	*7/17/2003*	*12/12/2003*
FACILITY	SFR	SFR	MFR	MFR	COM	COM	IND	IND	MXU	MXU
SITE	1	1	2	2	3	3	4	4	5	5
RAINFALL (in)	0.35	0.33	0.31	0.19	0.18	0.37	0.18	0.32	0.26	0.10
DURATION (minutes)	28	1260	18	604	46	1274	22	1260	230	102
LAST RAIN (days)	127	34	8	71	6	34	43	35	5	30
TOTAL FLOW (gal)	15,125	161,191	496,947	101,779	17,939	89,931	102,865	217,444	93,261	26,210
TEMPERATURE (C)	31.3	NA	25.3	11.8	23.4	17	30.6	17.3	25.8	7.1
pH	6.00	NA	6.00	7.10	6.00	6.73	6.09	6.77	6.00	7.48
Oil/Grease (mg/L)	<6.0	<5.1	6.0	<5.0	<5.0	<5.0	<5.1	<5.0	<5.1	<5.0
Arsenic, As (mg/L))	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010

DATE	*7/12/2003*	*11/12/2003*	*7/25/2003*	*1/22/2004*	*7/18/2003*	*11/12/2003*	*7/12/2003*	*11/12/2003*	*7/17/2003*	*12/12/2003*
Copper, Cu (mg/L)	0.052	0.018	0.014	0.017	0.018	0.010	0.12	0.041	0.057	0.021
Lead, Pb (mg/L)	0.018	<0.010	<0.010	<0.010	0.012	<0.010	0.048	<0.010	0.018	<0.010
Zinc, Zn (mg/L)	0.20	0.085	0.078	0.17	0.13	<0.050	0.67	0.16	0.43	0.32
Nitrogen, Total Kjeldahl, TKN (mg/L)	9.3	2.2	3.8	2.0	2.2	1.4	7.9	2.0	4.5	3.9
Nitrogen, Nitrate + Nitrite (as N) (mg/L)	2.1	0.72	1.9	1.2	1.0	<0.50	3.4	0.73	1.8	1.5
Phosphorus, P (mg/L)	0.58	0.41	0.39	0.32	0.25	0.18	0.61	0.39	0.49	0.30
COD (mg/L)	280	110	110	54	110	74	560	120	290	170
TSS (mg/L)	120	invalid	30	52	100	invalid	360	invalid	110	26
TSS* (mg/L) Resampled 1/22/04		93*				28*		340*		
BOD (mg/L)	120	13	27	13	16	9.2	130	23	46	49
Solids, Total Dissolved (mg/L)	320	74	90	94	92	64	380	100	170	200
Phenol (µg/l)	<13	<60	<10	<10	<10	<10	<56	<54	<50	<50
4,4-DDE (µg/l)	<3.3	<1.7	<0.30	<3.0	<1.6	<0.65	<3.1	<1.6	<1.5	<0.63
Hardness**									<10	

Total flow measured was for sampling period only.
Detection limit for DDE varies based on the dilution used during laboratory analysis.
All Samples were analyzed at Transwest Geochem.
*New TSS samples taken on January 22, 2004. Original TSS values were invalid because samples were analyzed after the holding time.
**Lab mistakenly analyzed one sample only for Hardness.
<u>Undetected phenols:</u> 4-Chloro-3-methylphenol (µg/l), 4,6-Dinitro-2-methylphenol (µg/l), 2-Chlorophenol (µg/l), 2,4-Dichlorophenol (µg/l), 2,4-Dimethylphenol (µg/l), 2,4-Dinitrophenol (µg/l), 2-Nitrophenol (µg/l), 4-Nitrophenol (µg/l), Pentachlorophenol (µg/l), and 2,4,6-Trichlorophenol (µg/l).

Table 3-27 is a similar table, indicating stormwater quality sampling results conducted by Pima County in 1999-2000. Five sites were monitored, each representing a different land use, as indicated below.

Site 1: Residential, low density
Site 2A: Residential, medium density
Site 3: Residential, high density
Site 4: Commercial
Site 5: Industrial

Table 3-27. FY 1999-2000 Monitoring Results for Pima County Stormwater
(Pima County, 2000)

Facility	*Site 1*	*Site 1*	*Site 1*	*Site2A*	*Site 3*	*Site 3*	*Site 3*	*Site 4*	*Site 4*	*Site 4*	*Site 5*	*Site 5*
Date	*7/14/99*	*3/6/00*	*6/22/00*	*7/6/99*	*7/14/99*	*3/6/00*	*6/22/00*	*7/14/99*	*3/6/00*	*6/22/00*	*7/5/99*	*6/19/00*
H2O Temperature on arrival °C	29.3	9.6	23.0	24.0	31.3	10.5	24.5	30.0	10.4	26.4	27.2	22.2
H2O Temperature + 1 hour °C	-	9.0	-	23.9	-	10.1	27.1	-	11.1	25.7	27.8	25.1
H2O Temperature +2 hours °C	-	-	-	-	-	9.7	-	-	11.5	25.8	27.9	29.8
H2O Temperature + 3 hours °C	30.7	9.2	23.3	24.6	29.6	9.7	25.6	28.4	11.6	25.6	-	30.7
pH at arrival s.u.	9.07	6.97	8.03	7.94	6.58	7.43	7.79	7.32	7.39	7.76	8.03	8.65
pH + 1 hour s.u.	-	7.45	-	7.91	-	7.55	7.05	-	7.44	7.67	7.84	8.06
pH+ 2 hours s.u.	-	-	-	-	-	7.51	-	-	7.54	7.81	7.94	7.90
pH + 3 hours s.u.	8.16	7.5	7.42	7.25	7.72	7.45	7.15	8.24	7.46	7.95	-	7.90
Fecal coliform on arrival Mpn/100ml	3000	500	3000	160000	3000	11000	900	9000	17000	50000	5000	900
Fecal coliform +1 hour Mpn/100ml	-	-	-	-	-	-	-	-	-	-	-	-
Fecal coliform + 2 hours Mpn/100ml	-	-	-	-	-	-	-	-	-	-	-	-
Fecal coliform + 3 hours MPn/100ml	220	1300	2400	30000	1700	30000	1600	2400	1700	900	300	16000
Cu (µg/l)(total)	183	13.6	21.6	21.5	27.9	18.4	31.9	34.0	29.8	50.0	81.2	107
Pb (µg/l)(total)	210	ND	17.4	T	ND	ND	T	T	T	T	93.3	136
Zn (µ/l)(total)	476	36.2	48.9	78.6	161	129	183	46.5	165	155	214	305
Hardness (calculated) mg/L	876	46.1	57.5	41.1	32.2	27.7	54.3	88	36.0	58.0	285	272
TSS mg/L	5631	49	273	125	55	29	32	120	65	52	712	596
4,4-DDE (µg/l)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Mpn/100mg/L- most probable number per 100mg/L
--- no measurement taken or no sample collected
T-trace

Additional stormwater runoff quality data is indicated on Tables 3-28, 3-29 and 3-30 for the Santa Cruz River, Tanque Verde Creek and Rillito Creek, respectively. These samples were collected in the referenced surface water drainage, where the water flow consisted solely of stormwater. Prior to the precipitation event, they were dry.

Table 3-28. 1989 Stormwater Quality Data for the Santa Cruz River at Congress Street Bridge (PAG, 1991)

Parameter	*Concentration (mg/L)*
Calcium	17.6
Magnesium	2.32
Sodium	9.1
Potassium	9.3
Bicarbonate	75
Chloride	1.1
Sulfate	10
NO2+NO3	0.61
TDS (total dissolved solids)	90
TSS (total suspended solids)	10,600

Table 3-29. 1986-1992 Stormwater Quality Data for Tanque Verde Creek at Sabino Canyon Road (USGS, 1994; USGS, 1995)

Constituent	*Average (mg/L)*	*Minimum (mg/L)*	*Maximum (mg/L)*
Calcium	10.4	4.3	25
Magnesium	1.6	0.98	4.6
Sodium	6.0	4.1	10
Potassium	2.2	0.7	6.5
Aluminum (total)	117	0.47	410
Bicarbonate	34	14	68
Chloride	4.0	2.1	7.2
Sulfate	9.9	4.5	16
Nitrate	0.3	0.07	0.81
TDS	93	41	205
TOC	84	8.8	240
TSS	2891	22	10300

Table 3-30. 1986-1993 Stormwater Quality Data for Rillito Creek at Dodge Boulevard (USGS, 1994;USGS 1995)

Constituent	*Average (mg/L)*	*Minimum (mg/L)*	*Maximum (mg/L)*
Calcium	15	8.2	46
Magnesium	1.9	0.8	5.9
Sodium	6.6	1.9	15
Potassium	2.5	0.8	5.1
Aluminum (total)	195	44	550
Bicarbonate	53	28	121
Chloride	3.8	1.5	12
Sulfate	13	4.6	52
Nitrate	0.5	0.18	1.3
TDS	100	19	243
TOC	117	19	210
TSS	12089	21	36700