ARIZONA WATER ATLAS
VOLUME 3 - SOUTHEASTERN ARIZONA PLANNING AREA

Preface

Volume 3, the Southeastern Arizona Planning Area, is the third in a series of nine volumes that comprise the Arizona Water Atlas. The primary objectives in assembling the Atlas are to present an overview of water supply and demand conditions in Arizona, to provide water resource information for planning and resource development purposes, and help to identify the needs of communities. The Atlas also indicates where data are lacking and further investigation may be needed.

The Atlas divides Arizona into seven planning areas (Figure 3.0-1). There is a separate Atlas volume for each planning area, an executive summary volume composed of background information, and a resource sustainability volume. "Planning areas" are an organizational concept that provide for a regional perspective on supply, demand and water resource issues. A complete discussion of Atlas organization, purpose and scope is found in Volume 1. Also included in Volume 1 is general background information for the state, a description of data sources and methods of analysis for the tables and maps presented in the Atlas, and appendices that provide information on water law, management and programs, and Indian water rights claims and settlements.

There are additional, more detailed data available to those presented in this volume. These data may be obtained by contacting the Arizona Department of Water Resources (Department).

Section 3.0 Overview of the Southeastern Arizona Planning Area

The Southeastern Arizona Planning Area is composed of 14 groundwater basins that vary significantly in size. Elevation ranges from 10,713 feet to 1,830 feet. Cochise County is entirely contained in the planning area as well as portions of seven other counties: Apache (0.1%), Gila (22%), Graham (95%), Greenlee (92%), Pima (6%), Pinal (27%) and Santa Cruz (44%) counties. Most of the San Carlos Apache Reservation, the fourth largest reservation in Arizona, is located within the planning area in parts of six basins: Aravaipa Canyon, Bonita Creek, Dripping Springs Wash, Lower San Pedro, Morenci and Safford basins.

The 2000 Census planning area population was approximately 188,300. Basin population ranged from 21 in the Bonita Creek Basin to over 78,000 in the Upper San Pedro Basin. Sierra Vista is the largest metropolitan area with about 38,000 residents in the incorporated area and an additional 14,300 residents in the unincorporated area southeast of the city.

An average of 515,100 acre-feet of water (including effluent) is used annually in the planning area for agricultural, municipal and industrial uses (cultural water demand). Of this total, approximately 85% is groundwater. The agricultural water use sector is the largest

Agriculture in the Safford Basin. The agricultural demand sector is the largest in the Planning Area with significant agricultural water use in the Douglas, Safford and Willcox Basins.

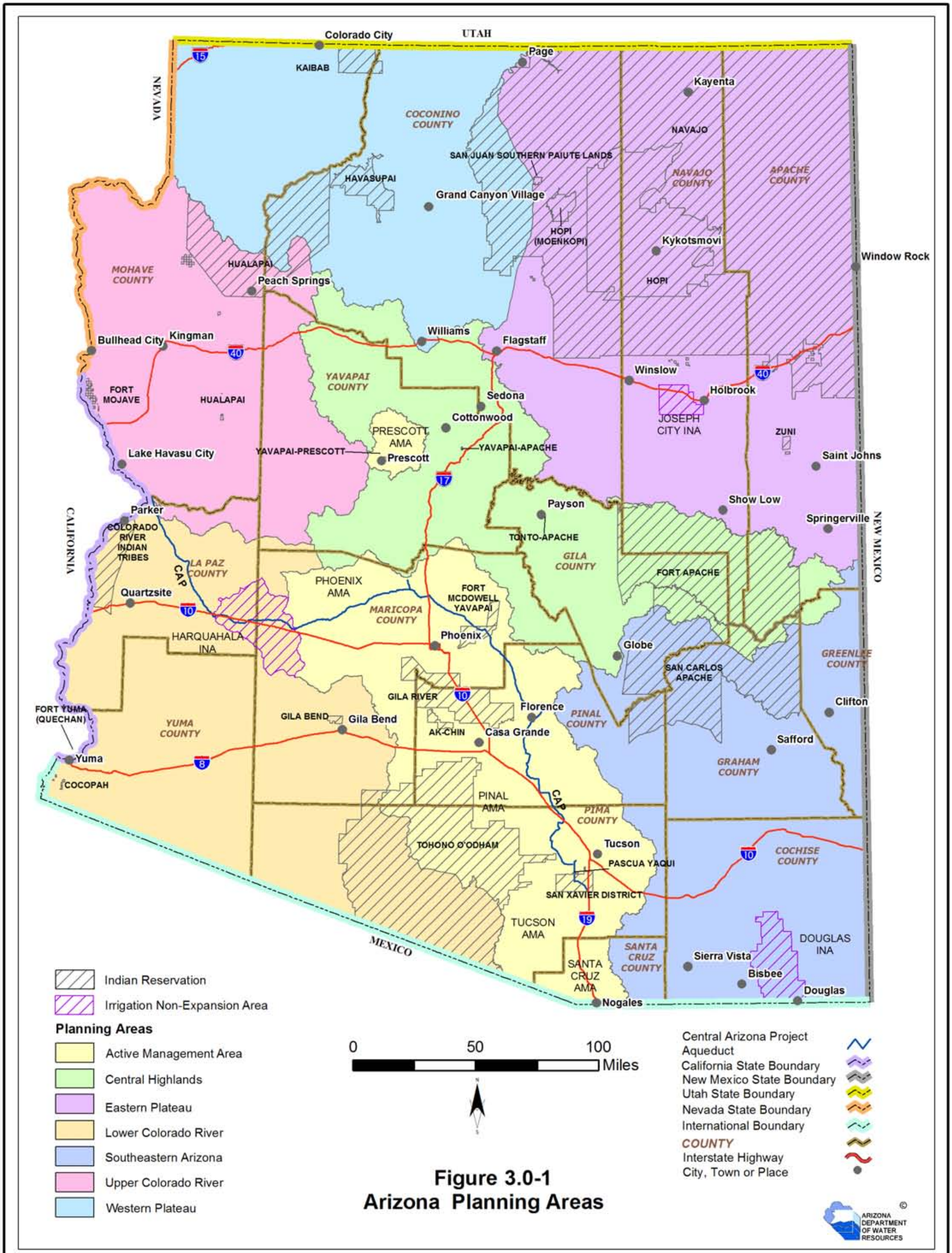


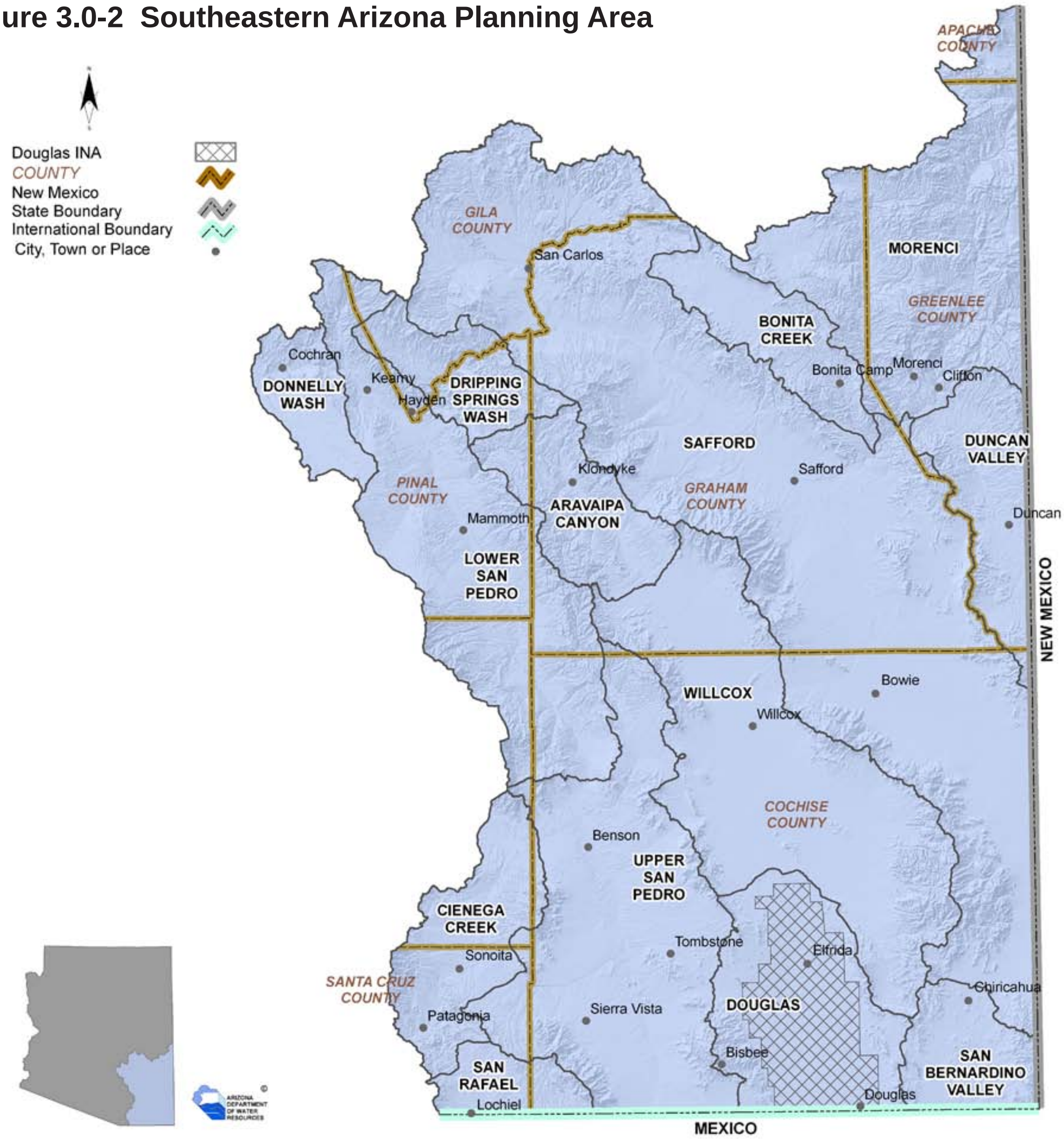
Figure 3.0-1
Arizona Planning Areas

user by far with an average annual demand of approximately 440,000 acre-feet. There is significant agricultural use in the Douglas, Safford and Willcox basins, with over 88% of the total agricultural demand. Most of the Douglas Basin contains an area designated as the Douglas Irrigation Non-expansion Area (INA). INAs were established in areas determined to have insufficient groundwater to provide a reasonably safe supply for irrigation. Average annual municipal demand in the planning area is approximately 40,500 acre-feet per year (AFA) and industrial demand is approximately 34,550 acre-feet.

3.0.1 Geography

The Southeastern Arizona Planning Area encompasses 16,072 square miles (sq. mi.) of geographically diverse groundwater basins in the southeastern corner of Arizona. Groundwater basins include: Aravaipa Canyon, Bonita Creek, Cienega Creek, Donnelly Wash, Douglas, Dripping Springs Wash, Duncan Valley, Lower San Pedro, Morenci, Safford, San Bernardino Valley, San Rafael, Upper San Pedro and Willcox. Basin boundaries, counties and prominent cities, towns, and places are shown in Figure 3.0-2.

Figure 3.0-2 Southeastern Arizona Planning Area



The planning area is bounded on the east by New Mexico, on the south by the international boundary with the state of Sonora, Mexico, on the west by the Active Management Area (AMA) Planning Area (Phoenix, Pinal, Santa Cruz and Tucson AMAs) and on the north by the Central Highlands Planning Area and a small portion of the Eastern Plateau Planning Area. The planning area includes parts of 5 watersheds, which are discussed in Section 3.0-2. Most of the 2,900 sq. mi. San Carlos Apache Reservation, (83.1% or about 2,400 sq. mi.), is located in the north central part of the planning area.

The majority of the planning area is within the Mexican Highland section of the Basin and Range physiographic province, which is characterized by northwest-southeast trending mountain ranges separated by broad alluvial valleys (see Figure 3.0-3). The Mexican Highland section is a higher elevation area of the province with valleys ranging from 2,500 to 4,000 feet above sea level and mountains and valleys covering about equal areas. The extreme northern portion of the planning area falls within the Central Highlands transition zone, which is characterized by rugged mountains of igneous, metamorphic and sedimentary rocks. The average elevation in the planning area is 4,500 feet. Elevation ranges from 10,713 feet at Mount Graham in the Pinaleño Mountains in the Safford Basin to 1,830 feet near Kearny where the Gila River exits the planning area in the Lower San Pedro Basin.

A unique feature of the planning area is mountain ranges that are isolated from each other by valleys of desert grasslands and desert scrub. These "sky islands" are part of a unique complex of about 27 mountain ranges in Arizona, New Mexico, and the Mexican States of Sonora and Chihuahua. The southwestern sky island complex extends from subtropical to temperate latitudes, a condition found nowhere else. (Warshall, 2006) The highest elevation sky islands are the Pinaleño Mountains found along the Safford/Willcox/Aravaipa Canyon basin boundary and the Chiricahua Mountains along the southern Willcox and Safford basin boundary. The planning area transitions to one of Arizona's major mountain ranges, the White Mountains, along the northeastern boundary.

The planning area includes drainages of the San Pedro River and Upper Gila River. The Gila River originates in western New Mexico and enters Arizona near Duncan in the Duncan Valley Basin. The river generally flows west through the Safford Basin. The San Pedro River flows north from Mexico through the Upper and Lower San Pedro Basins and joins the Gila River at Winkelman. Surface water in the planning area flows into the Gila River except for the Willcox Basin, a "closed basin" with internal drainage, and several basins where drainage flows south into Mexico. These basins are the Douglas, San Rafael and San Bernardino Valley basins. The Santa Cruz River originates in the San Rafael Basin, flows south into Mexico, turns north and enters the Santa Cruz AMA east of Nogales.

Figure 3.0-3 Physiographic Regions of Arizona

Data source: Fenneman and Johnson, 1946

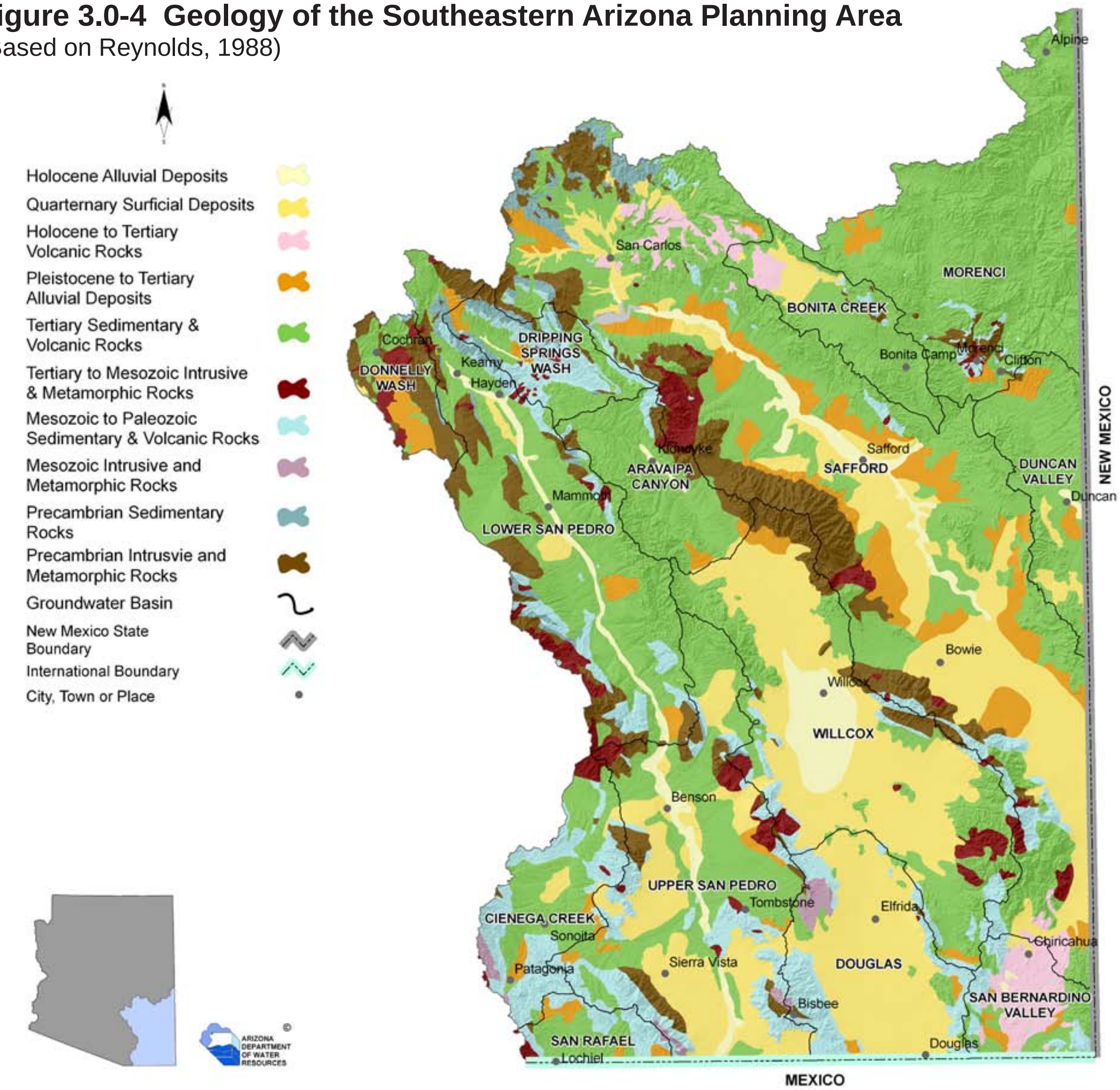
3.0.2 Hydrology[1]

Groundwater Hydrology

The Southeastern Arizona Planning Area is generally characterized by alluvial basins with relatively large reserves of groundwater in gently sloping valleys separated by mountain ranges. Anderson, Freethy and Tucci (1992) divided the alluvial basins of south-central Arizona into five groups based on similar hydrologic and geologic characteristics. One of these, the "Southeast Basins", covers most of the planning area.

The principal water-bearing deposits in southeast basins are moderately thick sediments deposited prior to the formation of the Basin and Range structure and an overlying layer of lower basin fill that can reach over 1,000 feet thick, derived from the subsequent partial erosion of the ranges (see Figure 3.0-4). Lower basin fill sediments are composed of fine-grained to moderately fine-grained materials. Upper basin fill deposits

Figure 3.0-4 Geology of the Southeastern Arizona Planning Area
(Based on Reynolds, 1988)



[1] Except as noted, information in this section is taken from the Arizona Water Resources Assessment, Volume II, ADWR, August 1994.

average about 300 feet thick and are generally composed of sands, gravels, silts, clays and some limestones. Aquifers in this region often consist of two or more water-bearing units separated by a fine-grained unit that forms a leaky confining layer over the lower basin fill. Thin layers of sand and gravel along major streams make up the stream alluvium.

Groundwater generally flows from the margins to the central axis of the basin where most groundwater discharge occurs. Confined groundwater (artesian conditions) can occur within the lower basin fill. Artesian conditions occur in a number of locations in the planning area including: the vicinity of Artesia south of Safford; washes and terraces at the base of the Pinaleño Mountains; the vicinity of Saint David; the San Bernardino Valley Basin; and the Lower San Pedro Basin.

Artesian well in the San Bernardino Valley Basin. Artesian conditions also occur in the vicinity of Artesia south of Safford, washes and terraces at the base of the Pinaleno Mountains, the Lower San Pedro Basin and in the vicinity of St. David in the Upper San Pedro Basin.

The major groundwater inflow components are mountain front recharge and stream infiltration with some underflow from adjacent up-gradient basins. Outflow consists of evapotranspiration, pumpage, discharge to streams as baseflow and some underflow to down-gradient basins, including into Mexico.

Each groundwater basin in the planning area is discussed briefly below. They are grouped into geographic areas according to their general location and similar hydrologic characteristics.

North/Northeastern Portion

Groundwater basins located in the north and northeastern portion of the planning area are Bonita Creek, Dripping Springs Wash, Duncan Valley, Morenci and Safford. The Safford Basin aquifers are primarily stream alluvium and basin fill, while the other basins also contain aquifers composed of volcanic rock or sedimentary rock (Gila Formation). Groundwater flow is toward the Gila River drainage and the Bonita Creek, Duncan Valley and Morenci basins contribute underflow to the Safford Basin.

Bonita Creek Basin

The portion of the Bonita Creek Basin located within the San Carlos Indian Reservation is characterized by a broad valley bordered by the Nantac Rim and the Gila Mountains. The valley consists of basin fill material with volcanic intrusions where most wells are drilled. The lower part of the basin is characterized by volcanic flows, agglomerates and tuffs interbedded with small sedimentary lenses. In this part of the basin, alluvial deposits along the creek are the main aquifer. Groundwater flow is toward the southeast. Groundwater recharge has been estimated at 9,000 AFA and groundwater in storage estimates vary from 1 to 2 million acre-feet (maf). The reported median well yield from 14 wells is over 1,100 gpm. (Table 3.2-4). Water levels are relatively shallow in the few wells measured in the basin, and all are located near the southern boundary. Water quality data are lacking. The City of Safford operates an infiltration galley along Bonita Creek and conveys water to Safford for municipal use.

Dripping Springs Wash Basin

Dripping Springs Wash is a mountainous basin containing small sediment-filled valleys with relatively little groundwater in storage.

The largest valley is north of the Gila River and drained by Dripping Springs Wash. Water producing units consist of younger alluvium and the Gila Conglomerate, with the younger alluvium along Dripping Springs Wash and its tributaries the major water producer. These deposits are reportedly less than 150 feet thick. Consolidated rocks compose the surrounding mountains and contain minor amounts of groundwater. Groundwater flow is towards the Gila River which bisects the basin (Figure 3.3-6). Groundwater recharge has been estimated at 3,000 to 9,000 AFA and groundwater in storage at less than 1maf. Well yields vary widely with a median well yield of about 394 gpm reported (Table 3.6-6). Recent water quality data are lacking.

Duncan Valley Basin

The Duncan Valley Basin consists of an elongate valley filled with sediments, drained by the Gila River and surrounded by low permeability rocks. Younger alluvial deposits along the Gila River and its tributaries are the principle source of groundwater. These deposits are up to 170 feet thick in some locations. Wells also tap the underlying Gila Formation composed of poorly consolidated sand, silt and gravel. The older basin fill contains only minor amounts of groundwater. Groundwater flow is toward the north and west along the Gila River drainage. Groundwater recharge estimates range from 6,000 to 14,200 AFA and groundwater storage estimates range from 9 to 19 maf. The median well yield reported for 165 large diameter wells was 850 gpm (Table 3.7-6). Water levels in measured wells varies from 24 feet to over 500 feet below land surface (bls), with slight water level declines observed from 1990-1991 to 2003-2004 (Figure 3.7-6). Arsenic and fluoride concentrations exceeding drinking water standards have been measured at a number of wells in this basin and a 15-mile reach of the Gila River is impaired due to elevated selenium concentrations (Table 3.7-7).

Morenci Basin

The Morenci Basin is characterized by steep canyons, mesas and mountains with numerous streams and washes. The basin consists mainly of volcanic rocks (rhyolite and agglomerates overlain by basalt flows). Groundwater is found primarily in alluvial deposits along major water courses and groundwater flow is to the south along the San Francisco River drainage. Groundwater recharge has been estimated at 15,000 AFA and groundwater in storage at 3 maf. Water level change data in the Morenci Basin are available only for the area near Alpine where the measured depth to water is less than 80 feet bls and water levels rose over 15 feet in one well from 1990-1991 to 2003-2004 (Figure 3.9-6). Water quality data shows metal contamination in the vicinity of the Morenci Mine.

San Francisco River at Clifton. In the Morenci Basin groundwater is found primarily in alluvial deposits along major water courses

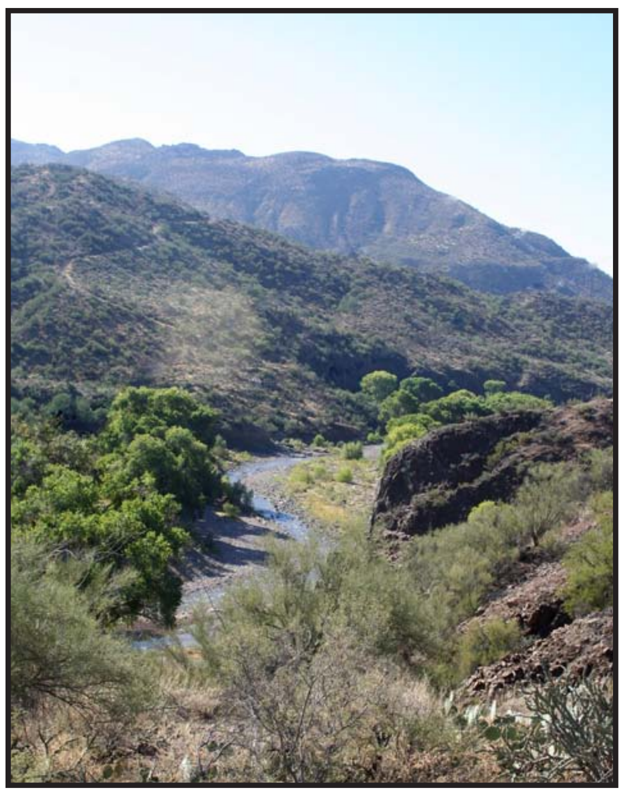
Safford Basin

The Safford Basin is a relatively large, alluvial filled depression rimmed by elongated mountain ranges. Basin fill is the major aquifer in all three sub-basins of the Safford Basin. Depth to water is relatively shallow in wells measured near the Gila River, while water levels are generally deeper in wells in the San Simon Valley sub-basin, the southernmost sub-basin. Water levels declined in most wells in the basin that were measured in 1990-1991 and 2003-2004, with the most significant declines south of San Simon where water levels declined by more than 30 feet during this time period (Figure 3.10-6). Water levels exceed 600 feet bls at two wells along the western boundary of the San Carlos Valley sub-basin, the northernmost sub-basin. In one of these wells, water levels declined over 60 feet between 1990 and 2004 (Figure 3.10-7). Fluoride and arsenic concentrations consistently exceed drinking water standards throughout the basin. Most of the groundwater development in the Safford Basin is in the Gila Valley sub-basin, the central sub-basin, which contain the basin's major population and agricultural centers.

In the San Simon Valley sub-basin a clay deposit, known as the Blue Clay unit, separates the upper and lower aquifers and may be as much as 600 feet thick. Groundwater is found under artesian conditions in the lower aquifer and is generally unconfined in the upper aquifer. Groundwater flow in the sub-basin is toward the north along the San Simon River drainage but also flows toward agricultural pumping centers. The upper aquifer generally contains elevated total dissolved solids (TDS) and fluoride concentrations. The principal aquifer in the Gila Valley sub-basin, located in the middle part of the Safford Basin, is the upper basin fill, underlain by the Blue Clay unit. Groundwater is also utilized from the lower basin fill, which generally is found under artesian conditions and where well discharges may be quite high. Groundwater flow is from south to north along the Gila River drainage. Groundwater in both the upper and lower basin fill may be high in TDS in this sub-basin. The main water-bearing unit in the San Carlos Valley sub-basin, located in the northern part of the Safford Basin, is the upper basin fill, which is found under unconfined conditions. As with the other sub-basins, groundwater in the lower basin fill is generally found under artesian conditions. Groundwater flow in the sub-basin is toward the Gila River drainage.

<u>Western Portion</u>
On the western side of the planning area are a group of basins that are tributary to the San Pedro and Gila rivers; Aravaipa Canyon, Donnelly Wash, Lower San Pedro and Upper San Pedro. Ggroundwater is found in stream alluvium and basin fill sediments in these basins.

Aravaipa Canyon Basin
The sparsely populated Aravaipa Canyon Basin is characterized by a relatively flat northwest-trending valley in the southern half of the basin and an incised valley, Aravaipa Canyon that cuts through the Galiuro Mountains, in the northern half. The principal aquifers are the unconfined stream alluvium, which is the major source of groundwater, and a confined basin fill aquifer. Water level records suggest that the confined aquifer leaks into the unconfined aquifer. The thickness of the younger alluvium decreases to



Aravaipa Creek. Groundwater flows toward the head of Aravaipa Canyon where its flow path is geologically restricted, resulting in the perennial portion of Aravaipa Creek the south. (Holmes, 2003) Groundwater flow is similar to the surface water runoff pattern; northwest along the central axis of the valley. Groundwater flows towards the head of Aravaipa Canyon where its flow path is geologically restricted, resulting in the perennial portion of Aravaipa Creek (Holmes, 2003). Groundwater recharge is from infiltrating precipitation and runoff and is estimated to range from 7,000 to 16,700 AFA (Table 3.1-3). Groundwater discharge is to Aravaipa Creek from springs and baseflow, with small discharge to wells. Freethey and Anderson (1986) estimated 5 maf of water in storage in the basin. Depth to water within the basin fill varies from 25 feet bls where the younger alluvium is thin to over 500 feet bls in the uplands in the southern part of the basin (Holmes, 2003). Two recent water level measurements in the central valley were 64 and 39 feet bls (Figure 3.1-6). Arsenic is the water quality parameter that most frequently exceeds drinking water standards in wells measured in the basin (Table 3.1-5), but groundwater is generally of good chemical quality (Holmes, 2003).

Donnelly Wash Basin

Donnelly Wash Basin is a relatively small basin with few inhabitants. The principal aquifer is a strip of basin fill that covers about 30 percent of the basin. The rest of the basin is composed of hardrock that surrounds and underlies the basin fill (Overby, 2000). A 16-mile reach of the Gila River flows east to west through the basin, which is also drained by Donnelly Wash and Box O Wash located on the south side of the Gila River. In general, groundwater flow follows surface water drainage patterns, flowing toward the Gila River. Aquifer recharge is from the mountain fronts and streambed infiltration. Groundwater is discharged from the alluvium into the Gila River and from domestic and stock wells. Storage estimates for the basin range from 140,000 acre-feet to 2 maf (Table 3.4-2.) Depth to water in the basin fill varies from about 150 feet in the north, 256 feet in the center, and about 370 feet in the south. Water levels are more shallow in wells located in the hardrock areas (Overby, 2000). Elevated fluoride concentrations were measured in two springs in the basin (Table 3.4-7). Eleven water samples collected by the Department in 1996 and 1997 did not find elevated fluoride levels in groundwater in either the alluvium or the hardrock (Overby, 2000).

Lower San Pedro Basin

The Lower San Pedro Basin consists of the northwest-trending San Pedro River Valley bordered by mountains ranging in elevation from 6,000 to over 8,000 feet in elevation. There are two sub-basins; the Mammoth sub-basin and the smaller Camp Grant Wash sub-basin (Figure 3.8-7). The two major water bearing units are stream alluvium and basin fill. Most mining, industrial and domestic/municipal wells are located in the regional basin fill aquifer while most irrigation wells are located in the stream alluvium. The stream alluvium along the San Pedro River and tributaries can be quite permeable with high well yields but this aquifer is often less than 50 feet thick south of Redington (USGS, 2006a). Groundwater in the alluvium is unconfined. The hydrologic characteristics of the basin fill aquifer vary widely due to the amount of cementation and occurrence of fine-

San Pedro River in the Lower San Pedro Basin. The streambed alluvium along the San Pedro River and tributaries is very permeable with high well yields.

grained layers. Both confined and unconfined conditions exist. Artesian conditions exist from about five miles north to ten miles south of Mammoth in wells drilled deeper than 500 feet.

Groundwater flow direction is from the mountains toward the valley floor and to the north. The estimated groundwater recharge ranges from 24,000 to 29,000 AFA (Table 3.8-6) from mountain front recharge, streambed infiltration and underflow from the Aravaipa Canyon and Upper San Pedro basins. Groundwater is discharged by pumpage, evapotranspiration, evaporation from streams, and springs and seeps. The estimated volume of groundwater in storage ranges from 11 maf to more than 27 maf (Table 3.8-6). Water level change data between 1990-1991 and 2003-2004 for 16 wells shows relatively stable levels in most wells (Figure 3.8-6). (A water level sweep was conducted in winter 2006-2007 and a hydrologic map series report is expected to be completed by fall 2009).Water quality data from selected sites show that fluoride was the parameter that most frequently exceeded drinking water standards, with elevated levels of cadmium found in the vicinity of Hayden and Dudleyville (Table 3.8-7).

Upper San Pedro Basin

The Upper San Pedro Basin consists of the northwest trending San Pedro River Valley and surrounding mountains that range from 5,000 to almost 10,000 feet in elevation. The basin contains two sub-basins: the Sierra Vista and the small Allen Flat sub-basin. Basin fill is the principal aquifer although the stream alluvium is also utilized. Groundwater in the basin fill aquifer is found in both unconfined and confined conditions. Artesian conditions exist near Palominas, Hereford, and more extensively near Benson and Saint David. These conditions supported modest groundwater discharges for irrigation use primarily in the Benson-Pomerene area. An interesting feature is a limestone aquifer in the Whetstone Mountains that contains a "live" or wet cave, Kartchner Caverns, a state park. The water level in the cavern is about 700 feet higher than that of the underlying alluvial aquifer (ADWR, 2005a).

Groundwater flow direction is from the mountain fronts toward the central valley and to the north. A cone of depression has formed in the Sierra Vista area that has altered flow direction (Figure 3.13-6). Groundwater recharge is approximately 35,700 AFA from the mountain fronts, underflow from Mexico and streambed infiltration. Two effluent recharge projects in the basin also recharge the aquifer. The most populous basin in the planning area, major discharge is from municipal and agricultural pumpage and from riparian evapotranspiration. (ADWR, 2005a) The most recent estimate of groundwater in storage is 19.8 to 26.1 maf although estimates of up to 59 maf exist (Table 3.13-5).

As shown in Figure 3.13-6, water levels declined in most wells measured in 1990-1991 and 2003-2004. Additional data show annual declines of 0.9 to 2.9 feet in some wells in the Bisbee-Naco area and rises of up to 0.6 feet per year in the Pomerene area north of Benson (ADWR, 2005a). The Department measured water levels in the basin in 2006 and these data are expected to be released in a water level change map series report in 2009. Preliminary data show water levels decreasing in most wells

Allen Flat, Upper San Pedro Basin. The basin contains two sub-basins: the Sierra Vista and the small Allen Flat sub-basin.

in the Bisbee and Naco area; about seven feet in five years from 2001 to 2006. In the Benson area, water levels west of the San Pedro River have declined most.

Groundwater quality is generally suitable for most uses. Arsenic and fluoride were the water quality parameters that most frequently exceeded drinking water standards in wells sampled in the basin. Localized nitrate contamination near St. David is being remediated as part of the Superfund Program.

Southern Portion

Groundwater from three basins in the southern portion of the planning area flows south into Mexico. These basins are the Douglas and San Bernardino Valley basins in the southeastern part of the planning area and the San Rafael Basin in the southwest corner.

Douglas Basin

The Douglas Basin occupies the southern portion of a northwest-southeast trending structural trough that extends from the central part of the Aravaipa Canyon Basin, through the Willcox Basin, to the northeastern part of Sonora, Mexico. The long alluvial valley in the Douglas Basin, (the southern part of the Sulphur Springs Valley), contains its main aquifer, basin fill, which supplies most of its large-capacity wells. The basin fill is composed of sand and gravel lenses interbedded with silt and clay lenses. The sand and gravel lenses are the main source of water. Groundwater is primarily unconfined although artesian conditions were reported locally in the upper alluvial deposits in the early 1950s prior to the start of heavy groundwater pumping (Rascona, 1993). Groundwater is also found in the mountain bedrock which provides relatively small amounts of water for stock and domestic use. In and adjacent to the City of Douglas, groundwater is pumped from basin fill with interbedded volcanic rock. Groundwater flow is generally from north to south although agricultural pumpage has altered flow directions in the vicinity of Elfrida where a cone of depression has developed.

Agriculture near Elfrida, Douglas Baisn. The basin has been severely over-drafted since the late 1940s and much of the basin is designated as an Irrigation Non-Expansion Area to restrict agricultural expansion.

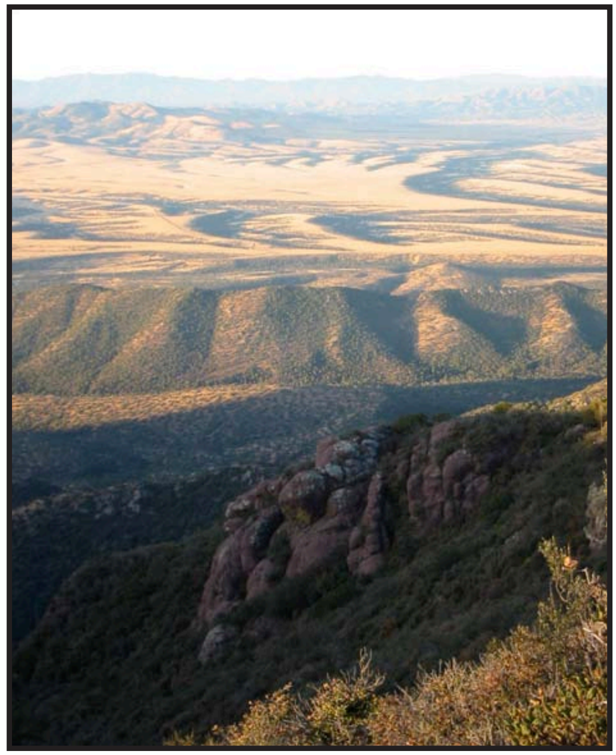
Groundwater recharge occurs mainly in washes and along mountain fronts (Rascona, 1993) and is estimated at 15,500 to 22,000 AFA (Table 3.5-5). Incidental recharge may also come from infiltration of agricultural irrigation (USGS, 2006b). Groundwater discharge is primarily from groundwater pumping of almost 53,000 AFA. Groundwater in storage estimates range from 26 to 32 maf. The basin has been severely over-drafted since the late 1940s and much of the basin was designated as an Irrigation Non-Expansion Area in 1980 to restrict agricultural expansion. As mentioned previously, concerns about the future availability of water in the basin is a subject of an investigation to compile hydrologic data and information (USGS, 2006b). Between 1990-1991 and 2003-2004, water levels declined in most wells measured in the basin, particularly in the Elfrida area and north of Douglas (Figure 3.5-6). Groundwater quality is generally suitable for most uses although elevated fluoride concentrations have been measured in a number of wells (Table 3.5-6).

San Bernardino Valley

The San Bernardino Valley Basin is covered by volcanic flows and cinder cones with some relatively thin alluvial deposits. Groundwater is obtained from sand and gravel interbedded with basalt flows or from shallow alluvium. Springs and artesian wells support wetlands designated as the San Bernardino National Wildlife Refuge adjacent to the international border. Groundwater flow is from the mountains toward the valley center and south to Mexico. Estimated groundwater recharge is 9,000 AFA and groundwater storage estimates range from 1.6 to 2.0 maf (Table 3.11-3). Most wells in the basin are located immediately north of the international border where water levels are generally less than 100 feet below land surface. The depth to water increases to the north and toward the mountains along the basin margins on the west, north and east. Little groundwater data are available for the basin.

San Rafael Basin

The San Rafael Basin consists of a broad north-trending valley surrounded by block-fault mountains and drained by the Santa Cruz River whose headwaters are in the northern portion of the valley. Groundwater is obtained from stream alluvium and basin fill. Groundwater is found in stream alluvium along the Santa Cruz River and its major tributaries. Basin fill occupies most of the valley and is composed of clay, silt, sand and gravel. The basin fill has been estimated to be as much as 1,900 feet deep based on well logs. Bultman (1999) estimated that the San Rafael basin may contain an aquifer up to approximately 1,000 feet thick over a substantial area consisting of upper basin fill. Groundwater flow is from the mountains toward the Santa Cruz River and then south. Groundwater recharge is from mountain front recharge and infiltration of runoff in stream channels. Groundwater recharge is estimated at 5,000 AFA (Table 3.12-5). Estimated groundwater in storage ranges from 4 to 5 maf. Water levels are relatively shallow (25 feet bls or less) in the streambed alluvium and generally at levels over 100 feet bls in the basin fill. Well yields are generally higher in the streambed alluvium. There is little water quality data available for the basin but drinking water exceedences of arsenic, antimony, lead and radionuclides have been detected in wells in the western part of the basin, an area of historic mining activity.



San Rafael Valley, San Rafael Basin.

<u>Other Basins</u>

Two basins, Cienega Creek and Willcox, have hydrogeologic conditions that are unique in the planning area. The Cienega Creek Basin has three groundwater sections based on the presence of distinctive aquifers and groundwater flows to the north and to the southwest. Groundwater in the Willcox Basin is generally isolated from surrounding basins, with groundwater flow primarily to the center of the basin, the Willcox Playa.

Cienega Creek Basin

The Cienega Creek basin consists of a narrow northeast trending alluvial valley, drained by Cienega and Sonoita creeks, and surrounded by fault-block mountains. There is a surface water divide southwest of Sonoita, with Cienega Creek flowing northeast and Sonoita Creek flowing to the south and west. Hydrogeologic conditions in the basin are complex. The basin has been divided into three subareas based on the presence of a distinctive aquifer or set of aquifers: upper Cienega Creek, lower Cienega Creek and Sonoita Creek. "The Narrows" (T18S, R18E, S6), where bedrock outcrops on both sides of the Cienega Creek channel, divides the lower and upper Cienega Creek subareas (Bota, 1997). The upper Cienega Creek subarea includes most of the basin's central valley. The main aquifer is basin fill, which is deepest in the southern part of the subarea between Sonoita and Elgin. To the north, the lower Cienega Creek subarea extends to the northern basin boundary. It contains three aquifers: stream alluvium, basin fill and the Pantano formation. The main aquifer in this subarea is the stream alluvium. The basin-fill alluvium is a relatively poor aquifer in this subarea with relatively low well yields and interbedded clay layers that create a leaky, confined and artesian aquifer conditions. The southwestern part of the basin is the Sonoita Creek subarea where the main aquifer is the stream alluvium that forms the floodplain of Sonoita Creek and its tributaries and may be up to 90-feet thick. Wells drilled in the basin fill are generally low yielding. Groundwater flow follows the surface water flow direction with flow toward the northeast, north of Sonoita, and to the south, south of Sonoita.

Groundwater recharge comes from mountain front recharge and streambed infiltration along Cienega and Sonoita creeks and their tributaries. Groundwater recharge estimates vary from 8,500 to 25,500 AFA, although this does not include the Sonoita Creek subarea (Table 3.3-5). Estimates of groundwater in storage range from 5.1 to 11 maf. Water level trends are generally stable with some declines noted near Patagonia and east of Sonoita (Figure 3.3-6). Groundwater quality is generally good although cadmium and copper concentrations exceeding drinking water standards have been measured in several wells in the vicinity of Patagonia.

Willcox Basin

The Willcox Basin occupies the northern part of the Sulphur Springs Valley and is hydrologically separate from the southern part of the valley, the Douglas Basin. Groundwater in the Willcox Basin is found in alluvial deposits consisting of stream and lake-bed deposits. The stream deposits are the most productive water-bearing unit. The clay-rich lake bed deposits outcrop in the Willcox Playa. There they create localized artesian conditions. Where the coarse-grained stream deposits are underlain by the lake-bed deposits, perched groundwater conditions may occur. A playa is a nearly level area at the bottom of a closed desert basin, sometimes temporarily covered by water.

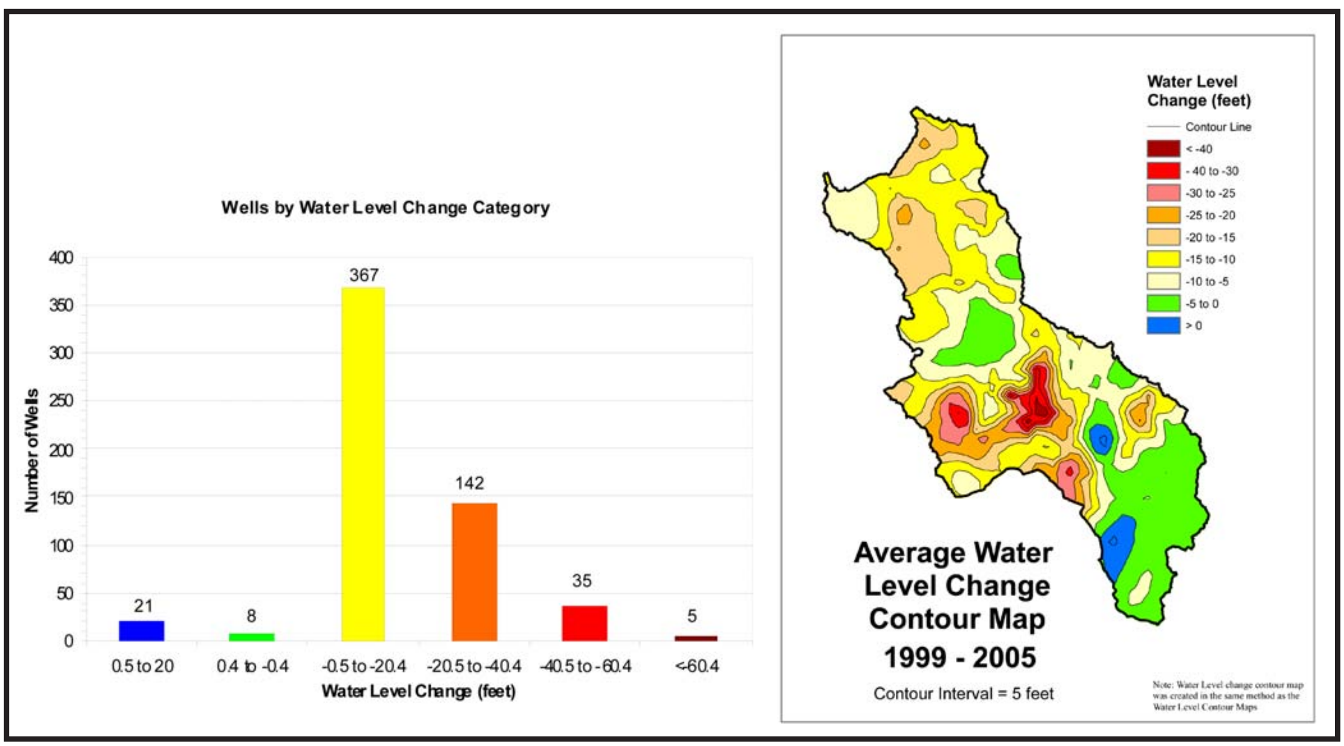
The Willcox Basin has internal surface water drainage and groundwater flow is thought to have mirrored surface drainage under predevelopment conditions; moving from the outer margins toward the Willcox Playa (Oram, 1993). However, groundwater flow conditions have been altered significantly due to groundwater pumping for agriculture. Several relatively large cones of depression have developed in the basin including one southeast of the Willcox Playa and another north of the City of Willcox (Figure 3.14-6). Groundwater recharge has been estimated at 15,000 to 47,000 AFA primarily from mountain front recharge and also from agricultural irrigation and stream channel runoff (USGS, 2006b). Groundwater discharge is primarily from groundwater pumping of more than 176,000 AFA. Estimates of groundwater in storage range from 42 to 59 maf (Table 3.14-6).

Declines in groundwater levels (in excess of 200 feet measured in nine wells between 1954 and 1975), may have caused land subsidence in the basin (USGS, 2006b). Figure 3.14-6 shows groundwater level changes between 1990-1991 and 2003-2004. A number of declines of greater than 30 feet were measured in wells in the central part of the basin during this period. Concerns about groundwater level declines and future availability of water for all uses has led to an investigation of the geology and hydrology of the Willcox and Douglas basins (USGS, 2006b). As part of this effort, the Department released a Water Level Change Map Series Report (No. 1) in 2008 summarizing depth to water measurements taken at 578 wells in the Willcox Basin in November/December 1999 and November/December 2005. Most of the wells (549 of 578 or 95%) showed a water level decline. Forty had declines of more than 40 feet and most of these were located in the area southeast of the Willcox Playa in a predominantly agricultural area (Jacobson and others, 2008). A summary of the water level changes and a water level change contour map from the map series report are shown in the graphic below. As shown, most water levels declined between 0.5 and 20.4 feet. A median well yield of 750 gpm was reported from over 1,000 large diameter wells in the basin (Table 3.14-6).

Elevated TDS concentrations exist in some areas and fluoride and arsenic concentrations above drinking water standards have been reported in a number of wells (Table 3.14-7).

Surface Water Hydrology

The U.S. Geological Survey (USGS) divides and subdivides the United States into successively smaller hydrologic units based on hydrologic features. These units are classified into four levels. From largest to smallest these are: regions, subregions, accounting units and cataloging units. A hydrologic unit code (HUC) consisting of two digits for each level in the system is used to identify any hydrologic area (Seaber et al., 1987). A 6-digit code corresponds to accounting units, which are used by the USGS for designing and managing the National Water Data Network. There are portions of five watersheds in the planning area at the accounting unit level: Lower Colorado River below Lake Mead; Middle Gila River; Rio Bavispe; San Pedro River; Santa Cruz River; and the Upper Gila River (Figure 3.0-5). More detailed information on stream flow, springs, reservoirs



Excerpt from ADWR Water Level Change Map Series Report No. 1 on the Willcox Basin (Jacobson and others, 2008) and general surface water characteristics are found in the individual basin sections.

Middle Gila
The Middle Gila Watershed extends west from Coolidge Dam to the confluence of the Gila and Salt rivers in the Phoenix AMA. The San Pedro River is the major tributary to this watershed in the Southeastern Arizona Planning Area. Dripping Springs Wash, Donnelly Wash and the northernmost part of the Lower San Pedro basins are included in the Watershed. Below Coolidge Dam, flow in the Gila River is from releases from the San Carlos Reservoir and flood flow from the San Pedro River (ADWR, 1994). Perennial streams include the Gila River, and portions of the San Pedro River and Mineral Creek in the Lower San Pedro Basin, Box Canyon in the Donnelly Wash Basin and Mescal Creek in the Dripping Springs Wash Basin (see Figures 3.8-6, 3.5-5 and 3.6-5).

Since 1936, an average of 260,000 AFA of reservoir storage and inflows have been released

Figure 3.0-5 Southeastern Arizona USGS Watersheds
(Data Source: USGS 2005)

to the river below Coolidge Dam (ADWR, 2006). There are three streamgages in the watershed. The highest annual flow was recorded at the Kelvin gage where a flow of 2.375 maf was measured in 1993. Annual median flow at this gage is approximately 324,300 acre-feet (see Table 3.8-2). This gage is located downstream of the confluence of the San Pedro and Gila rivers.

There are two major (10 gpm or greater) springs in the watershed, both located in the Dripping Springs Wash Basin. Both are warm springs with measured discharges of 200 gpm (Mescal Warm Spring) and 165 gpm (Coolidge Dam Warm Spring). These measurements were taken during or prior to 1982 and may not be indicative of current conditions.

Ten miles of Mineral Creek, located northwest of Kearny, are impaired due to elevated concentration of copper and selenium.

Rio de Bavispe

The Rio de Bavispe Watershed drains south and extends into New Mexico and Mexico. Major drainages in Arizona are Whitewater Draw and Black Draw which are tributary to the Rio de Bavispe in Mexico. The Rio de Bavispe joins the Rio Yaqui which discharges into the Gulf of California. The watershed includes most of the Douglas Basin, the southernmost portion of the Willcox Basin, and the entire San Bernardino Valley Basin. Whitewater Draw is the major drainage in the Douglas Basin. Black Draw is the main surface water drainage in the San Bernardino Valley Basin and becomes perennial just north of the international boundary. In this basin, artesian wells and springs support wetlands near the border. In addition to Black Draw, perennial streams in the watershed include reaches of Rucker Canyon in the Willcox Basin, and Leslie Creek in the Douglas and Willcox basins (see Figures 3.5-5 and 3.14-5).

Gila River, Donnelly Wash Basin. Below Coolidge Dam, flow in the Gila River is from releases from the San Carlos Reservoir and flood flow from the San Pedro River.

There are two active streamgages in the watershed. The gage at Whitewater Draw near Douglas recorded a maximum annual flow of approximately 22,300 acre-feet in 1955 with a median annual flow of 5,960 acre-feet. The other operating gage is on Leslie Creek near McNeal with a median annual flow of approximately 750 acre-feet. There are no major springs in the watershed.

San Pedro-Willcox Watershed

The Arizona portion of the San Pedro River Watershed is contained entirely within the planning area. Approximately 696 square miles of the Watershed extends into Mexico. In Arizona, the Watershed includes all of the Aravaipa Canyon and Upper San Pedro basins, most of the Lower San Pedro and Willcox basins and relatively small portions of the Cienega Creek, Douglas and San Rafael basins. A few tributaries to the San Pedro River begin on the southwest slopes of the Huachuca Mountains in the San Rafael Basin and drain into Mexico. (ADWR, 2005a) The San Pedro River enters the U.S. from Mexico near Palominas (see Figure 3.13-1) and flows north to its confluence with the Gila River. Major tributaries are the Babocomari River and Aravaipa Creek.

With the exception of Whitewater Draw in the extreme southern end of the basin that drains

San Pedro River at Charleston, Upper San Pedro Basin. The largest annual flow ever measured in the watershed, 152,798 acre-feet, was recorded at this gage in 1914.

into the Douglas Basin, most of the surface water drainage in the Willcox Basin is to the Willcox Playa. The playa occupies about 50 square miles in the center of the basin and is a remnant of Pleistocene-age Lake Cochise. (Oram, 1993)

Some stretches of the San Pedro River are perennial, although recent drought and delay of the summer monsoon has affected some previously perennial stretches for short periods of time, most notably at Charleston in the Upper San Pedro Basin. The Babocomari River, in the Upper San Pedro Basin, is perennial in its upper reach. Aravaipa Creek is perennial within Aravaipa Canyon above its confluence with the San Pedro River as are three of its tributaries in the Aravaipa Canyon Basin (see Figures 3.1-5 and 3.8-5). Other perennial streams are found in the Lower San Pedro, Upper San Pedro and Willcox basins (Figures 3.8-5, 3.13-5 and 3.14-5).

There are 12 active streamgages in the watershed; two in the Lower San Pedro Basin and 10 in the Upper San Pedro Basin. The gage on the San Pedro River at Charleston has been in operation since 1904. The largest annual flow ever measured in the watershed, (152,798 acre-feet), was recorded at this gage in 1914. More recently, in 1984, a maximum annual flow of 102,107 acre-feet was measured at the gage on the San Pedro River near Tombstone. Median annual flow at these gages is 33,203 acre-feet and 29,654 acre-feet, respectively.

The only major springs in the watershed are found in the Lower San Pedro and Upper San Pedro basins. There are 14 major springs in the Lower San Pedro Basin. The largest, Cooks Lake Spring, had a discharge rate of 1,000 gpm when last measured in 1951. Twelve major springs have been identified in the Upper San Pedro Basin. The largest is Garden Canyon No.1 with a discharge of 134 gpm measured in 1963. Most of the spring measurements in both basins date from before 1980 and may not be indicative of current conditions (see Tables 3.8-5 and 3.13-5).

Fifteen miles of the San Pedro River in the Lower San Pedro Basin, from Aravaipa Creek to the Gila River, are impaired due to elevated concentrations of E. coli and selenium (Table 3.8-7). In the Upper San Pedro Basin, water quality standards were exceeded in three reaches of the San Pedro River for a total of 53 miles. These reaches are impaired due to elevated levels of E. coli, nitrate and copper (Table 3.13-7).

<u>Santa Cruz Watershed</u>

The Santa Cruz Watershed includes most of the Cienega Creek and San Rafael basins and extends south into Mexico and west to include the Santa Cruz AMA and most of the Tucson and Pinal AMAs. The Santa Cruz River originates in the San Rafael Valley and flows southward to Mexico before turning north and reentering the U.S. east of Nogales, Arizona. Surface water in the Cienega Creek Basin drains west to the Santa Cruz River from Sonoita Creek and north to tributaries of the Santa Cruz River from Cienega Creek.

The Santa Cruz River is perennial in the planning area. In the Cienega Creek Basin

Santa Cruz River near the headwaters, San Rafael Basin.

there are perennial reaches of Cienega Creek, Sonoita Creek and Red Rock Canyon. The only streamgage on the Santa Cruz River is near Lochiel with a maximum annual flow of 12,600 acre-feet measured in 1955. Median flow at this gage is 1,410 acre-feet. The only other streamgage in the watershed is a gage on Cienega Creek near Sonoita (see Table 3.3-2).
Major springs are located only in the Cienega Creek Basin. The largest of the seven major springs is Monkey Spring with a discharge rate of 430 gpm. A measurement date is lacking for this spring (Table 3.3-5).

There are several impaired waters in the Santa Cruz Watershed. Parker Canyon Lake in the San Rafael Basin contains elevated levels of mercury. In the Cienega Creek Basin, a total of 20 miles of impaired stream reaches occur on Alum Gulch, Harshaw Creek, Humboldt Canyon and on an unnamed tributary to Harshaw Creek. These waters contain concentrations of cadmium, copper, zinc or pH that exceed standards (Table 3.3-6).

Upper Gila Watershed

The Upper Gila Watershed drains about 7,400 square miles in the planning area above Coolidge Dam and contains the Bonita Creek, Duncan Valley, Morenci, and Safford basins. Major tributaries include the San Francisco River, Eagle Creek, Bonita Creek, San Simon Creek and the San Carlos River.

An average of about 160,000 AFA of Gila River water flows into Arizona from New Mexico and over 40% of this flow typically occurs in the winter. Tributary inflows from the San Francisco River are significant, typically over 150,000 AFA. Inflow to the San Carlos Reservoir from the Gila and San Carlos Rivers averages about 310,000 AFA (ADWR, 2006). There are three active streamgages on the Gila River. The maximum annual flow recorded was at a gage near Solomon with a flow of 1.56 maf in 1993. Median flow at this gage is approximately 273,000 AFA (see Table 3.10-2).

The San Francisco River is perennial with a number of hot springs located above Clifton. The Gila River has a 35-mile perennial stretch

Upper Gila River near Three Way in the Duncan Valley Basin. The Gila River has a 35-mile perennial stretch about 20 miles northwest of the New Mexico state line. Flow in the River becomes intermittent downstream due to irrigation diversions and seasonal variations in flow.

about 20 miles northwest of the New Mexico border. Flow in this stretch is maintained by tributary inflow and springs, including hot springs (ADWR, 1994). Flow in the Gila River becomes intermittent farther downstream due to irrigation diversions and seasonal variations in flow (ADWR, 2006).

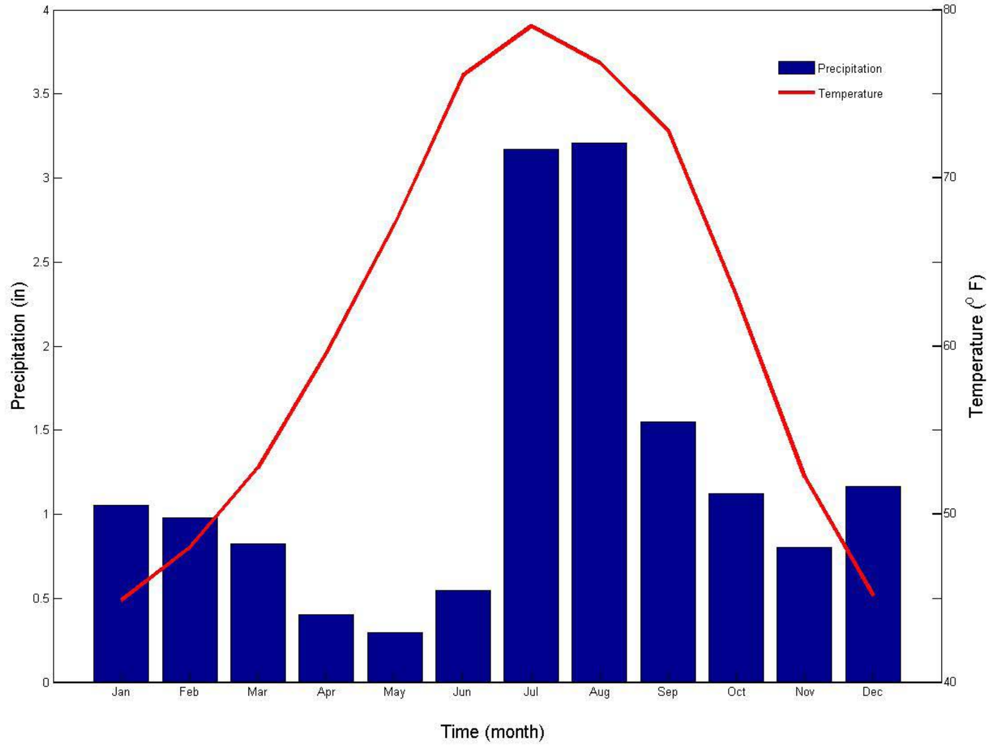
The largest spring in the planning area is located in the Safford Basin. Warm Springs, with a measured discharge of almost 3,400 gpm is located at the headwaters of the San Carlos River. There are also a number of large springs downstream of Pima near the Gila River (USGS, 2006c). In total, there are 22 major springs in the Safford Basin. Other major springs are found in the Bonita Creek Basin (1 spring), Duncan Valley Basin (2), and Morenci Basin (9). Most of the spring measurements shown on the springs tables in sections 3.2, 3.7, 3.9 and 3.10 were taken between 1940 and 1982 and may not be indicative of current conditions.

In the Safford Basin, a 6-mile reach of the Gila River exceeded the water quality standard for E.coli and turbidity and a 8-mile reach of Cave Creek exceeded the standard for selenium (Table 3.10-7). In the Morenci Basin, water quality standards were exceeded at Luna Lake and in a 13-mile reach of the San Francisco River near Alpine (Table 3.9-7).

3.0.3 Climate[2]

Annual average precipitation in the planning area is 14.7 inches, with over 52% coming in July, August, and September (Figure 3.0-6). This planning area receives the most summer precipitation in the state because of its proximity to the core monsoon region in Mexico. The monsoon is strongest in northwestern

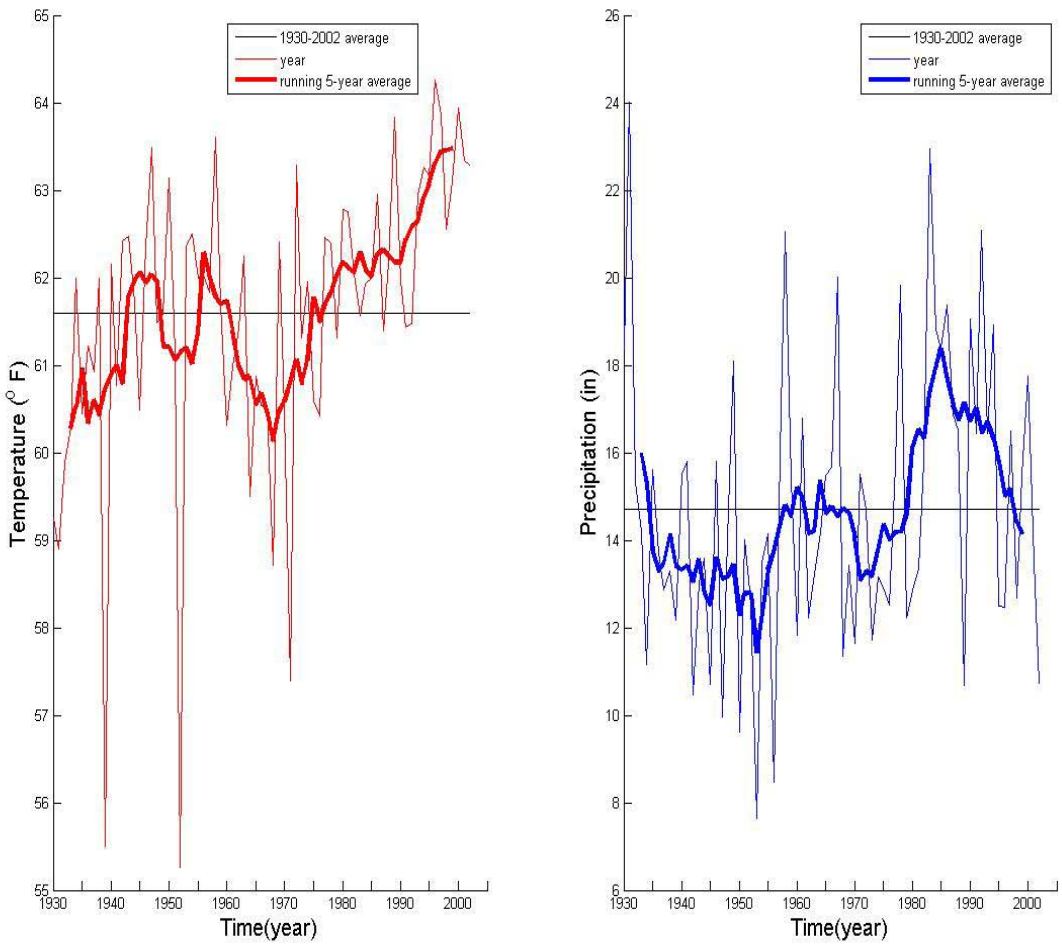
Figure 3.0-6 Average monthly precipitation and temperature in the Southeastern Arizona Planning Area, 1930-2002



Data are from selected Western Regional Climate Center cooperative weather observation stations.
Figure author: CLIMAS.

[2] Information in this section was provided by the Institute for the Study of Planet Earth, Climate Assessment for the Southwest (CLIMAS), University of Arizona, October, 2006.

Figure 3.0-7 Average temperature (left) and total precipitation in the Southeastern Arizona Planning Area from 1930-2002



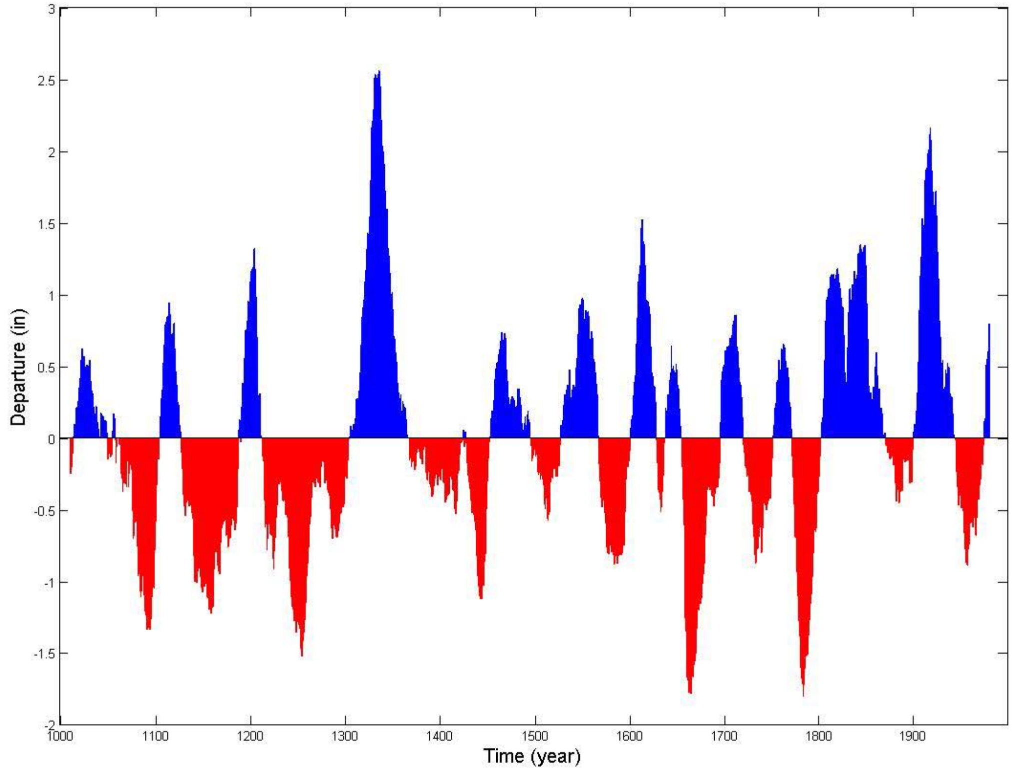
Horizontal lines are average temperature (61.6 °F) and precipitation (14.7 inches), respectively. Light lines are yearly values and highlighted lines are 5-year moving average values. Data are from selected Western Regional Climate Center cooperative weather observation stations. Figure author: CLIMAS.

Mexico, and Arizona usually only receives the northernmost fringes of precipitation. Pool and Coes (1999) noted that trends in seasonal precipitation at four stations in the southern half of the Upper San Pedro Basin showed a general trend of increasing winter precipitation and decreasing wet-season (summer) precipitation during the period 1956-1997.

Summer precipitation from thunderstorms is less hydrologically efficient than winter precipitation, because monsoon storm cells are spatially discontinuous and high summer temperatures result in high evaporation rates. About 35% of planning area precipitation occurs during winter months (November – April), mostly from frontal storm systems. At higher elevations, this precipitation falls as snow. Slow water release from high elevation spring snowmelt and low evaporation rates make winter precipitation more hydrologically efficient because there is less runoff and greater gain to streams.

As in other areas of Arizona, precipitation is extremely variable, both spatially and from year

Figure 3.0-8 Arizona NOAA climate division 7 (southeastern Arizona; Graham, Greenlee, Cochise, Santa Cruz, and Pima Counties) winter (November-April) precipitation departures from average, 1000-1988, reconstructed from tree rings



Data are presented as a 20-year moving average to show variability on decadal time scales. Values shown for each year are centered on a 20 year period. The average winter precipitation for 1000-1988 is 4.9 inches. Data: Fenbiao Ni, University of Arizona Laboratory of Tree-Ring Research and CLIMAS. Figure author: CLIMAS.

to year. For example, during the 2005-2006 winter, the planning area received 6.3 inches less precipitation than during the 2004-2005 winter. This variability can also be observed on longer time scales. The 1950s were a relatively dry decade with an average annual precipitation deficit of -1.46 inches, while the 1980s were a relatively wet decade with an average annual precipitation surplus of 1.86 inches (Figure 3.0-7). Annual average temperature in the planning area is 61.6° F, compared to the statewide average of 59.9° F. As in other parts of Arizona, temperatures have been increasing the past several decades. Temperature observations are consistent with global temperature trends; however, some warming may be attributed to changes in land-cover resulting from population growth.

Winter precipitation records dating to 1000 A.D. reconstructed from tree rings show extended periods of above and below average precipitation in every century (Figure 3.0-8) in the area encompassed in Climate Division 7, which includes the planning area and parts of others. A climate division is a region within a state that is generally climatically homogeneous. Arizona has been divided into seven climate divisions. These decadal and shorter time period shifts are related to circulation changes in the Pacific Ocean. On time scales of 10-30 years, precipitation variability is likely related to shifts in Pacific Ocean circulation patterns, such as the El Niño-Southern Oscillation (ENSO) or the Pacific Decadal Oscillation (PDO). On time scales of 2-7 years, the ENSO, with its phases of El Niño and La Niña, is associated with precipitation variations in the region, most notably during winter months (November-April). During El Niño episodes, there are greater chances for above-average winter precipitation, while La Niña conditions are usually associated with below-average winter precipitation. However, El Niño winters can also produce below-average precipitation. Generally, La Niña conditions are associated with drought in the region. The ENSO phases also impact precipitation and monsoon strength in the region.

3.0.4 Environmental Conditions

Environmental conditions reflect the impacts of geography, climate and cultural activities and may be a critical consideration in water resource management and supply development. The sky island ecosystems of the planning area are relatively isolated from each other, and as a result there are a large number of endemic species in the planning area mountain ranges. These ecosystems are of major interest to resource managers due to their biological diversity and distinct biogeography. (Warshall, 2006) Discussed in this section is vegetation, riparian protection through the Arizona Water Protection Fund Program, instream flow claims, threatened and endangered species, public lands protected from development as national parks, monuments, memorials, wildlife refuges, national conservation areas, wilderness areas and other protected areas, and unique waters.

Vegetation[3]

Four of Arizona's six ecoregions are included in the planning area: the Arizona Mountains Forests along the northern boundary; the Chihuahuan Desert, interspersed with Sierra Madre Occidental Pine-oak Forests, which covers most of the planning area; and the easternmost extension of the Sonoran Desert in the northwest. (Figure 3.0-9) The Chihuahuan Desert region may have grown by as much as a third in the last few hundred years due to human activities including poor agricultural practices that have eroded grasslands (CDRI, 2008).

Because of the wide elevation range in the planning area, many biotic communities are represented, ranging from sub-alpine forests at the highest elevations in the Pinaleño, Chiricahua and White mountains to Arizona Uplands Sonoran desertscrub.

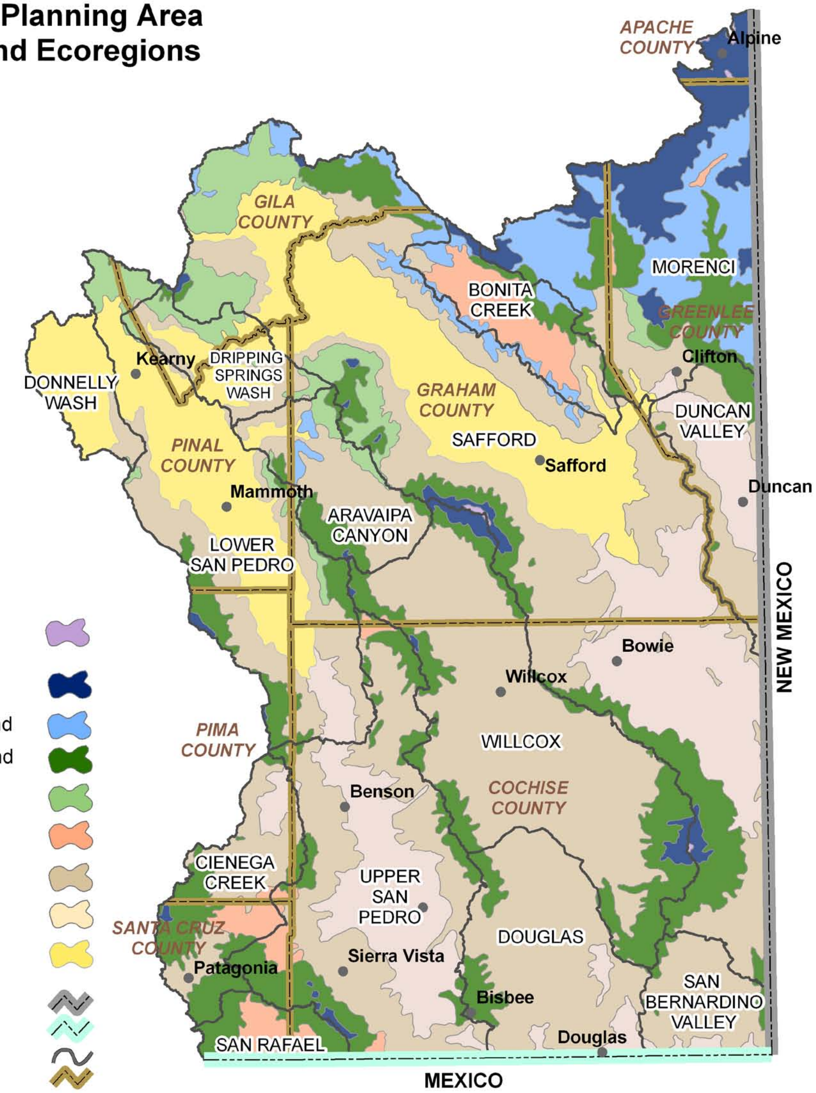
As shown in Figure 3.0-9 high elevation subalpine and montane conifer forests, consisting of dense stands of fir, spruce and aspen trees, are found at the highest elevations

Blue River, Morenci Basin. Conifer woodlands, consisting of primarily of ponderosa pine, occur at elevations between 6,000 and 9,000 feet that receive about 18 to 26 inches of annual precipitation.

[3] Except as noted, information in this section is from Brown, D, 1982 and from AZGF, 2004.

Figure 3.0-9
Southeastern Arizona Planning Area
Biotic Communities and Ecoregions

Ecoregions



Biotic Communities

- Rocky Mountain Subalpine Conifer Forest
- Rocky Mountain & Montane Madrean Conifer Forest
- Great Basin Conifer Woodland
- Madrean Evergreen Woodland
- Interior Chaparral
- Plains and Great Basin Grasslands
- Semidesert Grassland
- Chihuahuan Desertscrub
- Arizona Uplands Sonoran Desertscrub
- New Mexico State Boundary
- International Boundary
- Basin Boundary
- *COUNTY*

ARIZONA DEPARTMENT OF WATER RESOURCES ©

Biotic Communities Source: Brown and Lowe, 1980
Ecoregions Source: Olson et al, 2001

in the planning area, primarily in the Morenci Basin. These areas receive much of their annual precipitation as snow. Because of the forest density, sunlight reaches the ground and snow melts slowly, releasing snowmelt gradually to streams. Annual precipitation amounts are about 25 to over 30 inches a year in these areas.

Conifer woodlands consisting primarily of ponderosa pine occur at elevations between 6,000 and 9,000 feet that receive about 18 to 26 inches of annual precipitation. Piñon-juniper woodlands cover large areas below the ponderosa pine forest at elevations between 5,500 and 7,000 feet that receive 12 to 20 inches of precipitation. Plains and Great Plains grasslands occur in several locations in the planning area at elevations between 5,000 and 7,000 feet that receive between 11 and 18 inches of annual precipitation. These areas are located primarily in the Bonita Creek, Cienega Creek, San Rafael and Upper San Pedro basins. The piñon-juniper woodland and madrean evergreen woodland is often intermixed with this grassland in the planning area.

At lower elevations (4,000-6,000 feet), interior chaparral is found in areas that receive 13 to 23 inches of annual precipitation. Chaparral consists of dense shrubs that grow around the same height with occasional taller shrubs or small trees. Chaparral communities typically are a mix of several shrubby species such as mountain mahogany, shrub live oak, and manzanita and commonly include cactus, agave, and yucca. Chaparral plants are well adapted to drought conditions. This community is found in the northwestern part of the planning area.

Semi-desert grasslands are found in all planning area basins except the San Rafael basin, occurring in valleys between the desert and woodlands or chaparral at elevations between 3,500 and 5,000 feet that receive annual precipitation of 10 to 15 inches. This community is particularly predominant in the Douglas and Willcox basins.

Chihuahuan desertscrub in the Upper San Pedro Basin. The planning area contains the only Chihuahuan desertscrub community in Arizona.

Desert grasslands often contain a mixture of grasses, shrubs and small trees.

The planning area contains the only Chihuahuan desertscrub community in Arizona. Found primarily in northeastern Mexico, its easternmost extension occurs extensively in the Duncan Valley, Safford, and Upper San Pedro basins, with smaller areas in the Cienega Creek, Douglas, Lower San Pedro and San Bernardino Valley basins. In Arizona, this community occupies plains, low hills and bajadas generally above 4,000 feet in elevation. Precipitation averages range from about 8 inches to more than 12 inches, much of which falls during the summer. Prominent plant species include creosotebush, lechuguilla, sotol, yucca, ocotillo, acacia and mesquite. (CDRI, 2008)

Arizona Uplands Sonoran desertscrub extends into the northwestern portion of the planning area below about 3,500 feet, in Aravaipa Canyon, Dripping Springs, Donnelly Wash, Lower San Pedro and Safford basins. Typical vegetation includes palo verde, mesquite, creosote, and cacti, including Saguaro cacti.

There are extensive reaches of riparian vegetation in some locations in the planning area. The general location of riparian vegetation is shown in Figure 3.0-11. Cultural water use has lowered groundwater levels and surface water diversions and impoundments have impacted streamflow in a number of areas. On Bonita Creek, woodcutting for mines, overgrazing, beaver trapping and a water conveyance system to Safford has reportedly reduced topsoil as much as 50% and down cut the creek as much as 12 feet (Tellman, et al, 1997).

The Gila River, which once was perennial for most of its length in Arizona has been altered in the planning area by Coolidge Dam and farming activities. However, groundwater levels along the river remain high. Floods have had significant impacts on riparian vegetation in a number of locations. Cottonwood has increased in narrow reaches of the river and in bedrock canyons but has decreased in the wide valleys where it once was common due to channel-widening floods in the early part of the 20th century. Tamarisk and mesquite species have increased since the middle of the twentieth century, and large floods in the last third of the 20th century did not significantly reduce tamarisk. (Webb, et al 2007)

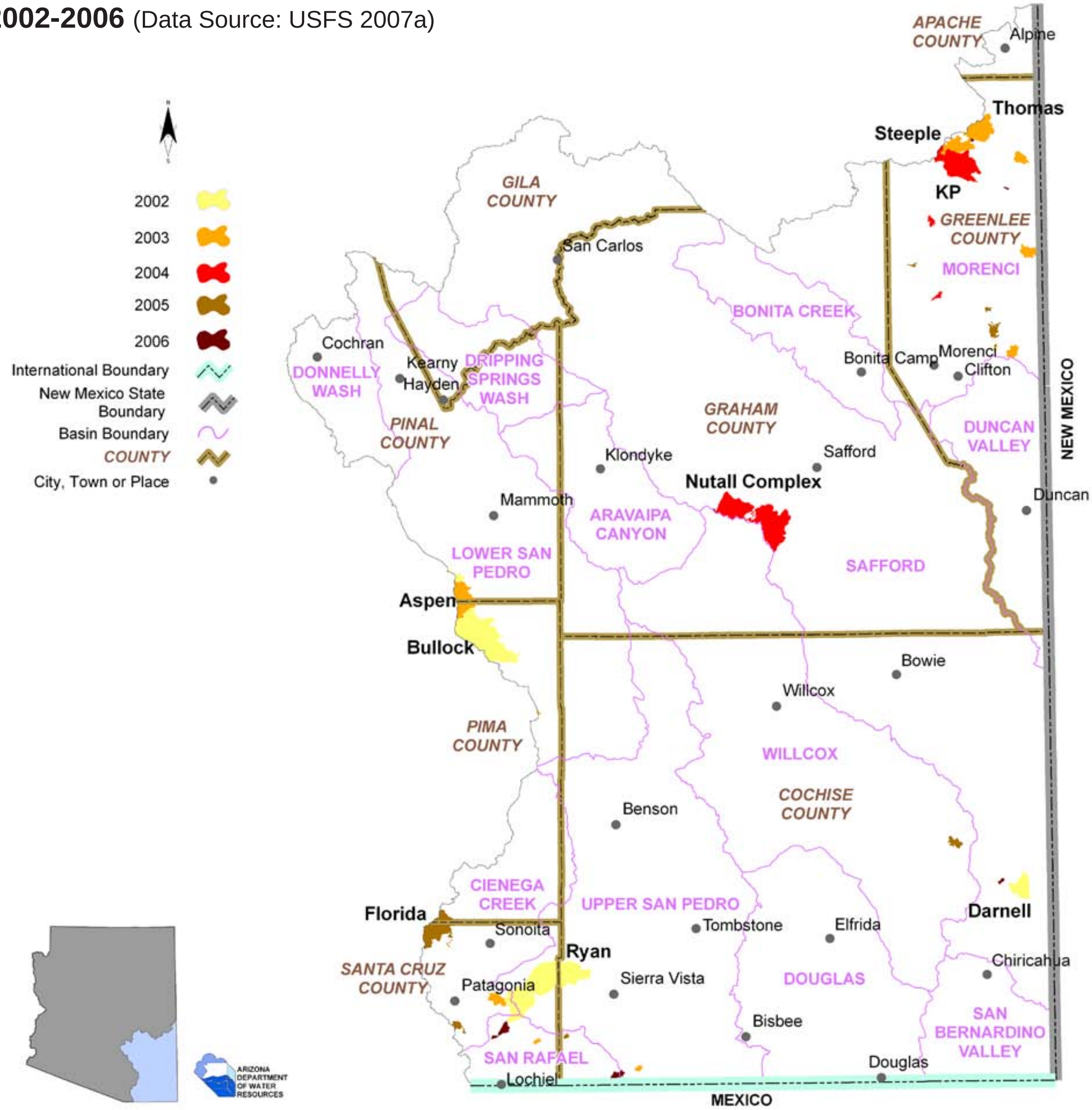
Gila River, Dripping Springs Wash Basin. Tamarisk and mesquite species have increased since the middle of the twentieth century on the Gila River.

The San Pedro River was a broad river of cienegas (marshes) when first observed by Spanish expeditions in the 1600s and 1700s. Stream entrenchment began in the 1880s and by the early 1890s had spread along the length of the river. The San Pedro River channel began to stabilize during the 1950s (ADWR, 2005a). Riparian vegetation has generally increased along the river north of the international border despite notable floods in 1983 and 1993. Gallery cottonwood forests exist along the upper San Pedro River, at scattered locations between Benson and San Manuel and near its confluence with the Gila River (Webb, et al., 2007).

Historically, the San Simon River was a broad intermittent stream that meandered through the San Simon Valley. Settlers channelized the river in the 1880s to control flooding and direct its flow until it eventually became a 60 mile long, 600 to 800 foot wide river, 10 to 30 feet deep. Restoration efforts began in the 1930s and numerous erosion control structures have been built on the river. (Tellman, et al, 1997) Since then, riparian vegetation, primarily tamarisk, has increased while mesquite have increased on channel banks. Downstream, near Solomon, native riparian species are increasing including Fremont cottonwood and black willow. (Webb, et al., 2007)

Several large fires have occurred in the planning area since 2002 as shown in Figure 3.0-10. The largest were the Nutall Complex fire in the Pinaleño Mountains, the Ryan Fire in the Huachuca Mountains and surrounding grasslands, and the Bullock and Aspen fires in the

Figure 3.0-10 Southeastern Arizona Planning Area Location of Major Wildfires 2002-2006 (Data Source: USFS 2007a)



Santa Catalina Mountains. The Nutall Complex fire burned over 29,400 acres and threatened the Large Binocular Telescope Observatory on Mount Graham. The Aspen Fire burned for a month and destroyed much of the community of Summerhaven in the Tucson AMA.

Arizona Water Protection Fund Program

Forty-five riparian restoration projects in the Southeastern Arizona Planning Area have been funded by the Arizona Water Protection Fund Program (AWPF) through FY 2008. The objective of the AWPF program is to provide funds for protection and restoration of Arizona's rivers and streams and associated riparian habitats. There are funded projects in ten of the fourteen planning area basins. Most projects have been funded in the Safford, Upper San Pedro, Cienega Creek and Lower San Pedro basins. Many of these projects were for the purpose of fencing, often in conjunction with water development, and for research. A list

list of projects and types of projects funded in the Southeastern Arizona Planning Area through FY 2008 is found in Appendix A of this volume. (A description of the program, a complete listing of all projects funded, and a reference map is found in Appendix C of Volume 1.)

Instream Flow Claims

An instream flow right is a non-diversionary appropriation of surface water for recreation and wildlife use. Thirty-four applications for instream flow claims have been filed in the Southeastern Arizona Planning Area as of August 2008. They are listed in Table 3.0-1 and shown on Figure 3.0-11. Claims have been filed in nine of the fourteen planning area basins. Certificates have been issued for claims on Aravaipa Creek in the Aravaipa Canyon and Lower San Pedro basins; Bass Canyon in the Lower and Upper San Pedro basins; Hot Springs Canyon and Wildcat Canyon in the Lower San Pedro Basin; Leslie Creek in the Douglas Basin; Mescal Creek in the Dripping Springs Wash Basin; and O'Donnell Creek, Ramsey Canyon and the San Pedro River in the Upper San Pedro Basin. Other basins with instream flow applications are Bonita Creek, Duncan Valley, Morenci and Safford.

Table 3.0-1 Instream flow applications in the Southeastern Arizona Planning Area

Map Key	Stream	Applicant	Application No.	Permit No.	Certificate No.	Filing Date
1	Aravaipa Creek	BLM (Phoenix)	33-87114.0	87114	87114	6/1/1981
2	Aravaipa Creek	The Nature Conservancy	33-95488.0	95488	95488	10/31/1990
3	Aravaipa Creek	The Nature Conservancy	33-95489.0	95489	95489	10/31/1990
4	Aravaipa Creek	The Nature Conservancy	33-95490.0	95490	95490	10/31/1990
5	Aravaipa Creek	The Nature Conservancy	33-95771.0	95771	95771	10/31/1990
6	Babocomari River	BLM (Safford)	33-95487.0	Pending	Pending	10/2/1990
7	Babocomari River	BLM (Safford)	33-96167.0	Pending	Pending	2/3/1992
8	Bass Canyon	BLM (Safford)	33-94371.0	94371	94371	12/1/1988
9	Bass Canyon	The Nature Conservancy	33-96278.0	96278	96278	12/1/1988
10	Bonita Creek	BLM (Safford)	33-90250.0	Pending	Pending	10/21/1985
11	Buehman Canyon	Arizona State Land Department	33-90249.1	Pending	Pending	10/21/1985
12	Buehman Creek	The Nature Conservancy	33-96545.0	Pending	Pending	3/4/1997
13	Gila River	BLM (Safford)	33-94379.0	Pending	Pending	12/14/1988
14	Hot Springs Canyon	BLM (Safford)	33-94372.0	94372	94372	12/1/1988
15	Hot Springs Canyon	The Nature Conservancy	33-96279.0	96279	96279	12/1/1988
16	Leslie Creek	U.S. Fish & Wildlife Service	33-96176.0	96176	96176	3/20/1992

Table 3.0-1 Instream flow applications in the Southeastern Arizona Planning Area (Cont)

Map Key	Stream	Applicant	Application No.	Permit No.	Certificate No.	Filing Date
17	Mescal Creek	BLM (Phoenix)	33-90252.0	90252	90252	10/21/1985
18	Miller Canyon Draw	Coronado National Forest	33-95366.0	Pending	Pending	12/29/1989
19	Oak Grove Canyon	BLM (Safford)	33-96811.0	Pending	Pending	7/21/2005
20	O'Donnell Creek	The Nature Conservancy	33-78421.0	78421	78421	6/27/1979
21	O'Donnell Creek	The Nature Conservancy	33-96449.0	96449	96449	2/21/1991
22	Peppersauce Creek	Murray, William L.	33-96564.0	Pending	Pending	8/6/1997
23	Ramsey Creek	The Nature Conservancy	33-78419.0	78419	78419	6/27/1979
24	Redfield Canyon	BLM (Safford)	33-94369.0	Pending	Pending	12/1/1988
25	San Francisco River	BLM (Safford)	33-90251.0	Pending	Pending	10/21/1985
26	San Francisco River	Phelps Dodge Corporation	33-96759.0	Pending	Pending	6/3/2004
27	San Pedro River	BLM (Safford)	33-90103.1	90103	90103	8/12/1985
28	San Pedro River	BLM (Safford)	33-95780.0	Pending	Pending	1/8/1991
29	San Pedro River	BLM (Safford)	33-95789.0	Pending	Pending	4/1/1991
30	San Pedro River	BLM (Safford)	33-96126.1	Pending	Pending	8/6/1991
31	San Pedro River	BLM (Safford)	33-96127.1	Pending	Pending	8/6/1991
32	Spring Canyon Spring	BLM (Safford)	33-96799.0	Pending	Pending	6/13/2005
33	Wet Canyon	Coronado National Forest	33-96681.0	Pending	Pending	10/6/2000
34	Wildcat Canyon	BLM (Safford)	33-95454.0	95454	95454	6/6/1990

Source: ADWR 2008a

Threatened and Endangered Species[4]

A number of listed threatened and endangered species may be present in the Southeastern Arizona Planning Area. Those listed by the U.S. Fish and Wildlife Service (USFWS) as of 2008 are shown in Table 3.0-2. Presence of a listed species may be a critical consideration in water resource management and supply development in a particular area. The USFWS should be contacted for details regarding the Endangered Species Act (ESA), designated critical habitat and current listings.

[4] An "endangered species" is defined by USFWS as "an animal or plant species in danger of extinction throughout all or a significant portion of its range," while a threatened species" is "an animal or plant species likely to become endangered within the forseeable future throughout all or a significant portion of its range

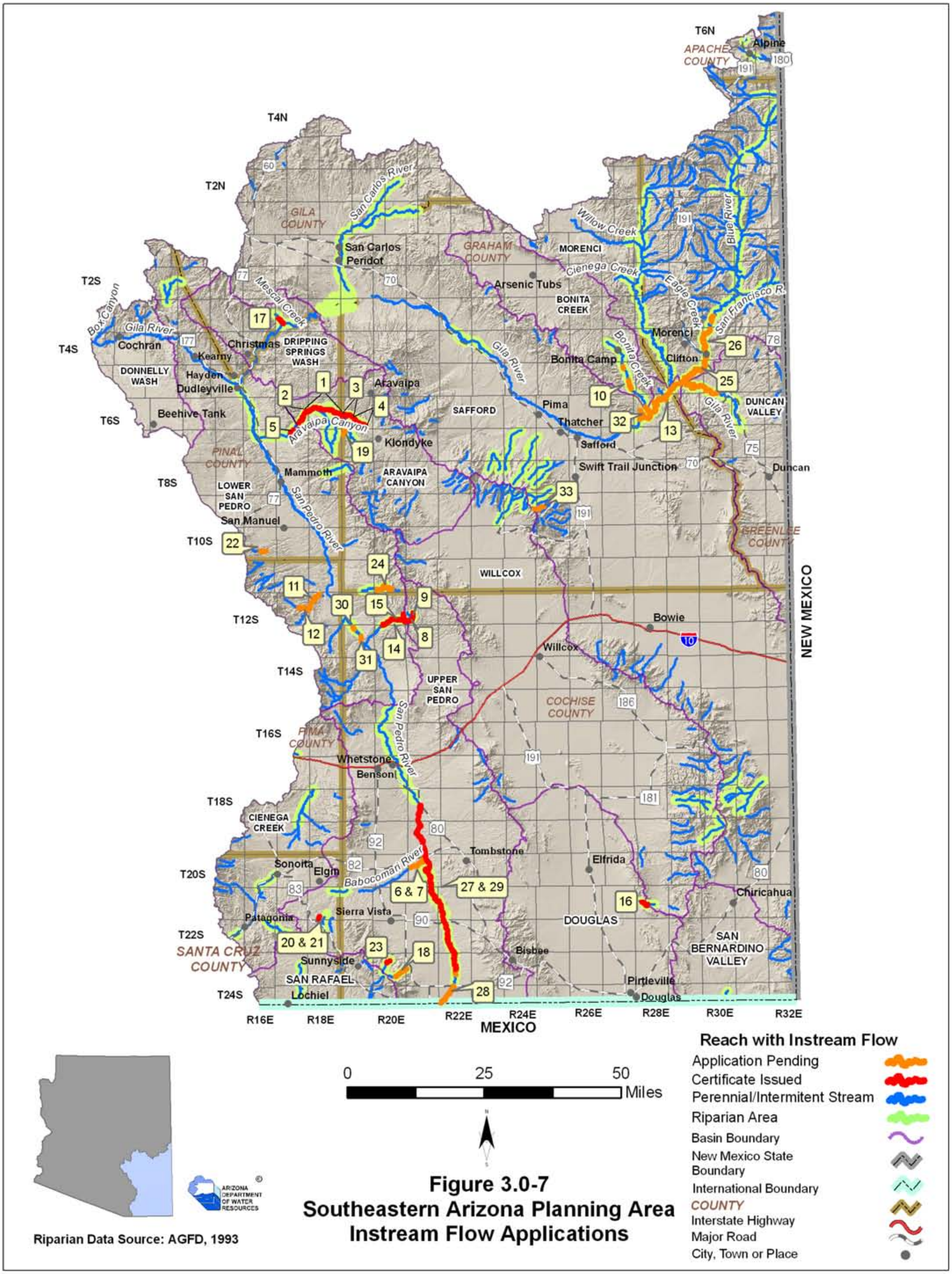


Figure 3.0-7
Southeastern Arizona Planning Area
Instream Flow Applications

Table 3.0-2 Listed threatened and endangered species in the Southeastern Arizona Planning Area

Common Name	Threatened	Endangered	Elevation/Habitat
Apache Trout	X		>5000 ft./cold mountain streams
Arizona Cliff-rose		X	<4,000 ft./white soils of tertiary limestone lakebed deposits
Arizona hedgehog cactus		X	3,700-5,200 ft./ecotone between interior chapparal and madrean evergreen woodland
Bald Eagle	X		Varies/large trees or cliffs near water
California Brown Pelican		X	Varies/lakes and rivers
Canelo Hills ladies'-tresses		X	5,000 ft./finely grained, highly organic, saturated soils of cienegas
Chiricahua Leopard Frog	X		3,300-8,900ft./streams, rivers, backwaters, ponds stock tanks
Cochise pincushion cactus	X		>4,200 ft./ semidesert grassland with small shrubs, agave, cacti, grama grass
Desert pupfish		X	<5,000 ft./shallow springs, small streams and marshes. Tolerates saline and warm water
Gila Chub		X	2,000-5,500 ft./pools, springs, cienegas and streams
Gila topminnow		X	<4,500 ft./small streams, springs and cienegas vegetated shallows
Gila trout	X		5,000-10,000 ft./small, high mountain streams
Huachuca water umbel		X	3,500-6,500 ft./cienegas, perennial low gradient streams, wetlands
Jaguar		X	1,600->9,000 ft./Sonoran desertscrub through subalpine conifer forest
Lesser long-nosed bat		X	<6,000 ft./desert scrub with agave and columnar cacti
Loach Minnow	X		<8,000ft./benthic species of small to large perennial streams
Mexican Gray Wolf		X	4,000-12,000 ft. /chapparal, woodland, forests
Mexican Spotted Owl	X		4,100-9,000 ft./canyons, dense forests with multi-layered foliage structure
Mount Graham red squirrel		X	>8,000 ft./montane upper elevation mature to old-growth conifer forest
New Mexico ridge-nosed rattlesnake	X		5,000-6,600 ft./canyon bottoms in pine-oak communities
Nichol's Turk's head cactus		X	2,400-4,100 ft./Sonoran desertscrub
Northern aplomado falcon		X	3,500-9,000 ft./grassland and savannah
Ocelot		X	<8,000 ft./humid tropical and sub-tropical forests, savannahs and semi-arid thornscrub

Table 3.0-2 Listed threatened and endangered species in the Southeastern Arizona Planning Area (Cont)

Common Name	Threatened	Endangered	Elevation/Habitat
Pima pineapple cactus		X	2,300-5,000 ft./Sonoran desertscrub or semi-desert grassland
Razorback sucker		X	<6,000 ft./riverine and lacustrine areas, not in fast moving water
Sonora tiger salamander		X	4,000-6,300 ft./stock tanks and impounded cienegas
Southwestern Willow Flycatcher		X	<8,500 ft./cottonwood-willow and tamarisk along rivers and streams
Spikedace	X		<6,000 ft./moderate to large perennial streams with gravel cobble substrates
Yaqui catfish	X		4,000-5,000 ft./moderate to large streams with slow current
Yaqui chub		X	4,000-6,000 ft./deep pools of small streams or ponds near undercut banks
Yaqui topminnow		X	<4,500ft./small to moderate sized streams, springs, cienegas in shallows

Source: AGFD 2008, USFWS 2008

National Parks, Monuments and Memorials, Wildlife Refuges, National Conservation Areas, Wilderness Areas and other Protected Areas

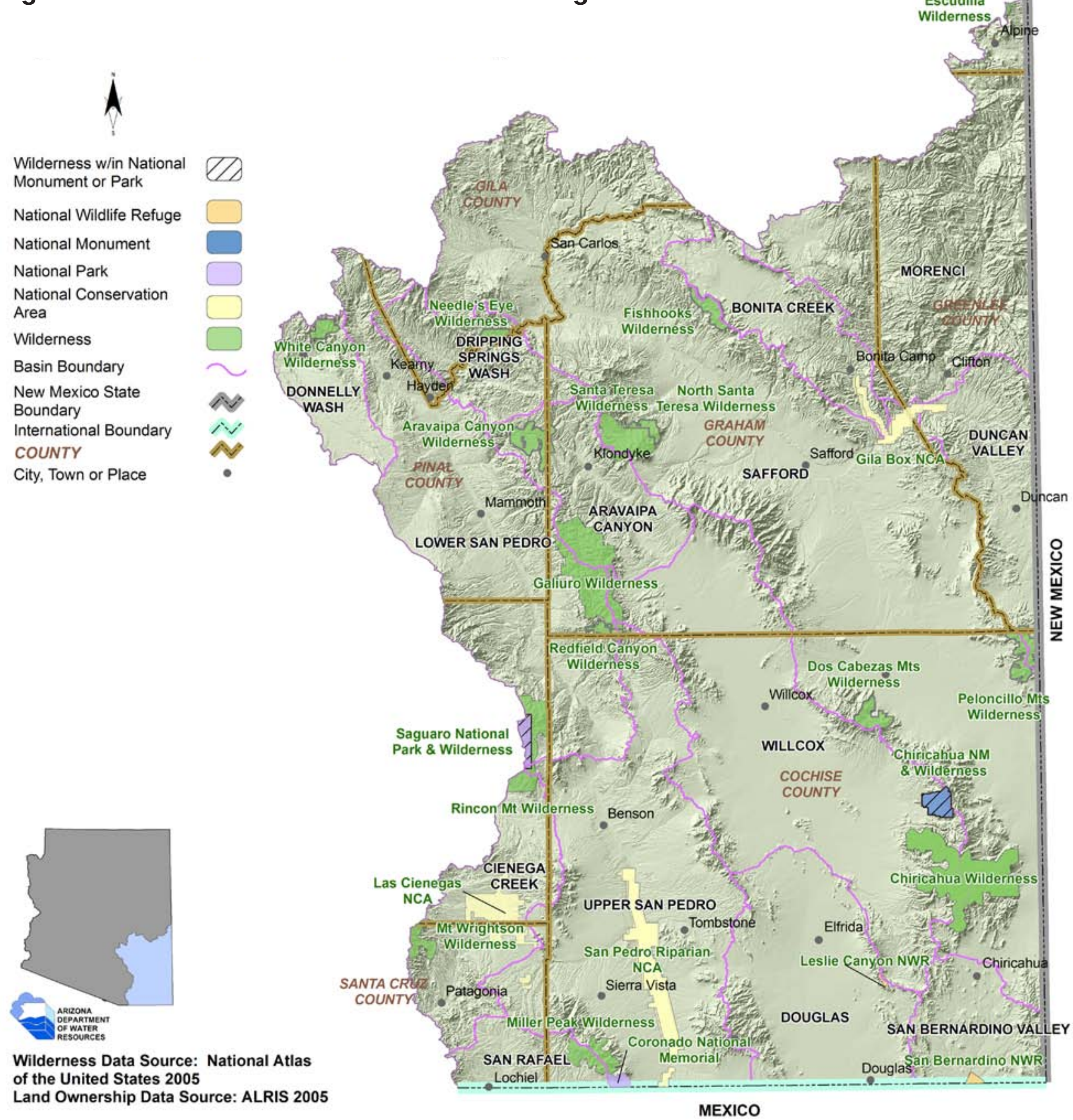
Protected areas are shown in Figure 3.0-12. There are parts of one national park, a national monument, a national memorial, a national conservation area, two riparian conservation areas, two wildlife refuges and fifteen wilderness areas in the planning area.

An almost 9,000-acre portion of the Rincon Mountain District of Saguaro National Park extends into the Lower San Pedro Basin. The park was established as a national monument in 1933 to protect Saguaro cactus forests, and achieved national park status in 1994. Much of the Rincon Mountain District is wilderness area.

The planning area contains Chiricahua National Monument and Coronado National Memorial. The monument, located almost entirely in the Willcox Basin, was created in 1924 to protect its unique rock formations. In 1976, 87% of the monument's approximately 12,000 acres were designated as wilderness to further preserve the geologic formations and unique plants and animals. (NPS, 2006) Coronado National Memorial, located primarily in the Upper San Pedro Basin adjacent to the Mexican border, commemorates the significance of Francisco Vásquez de Coronado's expedition of 1540-1542. The Memorial was created in 1941 and has two sister parks in Mexico. (NPS, 2007)

The two National Wildlife Refuges (NWR) in the planning area are the San Bernardino NWR in the San Bernardino Valley Basin and Leslie Canyon NWR located in the Douglas and Willcox Basins. Both refuges were established in the 1980s to protect water resources and habitat for endangered native fishes and rare velvet ash-cottonwood-black willow gallery forest. (USFWS, 2006)

Figure 3.0-12 Southeastern Arizona Planning Area Protected Areas



The only two Riparian National Conservation Areas in the nation are found in the planning area: the San Pedro Riparian National Conservation Area (SPRNCA) and the Gila Box Riparian National Conservation Area. The SPRNCA was established in November 1988 and contains about 40 miles of riparian area along the San Pedro River in the Upper San Pedro Basin. It includes over 58,000 acres of land between the international border with Mexico and the community of Saint David south of Benson. The primary purpose for the designation is to protect and enhance the desert riparian ecosystem (BLM, 2006a). The 22,000 acre Gila Box Riparian National Conservation Area was established in November 1990 to "conserve, protect, and enhance" the riparian and associated values of the area. The conservation area is located within the Bonita Creek, Duncan Valley, Morenci and Safford basins. Four perennial waterways, the

Leslie Canyon National Wildlife Refuge in the Douglas Basin.

Gila River, Bonita Creek, Eagle Creek, and the San Francisco River are contained in the area. A 15-mile segment of Bonita Creek and 23 miles of the Gila River are included in the conservation area (BLM, 2006b).

The Las Cienegas National Conservation Area was established in December 2000 and encompasses about 45,000 acres. Most of the conservation area is located between the Empire and Whetstone mountain ranges generally north of Sonoita within the Cienega Creek Basin. A small part of the conservation area extends into the Upper San Pedro Basin. The conservation area was designated to protect aquatic, wildlife, vegetative and riparian resources. Livestock grazing and recreation are allowed to continue in “appropriate” areas. Goals include protecting water quality and water quantity. (BLM, 2006c).

All or portions of 15 wilderness areas with a combined area of 318,797 acres, are located in the planning area. Wilderness Areas are designated under the 1964 Wilderness Act to preserve and protect the designated area in its natural condition. Designated wilderness areas, their size, basin location and a brief description of the area are listed in Table 3.0-3.

A notable wilderness area, Aravaipa Canyon, is located in the Aravaipa Canyon Basin. Administered by the Bureau of Land Management, it was designated in 1984 and includes 19,700 acres along the 10-mile long central gorge of the canyon, which cuts through the northern end of the Galiuro Mountains. The Nature Conservancy’s (TNC) Aravaipa Canyon Preserve, consisting of about 7,000 acres, includes lands at both the east and west ends of Aravaipa Canyon as well as lands on the canyon’s south rim (TNC, 2006). In 2007, the 1,250-acre Cobra Ranch near the east end of the canyon was donated to the TNC. Cobra Ranch contains Stowe Gulch, a drainage area estimated to contribute nearly half of the groundwater flowing to the headwaters of Aravaipa Creek (TNC, 2007).

The Nature Conservancy has acquired a number of properties in the planning area for habitat protection, particularly in the Lower San Pedro Basin. In addition to the Aravaipa Canyon Preserve, TNC preserves include Buehman Canyon Preserve and the San Pedro River Preserve near Winkelman, located in the Lower San Pedro Basin. Other TNC preserves include the Ramsey Canyon Preserve in the Huachuca Mountains in the Upper San Pedro Basin, and the Patagonia-Sonoita Creek Preserve in the Cienega Creek Basin. The Muleshoe Ranch Cooperative Management Area is a 49,000 acre preserve established to preserve native fish and grassland located in the Lower San Pedro,

Aravaipa Canyon Wilderness Area. The wilderness area includes 19,700 acres along the 10-mile long central gorge of the Canyon

Table 3.0-3 Wilderness areas in the Southeastern Arizona Planning Area

Wilderness Area	Acres in the Planning Area	Basin	Description
Aravaipa Canyon	19,410	Aravaipa Canyon	11-mile long Aravaipa Canyon, surrounding tablelands and nine side canyons.
Chiricahua*	87,700	Willcox, Safford	Sharp ridges, high peaks, including Chiricahua Peak (9,797 ft), and deep canyons. Largest mountain range of the sky islands.
Dos Cabezas Mountains	11,700	Safford	Steep mountain slopes, granite outcroppings and vegetated canyon floors.
Escudilla	1,330 (Partial)	Morenci	Mountain meadows and Escudilla Mountain (10,912 ft).
Fishhooks	10,500	Safford	Pinon pine forest, grassland, chaparral and canyons.
Galiuro	76,317	Aravaipa Canyon, Lower San Pedro, Upper San Pedro, Willcox	Douglas-fir, big tooth maple and aspen trees, canyons and peaks.
Miller Peaks	20,190	San Rafael, Upper San Pedro	Sheer cliffs, summits and deep canyons. Habitats ranging from desert grassland to mixed conifer and aspen forest.
Mount Wrightson	9,730 (Partial)	Cienega Creek	Deep canyons, ridges and peaks surrounded by semiarid hills and grasslands. Ponderosa pine, douglas fir and montane Mexican plants that grow nowhere else north of the border
Needles Eye	8,760	Dripping Springs Wash	Gila River, Needle's Eye canyon and riparian areas.
North Santa Teresa	5,800	Safford	Contains the Black Rock, a 1,000 ft high rhyolitic plug, desert and mountain shrub, grassland and riparian vegetation.
Peloncillo Mountains	19,440	Duncan Valley, Safford	Desert shrub grasslands to oak juniper woodlands in the higher reaches of the Peloncillo Mountains.
Redfield Canyon	6,600	Lower San Pedro, Upper San Pedro	Galiuro escarpment, canyons and perennial streams.
Saguaro*	8,740 (Partial)	Cienega Creek, Upper San Pedro, Lower San Pedro	Vegetation varies with elevation and includes desert scrub, desert grassland, oak woodland, pine-oak woodland, pine forest and mixed conifer forest.
Santa Teresa	26,780	Safford, Aravaipa Canyon	Deep canyons, rocky outcrops and bald summits. Vegetation is predominantly chaparral with forests of ponderosa pine on high ridges.
White Canyon	5,800	Donnelly Wash	Box Canyon stream, White Canyon, sonoran desert and chaparral.
Total	**318,797**		

Source: BLM 2008, USFS 2007b
*A portion of these wilderness areas are within the boundaries of a National Monument or National Park

Upper San Pedro and Willcox Basins. This area is managed cooperatively by the TNC, BLM and USFS. (TNC, 2006)

In addition to preserves, the TNC has acquired properties to establish conservation easements that retire irrigated agriculture and reduce groundwater pumping along the San Pedro River. These include the 2,150 acre Three Links Farm, located about 15 miles north of Benson in the Lower San Pedro Basin that contains more than six miles along the river, and a property near the San Pedro River Preserve. Other TNC-facilitated areas with conservation easements are the 18,500 acre San Rafael Ranch Natural Area in the San Rafael Basin and the 909 acre Sylvester Ranch in Palominas in the Upper San Pedro Basin. (TNC, 2008)

Pima County has acquired two ranches in the Lower San Pedro Basin as part of the Sonoran Desert Conservation Plan; the A-7 Ranch located in the northeast corner of Pima County and the northwest corner of Cochise County, and the Six-Bar Ranch located ten miles south of San Manuel, west of the San Pedro River. These two conservation preserves total over 10,000 acres (Pima County, 2006). The County also owns the Bingham Cienega Preserve in the Lower San Pedro Basin where it is restoring riparian and grassland ecosystems.

In the Lower San Pedro Basin, the Salt River Project and the US Bureau of Reclamation (USBOR) have acquired, or are proposing to acquire, lands for Southwestern Willow Flycatcher habitat along the San Pedro River. The USBOR has also completed an Environmental Assessment as part of the acquisition of lands for Southwestern Willow Flycatcher habitat in the Safford Basin. (USBOR, 2006)

Kartchner Caverns State Park is located south-west of Benson in the Whetstone Mountains. A wet cave, it is supported by a limestone aquifer that is recharged by infiltration from ephemeral washes. There is concern about the impact on this hydrologic system from impending development in the area.

Unique Waters

Six “unique waters”, designated by the Arizona Department of Environmental Quality (ADEQ) pursuant to A.C.C. R18-11-112, as having exceptional recreational or ecological significance and/or providing habitat for threatened or endangered species, have been identified in the planning area. These include:

- Aravaipa Creek from its confluence with Stowe Gulch to the downstream boundary of Aravaipa Canyon Wilderness Area (Aravaipa Canyon and Lower San Pedro basins)
- Bonita Creek, tributary to the upper Gila River (Bonita Creek and Safford basins)
- Buehman Canyon Creek from its headwaters to approximately 9.8 miles downstream (Lower San Pedro Basin)
- Cave Creek and the South Fork of Cave Creek (Chiricahua Mountains), from the headwaters to the Coronado National Forest boundary (Safford Basin)
- Cienega Creek, from its confluence with Gardner Canyon and Spring Water Canyon to the USGS gaging station in Pima County (Cienega Creek Basin)
- KP Creek, from its headwaters to its confluence with the Blue River (Morenci Basin)

3.0.5 Population

Census data for 2000 show about 188,300 residents in the Southeastern Arizona Planning Area. Arizona Department of Economic Security (DES) population projections forecast about 294,600 residents by 2030. Historic, current and projected basin populations are shown in the cultural water demand tables for

Table 3.0-4 2000 Census population of basins and Indian reservations in the Southeastern Arizona Planning Area

Basin/*Reservation*	2000 Census Population
Upper San Pedro	78,013
Safford	42,218
San Carlos Apache	*8,270*
Douglas	26,220
Lower San Pedro	15,515
Willcox	12,354
Morenci	5,141
Cienega Creek	4,355
Duncan Valley	3,757
Dripping Springs Wash	175
Donnelly Wash	165
San Rafael	147
Aravaipa Canyon	135
San Bernardino Valley	66
Bonita Creek	21
San Carlos Apache	*21*

each basin in Sections 3.1-3.11. Projections may not accurately reflect the most recent proposed developments.

The most populous basins reported in the 2000 census are the Upper San Pedro (78,013), Safford (42,281), Douglas (26,220), Lower San Pedro (15,515), and Willcox (12,354) basins. Six basins in the planning area are sparsely populated, with less than 200 residents including Aravaipa Canyon, Bonita Creek, Donnelly Wash, Dripping Springs Wash, San Bernardino Valley and San Rafael basins. The 2000 Census population of the San Carlos Apache Reservation was 9,385, an increase of over 2,000 residents since the 1990 census. The 2000 Census populations for each basin and Indian reservation, listed from highest to lowest, are shown in Table 3.0-4.

Shown in Table 3.0-5 are incorporated and unincorporated communities in the planning area with 2000 Census populations greater than 1,000 and growth rates for two time periods. Communities are listed from highest to lowest population in 2000. As shown, there are several rapidly growing communities including Sierra Vista and adjacent areas, Douglas, Whetstone and Swift Trail Junction south of Safford. The largest municipality in the planning area is Sierra Vista with a 2000 Census population of 37,775, or 20% of the planning area population. The population of the Sierra Vista subwatershed (roughly the southern half of the basin), contained about 37% of the planning area population in 2000. Approximately half the population of the San Carlos Apache Reservation resides in the communities of Peridot and San Carlos (the 10th largest community in the planning area and the tribal headquarters). Some communities in the planning area, including Clifton, Kearny and Mammoth have lost population due to declines or closures of mining operations. Between 1990 and 2000, the population living in smaller communities and rural areas grew faster than the population living in communities with 1,000 or more residents.

Population Growth and Water Use

Arizona has limited mechanisms to address the connections between land use, population growth and water supply. A legislative attempt to link growth and water management planning is the Growing Smarter Plus Act of 2000 (Act) which requires that counties with a population greater than 125,000 (2000 Census) include planning for water resources in their comprehensive plans.

City of Sierra Vista, including Fort Huachuca, in the Upper San Pedro Basin. Sierra Vista is the largest municipality in the planning area. The Sierra Vista Subwatershed contained about 37% of the planning area population in 2000.

Table 3.0-5 Communities in the Southeastern Arizona Planning Area with a 2000 Census population or greater than 1,000

Communities	Basin	1990 Census Pop.	2000 Census Pop.	Percent Change 1990 2000	2006 Pop. Estimate[1]	Percent Change 2000-2006	Projected 2030 Pop.
Sierra Vista	USP	32,983	37,775	14.5	44,870	18.8%	67,264
Sierra Vista SE	USP	9,237	14,348	55.3	16,551	15.4%	23,398
Douglas	DOU	13,137	14,312	8.9	17,660	23.4%	28,685
Safford	SAF	7,359	9,232	25.5	9,835	6.5%	9,953
Bisbee	USP/DOU	6,288	6,090	-3.1	6,355	4.4%	8,483
Benson	USP	3,824	4,711	23.2	4,820	2.3%	4,856
San Manuel	LSP	4,009	4,375	9.1	NA	--	5,102
Thatcher	SAF	3,763	4,022	6.9	4,970	23.6%	6,994
Willcox	WIL	3,122	3,733	19.6	3,910	4.7%	4,491
San Carlos	SAF	2,918	3,716	2.7	4,918	32.4%	6,074
Oracle[2]	LSP	3,043	3,563	17.1	NA	--	NA
Clifton	MOR	2,840	2,596	-8.6	2,485	-4.3%	2,526
Whetstone	USP	1,289	2,354	82.6	2,810	19.4%	4,228
Kearny	LSP	2,262	2,249	-0.6	2,270	0.9%	3,740
Swift Trail Jct.	SAF	1,203	2,195	82.5	2,558	16.5%	3,878
Pima	SAF	1,725	1,989	15.3	2,080	4.6%	2,529
Morenci	MOR	1,799	1,879	4.4	1,821	-3.1%	1,828
Huachuca City	USP	1,782	1,751	-1.7	1,825	4.2%	2,145
Mammoth	LSP	1,845	1,762	-4.5	1,805	2.4%	2,228
St. David	USP	1,468	1,744	18.8	1,862	6.8%	2,229
Tombstone	USP	1,220	1,504	23.3	1,655	10.0%	2,032
Dudleyville	LSP	1,356	1,323	-2.4	NA	--	2,769
Peridot	SAF	957	1,266	32.3	NA	--	NA
Total >1,000		109,429	128,489	17.4	NA	--	195,431
Remainder of Planning Area		46,236	59,793	29.3	NA	--	99,197
Total		**155,665**	**188,282**	**20.9**	**NA**	**--**	**294,628**

Sources: ADOC 2006, U.S. Census 2006

[1] 2006 population shown is the 2006 estimate for incorporated areas and the 2006 projection for unicorporated areas.

[2] The community of Oracle is located in the Lower San Pedro Basin but its wter supply comes from wells at Oracle Junction in the Tucson AMA.

USP = Upper San Pedro, DOU = Douglas Basin, SAF = Safford Basin, WIL = Willcox Basin, LSP = Lower San Pedro Basin MOR = Morenci Basin

None of the counties in the planning area fit this population criterion. However, Cochise County has incorporated water resource planning into its comprehensive plan, has adopted water use guidelines for certain area plans and has adopted a Water Conservation and Management Policy Plan for the Sierra Vista sub-watershed portion of the basin. Its goal is to "sustain an adequate, safe water supply through water conservation measures; policies; incentive programs; education; conservation and enhancement of natural recharge areas; and cooperative, multi-jurisdictional planning". The Act also requires that twenty-three communities outside AMAs include a water resources element in their general plans. In the Southeastern Arizona Planning Area this includes the communities of Benson, Douglas, Safford and Sierra Vista.

Plans must consider water demand and water resource availability in conjunction with growth, land use and infrastructure. References to completed plans are listed in basin references in this volume.

Beginning in 2007, all community water systems in the state were required to submit Annual Water Use Reports and System Water Plans. The reports and plans are intended to reduce community water systems' vulnerability to drought, and to promote water resource planning to ensure that water providers are prepared to respond to water shortage conditions. In addition, the information will allow the State to provide regional planning assistance to help communities prepare for, mitigate and respond to drought. An Annual Water Use Report must be submitted each year by the systems that includes information on water pumped, diverted and received, water delivered to customers, and effluent used or received. The System Water Plan must be updated and submitted every five years and consist of three components, a Water Supply Plan, a Drought Preparedness Plan and a Water Conservation Plan. By January 1, 2008, all systems were required to submit plans and by the end of 2008, plans were submitted by 61 community water systems in the planning area. Almost all of the larger systems submitted plans and were used to prepare this document. Annual water report information and a list of water plans are found in Appendix B.

The Department's Water Adequacy Program also relates water supply and demand to growth to some extent, but does not control growth. Developers of subdivisions outside of AMAs are required to obtain a determination of whether there is sufficient water of adequate quality available for 100 years. If the supply is inadequate, lots may still be sold, but the condition of the water supply must be disclosed in promotional materials and in sales documents. Legislation adopted in June 2007 (SB 1575) authorizes a county board of supervisors to adopt a provision, by unanimous vote, which requires a new subdivision to have an adequate water supply in order for the subdivision to be approved by the platting authority. If adopted, cities and towns within the county may not approve a subdivision unless it has an adequate water supply. If the county does not adopt the provision, the legislation allows a city or town to adopt a local adequacy ordinance that requires a demonstration of adequacy before the final plat can be approved. The Cochise County Board of Supervisors was the first in the state to adopt the provisions of SB 1575 in March, 2008. The Town of Patagonia, located in Santa Cruz County, has also adopted the provision since Santa Cruz County has not adopted the new standards.

Subdivision adequacy determinations (Water Adequacy Reports), including the reason for the inadequate determination, are provided in basin tables and maps and are summarized in Table 3.0-6. Also shown in the basin sections are approved applications for an Analysis of Adequate Water Supply (AAWS). This application is typically associated with large, master planned communities. As of December, 2008, AAWS applications had been approved in three basins for a total of 10,357 lots: Cienega Creek Basin, 189; Lower San Pedro Basin,

Main Street, Patagonia. As of December 2008 the only two jurisdictions to adopt the new water adequacy provisions (SB 1575) are Cochise County and the Town of Patagonia, located in Santa Cruz County.

Table 3.0-6 Water adequacy determinations in the Southeastern Arizona Planing Area as of 12/2008

Basin	Number of Subdivisions	Number of Lots[1]	Adequate	Inadequate	Approx. Percent Inadequate
Aravaipa Canyon	none	none	none	none	none
Bonita Creek	none	none	none	none	none
Cienega Creek	13	>1,023	867	>156	15%
Donnelly Wash	1	59	0	59	100%
Douglas	8	433	83	350	81%
Dripping Springs Wash	none	none	none	none	none
Duncan Valley	3	>268	61	>207	77%
Lower San Pedro	12	>1,211	1,195	>16	1%
Morenci	11	>1,859	>1,825	34	2%
Safford	23	>905	139	>766	85%
San Bernardino Valley	none	none	none	none	none
San Rafael	none	none	none	none	none
Upper San Pedro	202	>24,923	>18,218	>6,705	27%
Willcox	20	>1577	989	>588	37%
TOTAL	**293**	**>32,258**	**>23,377**	**>8,881**	**28%**

Source: ADWR 2008b
Notes:
[1] Data on number of lots are missing for some subdivisions, actual number is larger

2,948; and Upper San Pedro Basin, 7,220. (See Tables 3.3-11, 3.8-11 and 3.13-11)

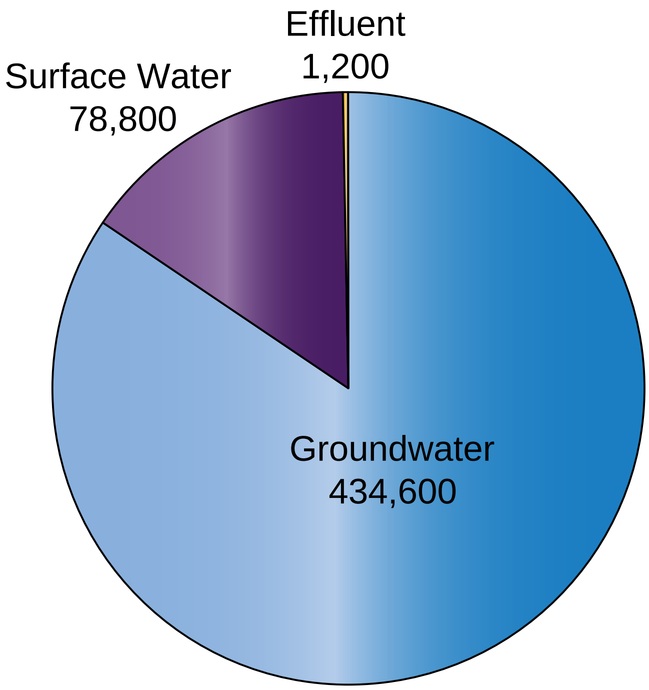
Six water providers in the planning area are designated as having an adequate water supply for their entire service area. A service area designation exempts subdivisions from demonstrating water adequacy if served by the provider. Designation information and the general location of the service area are also shown in basin maps and tables. As of December, 2008, designated providers included:

- City of Benson
- City of Douglas
- City of Safford
- City of Willcox
- Empirita Water Company – West of Benson, Cienega Creek Basin
- Bachmann Springs Utility Company – Bachman Springs Development near Tombstone

3.0.6 Water Supply

Local aquifers are the primary water supply for the planning area for municipal, industrial and agricultural use as shown in Figure 3.0-13. Approximately 15% of the cultural water demand is served by surface water. Most of the surface water is for agricultural use, and includes diversion from the San Pedro River, Aravaipa Creek and the Gila River. Gila River diversions are substantial, accounting for 92% of all surface water diversions in the planning area during the period 2001-2005. Small amounts of surface water are diverted for municipal use in the Morenci, Upper San Pedro and Willcox Basins and for industrial use in the Morenci Basin. Some communities utilize effluent for golf course irrigation and for groundwater recharge. Sites of environmental contamination may impact the availability of water supplies in some locations.

Figure 3.0-13 Water Supplies Utilized in the Southeastern Arizona Planning Area in acre-feet (average annual use 2001-2005)



Legal availability of water supplies is an issue in the Southeastern Arizona Planning Area. The right to use Gila River water is governed by the Globe Equity Decree (described below). The Arizona Water Rights Settlement Act of 2004 (P.L. 108-45) includes settlement of the Gila River Indian Community's water rights claims in Title II of the Act. This settlement affects the volume and utilization of groundwater and surface water upstream from the Community in parts of the planning area. (See ADWR, 2006).

Surface Water

Surface water is a municipal supply for the City of Tombstone in the Upper San Pedro Basin, for the town of Morenci in the Morenci Basin and Fort Grant in the Willcox Basin. The City of Safford uses water collected in an infiltration gallery along Bonita Creek in the Bonita Creek Basin, but for the purposes of this report the water is considered groundwater. The City of Tombstone began using surface water from springs in the Huachuca Mountains west of Tombstone in 1881 and currently diverts water from Miller and Carr Springs. This water is conveyed through a more than 25-mile, gravity fed, seven-inch diameter steel pipeline to Tombstone.

Surface water is diverted from several rivers in the planning area for agricultural irrigation. This supply may not always be available when needed. For example, surface water from the San Pedro River in the vicinity of Saint David is typically only available during the period from November to May. In addition to diversions from the San Pedro River in the Lower and Upper San Pedro Basins, there are small surface water diversions from Aravaipa Creek in the Lower San Pedro and Aravaipa Canyon basins, and larger diversions from the Gila River. Water diverted from the Gila River is delivered to agricultural lands in the Safford and Duncan Valley Basins. When sufficient surface water is not available, the shortfall is made up by additional groundwater withdrawals. This shortfall may be dramatic. For example, the percentage of surface water used in the Safford and Duncan Valley Basins in 2000 was 27% compared to 60% in 1999.

Phelps Dodge Corporation provides water to the Morenci Mine Complex and the town of Morenci in part through complex exchange agreements involving several water sources, some of which are located outside the planning area. Currently, Phelps Dodge utilizes exchange credits from both Horseshoe Reservoir on the Verde River and the Central Arizona Project through lease agreements with the San Carlos Apache Tribe, to divert water from the Black River at the Black River Pump Station in the Salt River Basin. This water is pumped over the watershed divide into Willow and Eagle Creeks where it is transported about 51 miles before being commingled with water from Phelps Dodge's Upper Eagle Creek Well Field. Phelps

Dodge also uses water from Eagle Creek, Chase Creek and the San Francisco River (ADWR, 2005b). Historically, Phelps Dodge also had water exchange agreements involving Show Low Lake and Blue Ridge Reservoir in the Little Colorado River Basin. It relinquished its certificated rights to both water sources in 2005.

Legal availability of a surface water supply is also an important consideration. As described in detail in Appendix C, the legal framework and process under which surface water right applications and claims are administered and determined is complex. Rights to surface water are subject to the doctrine of prior appropriation which is based on the tenet "first in time, first in right". This means that the person who first put the water to a beneficial use acquires a right that is superior to all other surface water rights with a later priority date. Under the Public Water Code, beneficial use is the basis, measure and limit to the use of water. Each type of surface water right filing is assigned a unique number as explained in Appendix C and shown in Table 3.0-7. On the other hand, the act of filing a statement of claim of rights to use public waters (36) does not in itself create a water right. A Certificate of Water Right (CWR) may be issued if the terms of the permit to appropriate water (3R, 4A, or 33, and in certain cases 38), are met. CWRs retain the original permit application number.

Surface water rights may also be determined through judicial action in state or federal court in which the court process establishes or confirms the validity of the rights and claims and ranks them according to priority. Court decreed rights are considered the most certain surface water right. There are several court determinations in the planning area including the Doan and Jenkes decrees involving landowners, canal companies and irrigation water users in the Safford Valley, the Ling Decree in the San Francisco River Valley and Duncan Valley, and the Globe Equity No.59 Decree. In 1935 the U.S. District Court entered a consent decree (Globe Equity No. 59) for all diversions of the mainstem of the Gila River from confluence with the Salt River to the headwaters in New Mexico, including the Gila River and San Carlos Apache reservations, and non-Indian landowners below and above Coolidge Dam. It awarded rights to use water on lands within the Gila River Indian Reservation with a priority date of "time immemorial" and also awarded rights to the San Carlos Apache Tribe with a priority date of 1846. Rights and priority dates were established for non-Indian land in the San Carlos Project area including the Safford Valley, the Duncan Valley and the Winkelman Valley (Pearce, 2002). The Gila Water Commissioner is appointed by the US District Court to administer the Decree. Each year the Commissioner issues a report on the distribution of waters of the Gila River.

Arizona has two general stream adjudications in progress to determine the nature, extent and priority of water rights across the entire river systems of the Gila River and the Little Colorado River. Pertinent to the Southeastern Arizona Planning Area, the Gila River Adjudication is being conducted in the Superior court of Arizona in Maricopa County. The Gila Adjudication was initiated by petitions filed by several parties in the 1970's, including Salt River Project, Phelps Dodge Corporation and the Buckeye Irrigation Company. The petitions were consolidated in 1981 into a single proceeding. The Gila Adjudication includes seven adjudication watersheds; Upper Salt, San Pedro, Agua Fria, Upper Gila, Lower Gila, Verde, and Upper Santa Cruz. The entire Upper Gila and San Pedro adjudication watersheds and part of the Upper Santa Cruz watershed are within the planning area boundaries. These watersheds do not coincide with the 6-digit HUC watersheds discussed previously and shown in Figure 3.0-5. The Willcox, Douglas and San Bernardino Valley basins are not included within the adjudication boundary.

The entire Gila Adjudication includes over 24,000 parties. All parties who claim to have a water right within the river system are required to file a statement of claimant (SOC) (39), or risk loss of their right. This includes reserved water rights for public lands and Indian reservations, which for the most part have not been quantified or prioritized. Results from the Department's investigation of surface water right and adjudication filings are presented in Hydrographic Survey Reports (HSRs). Within the Southeastern Arizona Planning Area, an HSR has been published for the San Pedro River Watershed (ADWR, 1991). In conjunction with the Gila Adjudication, the Subflow Technical Report San Pedro River Watershed was published in 2002.

Table 3.0-7 summarizes the number of surface water right and adjudication filings in the planning area. The methodology used to query the Department's surface water right and SOC registries is described in Appendix C. Of the 36,483 filings that specify surface water diversion points and places of use in the planning area, 2,766 CWRs have been issued to date. Figure 3.0-14 shows the general location of surface water diversion points listed in the Department's

Table 3.0-7 Count of inventory of surface water right and adjudication filings in the Southeastern Arizona Planning Area

Basin	Type of Filing							Total
	BB[2]	3R[3]	4A[3]	33[3]	36[4]	38[5]	39[6]	
Aravaipa Canyon	0	37	37	67	586	316	1,063	**2,106**
Bonita Creek	0	2	15	10	13	17	55	**112**
Cienega Creek	0	14	19	47	472	432	2,123	**3,107**
Donnelly Wash	0	9	23	25	117	100	237	**511**
Douglas	0	24	16	26	272	245	0	**583**
Dripping Springs Wash	0	13	63	21	237	82	340	**756**
Duncan Valley	161	38	22	33	347	402	1,113	**2,116**
Lower San Pedro	0	62	115	91	1,329	711	2,320	**4,628**
Morenci	33	16	136	62	1,408	711	2,273	**4,639**
Safford	289	51	141	244	1,269	1,345	4,408	**7,747**
San Bernardino Valley	0	12	4	21	150	167	0	**354**
San Rafael	0	4	6	76	268	235	639	**1,228**
Upper San Pedro	0	56	44	75	1,212	967	4,717	**7,071**
Willcox	0	57	75	100	608	685	0	**1,525**
Total	**483**	**395**	**716**	**898**	**8,288**	**6,415**	**19,288**	**36,483**

Notes:

[1] Based on a query of ADWR's surface water right and adjudication registries in February 2009. A file is only counted in this table if it provides sufficient information to allow a Point of Diversion (POD) and/or Place of Use (POU) to be mapped within the basin. If a file lists more than one POD or POU in a given basin, it is only counted once in the table for that basin. Several surface water right and adjudication filings are not counted here due to unsufficient locational information. However, multiple filings for the same POD/POU are counted.

[2] Court decreed rights; not all of these rights have been identified and/or entered into ADWR's surface water rights registry.

[3] Application to construct a reservoir, filed before 1972 (3R); application to appropriate surface water, filed before 1972 (4A); and application for permit to appropriate public water or construct a reservoir, filed after 1972 (33).

[4] Statement of claimant of rights to use public waters of the state, filed pursuant to the Water Rights Registration Act of 1974.

[5] Claim of water right for a stockpond and application for certification, filed pursuant to the Stockpond Registration Act of 1977.

[6] Statement of claimant, filed in the Gila or LCR General Stream Adjudications.

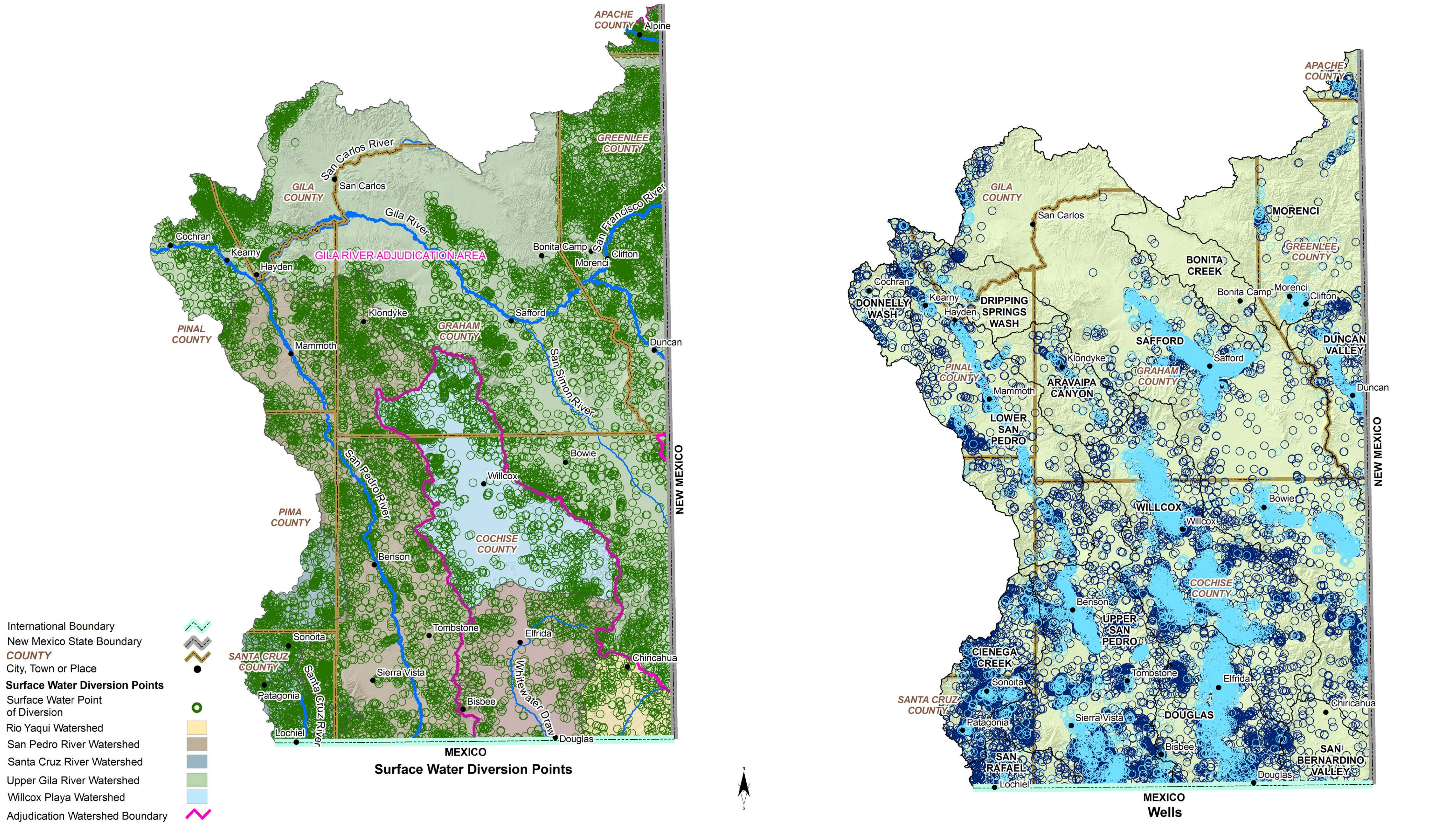


Figure 3.0-14
Southeastern Arizona Planning Area
Registered Wells and Surface Water Diversion Points

listed in the Department's surface water rights registry. The numerous points reflect the large number of stockponds and reservoirs that have been constructed in the planning area as well as diversions from streams and springs. Locations of registered wells, many of which are referenced as the basis of claim in SOCs are also shown in Figure 3.0-14.

The location of surface water resources are shown on surface water condition maps and maps showing perennial and intermittent streams and major springs for each basin, and in basin tables that contain data on streamflow, flood ALERT equipment, reservoirs, stockponds and springs.

Groundwater

Groundwater is the major water supply in the planning area, meeting 85% of the total demand, 92% of the municipal demand, 83% of the agricultural demand and 97% of the industrial demand during the period 2001-2005. The location of registered exempt and non-exempt wells is shown in Figure 3.0-14. Groundwater is the sole supply utilized in Bonita Creek, Cienega Creek, Donnelly Wash, Douglas, Dripping Springs Wash, San Bernardino Valley and San Rafael Valley basins. Major aquifers supplying groundwater are basin fill, sedimentary rock (Gila Conglomerate), volcanic rock and recent stream alluvium. Groundwater is relatively abundant and well yields are high in most basins.

In the north and northeastern portion of the planning area (Bonita Creek, Dripping Springs Wash, Duncan Valley and Morenci basins), groundwater development is primarily from wells that tap the younger basin fill or the Gila Formation. Median well yields from large (>10 inch diameter) wells ranges from 395 gpm in Dripping Springs Wash Basin to over 1,100 gpm in the southern part of Bonita Creek Basin. Estimated groundwater in storage ranges from as low as 150,000 acre-feet in Dripping Springs Wash Basin to as high as 19 maf in the Duncan Basin.

Groundwater is a stock and domestic supply in the Bonita Creek and Dripping Springs Wash basins. In the Duncan Valley Basin groundwater meets about half (10,000 acre-feet) of the agricultural demand and supplies all the municipal and industrial water. Groundwater is the primary water supply for mining and municipal uses in the Morenci Basin.

The Safford Basin contains almost 5,000 registered wells that utilize basin fill, the major aquifer, and the stream bed alluvium along the Gila River drainage. Well yields are generally high with a median well yield of 600 gpm reported from almost 1,500 wells. Groundwater in storage may be as high as 69 maf in the basin. While surface water is an important agricultural water supply in the basin, groundwater is now the largest supply utilized, with over 121,000 acre-feet pumped annually from the basin during the period 2001-2005, particularly from the Gila Valley sub-basin, which contain the basin's population and agricultural centers.

Basins located on the western side of the planning area (Aravaipa Canyon, Donnelly Wash, Cienega Creek, Lower and Upper San Pedro), yield groundwater from the stream alluvium and basin fill. Most irrigation wells are located in the stream alluvium while most industrial and domestic wells are located in the basin fill. Stream alluvium aquifers support stock, agricultural and domestic uses in the northern and southwestern parts of the Cienega Creek Basin, while basin fill is the principal aquifer in the central valley.
the northern and southwestern parts of the Cienega Creek Basin, while basin fill is the principal aquifer in the central valley.

As shown in the groundwater data tables for each basin, median well yields range from 62 gpm in the Donnelly Wash Basin to as high

ASARCO Hayden Smelter, Lower San Pedro Basin. Basins located on the western side of the planning area yield groundwater from the stream alluvium and basin fill. Most irrigation wells are located in the stream alluvium while most industrial and domestic wells are located in the basin fill.

as 1,000 gpm in the Lower San Pedro Basin. Groundwater in storage estimates range from as low as 140,000 acre-feet in the relatively undeveloped Donnelly Wash Basin to as high as 26.1 maf in the populous Upper San Pedro Basin.

Groundwater supplies the domestic and about half of the small scale farming demands in the Aravaipa Canyon Basin. Historically, mining and grazing activities were also important land and water uses. Groundwater is the sole water supply available for domestic uses in the Donnelly Wash Basin and for municipal, agricultural and industrial purposes in the Cienega Creek Basin. All of the industrial demand, the largest demand sector in the Lower San Pedro Basin (almost 16,000 AFA), is met by groundwater, which is also the primary water supply for agricultural and municipal purposes. In the Upper San Pedro Basin, groundwater meets almost all the municipal demand (17,300 AFA) and the majority of the agricultural demand.

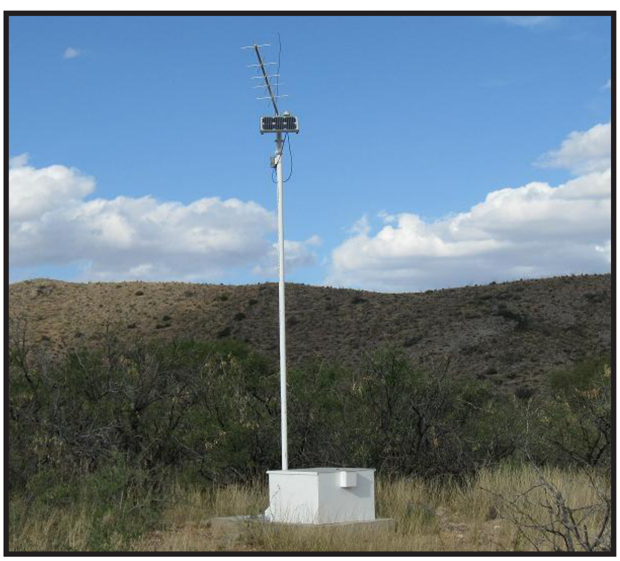
Almost all the water supply available for agricultural, municipal and industrial purposes in the Willcox Basin is groundwater found primarily in basin fill deposits. Median well yield is 750 gpm with as much as 59 maf of groundwater in storage (Table 3.14-6). Groundwater has been heavily utilized for agricultural purposes for many years and there are concerns about the future availability of this water supply, prompting recent water level monitoring investigations (USGS, 2006b).

The three basins with groundwater outflow to Mexico have differing groundwater supply conditions. In the San Bernardino Valley Basin, groundwater is obtained from thin units of sand and gravel interbedded with basalt flows or from shallow alluvium. There are only 12 registered wells with a pump capacity greater than 35 gpm in the basin with a range of 22 to 600 gpm reported for three of them. Groundwater is the water supply for stock and domestic uses. The main aquifer in the Douglas Basin is basin fill, which is used to support extensive agricultural irrigation in the basin. As with the Willcox Basin, there are concerns about the long-term pumpage of groundwater from the basin aquifers and future groundwater supply availability. Protection of the groundwater supply from agricultural expansion was first initiated in 1965 when the area was designated as a Critical Groundwater area and its subsequent

APECO Power Plant, Willcox Basin. Almost all the water supply for this basin is found in basin fill deposits designation as an Irrigation Non-expansion Area in 1980. In the City of Douglas area, groundwater is pumped from basin fill with interbedded volcanic rock. Median well yield in the Douglas basin is 600 gpm (Table 3.5-6). In the San Rafael Basin, where ranching is the primary activity, groundwater is obtained from stream alluvium and basin fill and median well yields are about 145 gpm from large diameter wells (Table 3.12-6).

The Department's Groundwater Site Inventory (GWSI) database, the main repository for statewide groundwater well data, is available on the Department's website (www.azwater.gov/). The GWSI database consists of over 42,000 records of wells and over 210,000 ground-water level records statewide. GWSI contains spatial and geographical data, owner information, well construction and well log data, and historic groundwater data including water level, water quality, well lift and pumpage records. Included are hydrographs for statewide Index Wells and Automated Groundwater Monitoring Sites, which can be searched and downloaded to access local information for planning, drought mitigation and other purposes.

Approximately 1,700 wells are designated as Index Wells statewide out of over 43,700 GWSI sites. (GWSI sites are primarily well sites but include other types of sites such as springs and drains). Typically, index wells are visited once each year by the Department's field staff to obtain a long-term record of ground water level fluctuations. Approximately 200 of the GWSI sites are designated as Automated Wells. These systems measure water levels 4 times daily and store the data electronically. Automated groundwater monitoring sites are established to better understand the water supply situation in areas of the state where data are lacking. These devices are located based on areas of growth, subsidence, type of land use, proximity to river/stream channels, proximity to water contamination sites or areas affected by drought.



Automated Well, Upper San Pedro Basin

Volume 1 of the Atlas shows the location of index wells and automatic water-level recording sites as of January, 2009. At that time there were a total of 250 index wells and 9 ADWR automatic water-level sites in the Southeastern Arizona Planning Area. The automated sites are located at Bowie, Sunizona, Kansas Settlement, near Sierra Vista, south of Safford, Benson (3) and near the San Pedro River near the southern boundary of the Lower San Pedro Basin. The most updated maps may be viewed at the Department's website.

Information on major aquifers, well yields, estimated natural recharge, estimated water in storage, aquifer flow direction, and water level changes are found in groundwater data tables, groundwater conditions maps, hydrographs and well yield maps for each basin in the basin sections.

Effluent

Effluent is utilized as a water supply in the Lower San Pedro, Safford, Upper San Pedro, and Willcox basins for golf course irrigation, industrial processes and groundwater recharge. An average of approximately 1,700 acre-feet of effluent was used annually for golf course irrigation, and an unknown quantity was used for mining purposes at the Morenci Mine during the period 2001-2005. Effluent is recharged to the aquifer in the Upper San Pedro Basin. Over 10,600 acre-feet of effluent is estimated to be produced annually, with about half of it generated in the Upper San Pedro Basin.

In the Upper San Pedro Basin, about 800 acre-feet of effluent from the Fort Huachuca and Benson Wastewater Treatment Plants was delivered for golf course irrigation and approximately 2,380 acre-feet of effluent was recharged to the aquifer at Fort Huachuca and at the Sierra Vista Recharge Facility in 2005 (USGS, 2007). By 2007, over 10,700 acre-feet had been recharged at the Sierra Vista Facility. Beginning in 2009, the Turquoise Valley Golf Course will begin receiving approximately 100 AFA of effluent from the City of Bisbee San Jose Wastewater Treatment Facility. The unused remainder will be discharged to Greenbush Draw.

Elsewhere, effluent is used to irrigate the Mt. Graham Golf Course in the Safford Basin, the Kearny Golf Course in the Lower San Pedro Basin and the Twin Lakes Golf Course in the Willcox Basin. At some treatment plants, wastewater is applied to pasture as a disposal method; for example from the Safford WWTF.

There are two effluent treatment wetlands located in the Upper San Pedro Basin. The wetland at the Apache Nitrogen Products facility was constructed as part of the Superfund clean-up and the wetland at the Sierra Vista Treatment Plant is operated in conjunction with the recharge facility.

Contamination Sites

Sites of environmental contamination may impact the availability of water supplies. An inventory of Department of Defense (DOD), Superfund (Environmental Protection Agency designated sites), Water Quality Assurance

Recharge basins at Fort Huachuca, Upper San Pedro Basin. Approximately 2,380 acre-feet of effluent were recharged to the aquifer at the Fort Huacucha and Sierra Vista Recharge facilities in 2007.

Revolving Fund (WQARF, state designated sites), Voluntary Remediation Program (VRP) and Leaking Underground Storage Tank (LUST) sites was conducted for the planning area.

Table 3.0-8 lists the DOD, Superfund, VRP and WQARF sites, the contaminant and affected media and the basin location of the site. In addition, there are 203 active Leaking Underground Storage Tank (LUST) sites in the planning area, most of which are located in the Safford Basin (38), the Upper San Pedro Basin (81) and the Willcox Basin (32). The location of all contamination sites is shown on Figure 3.0-15.

Morenci Mine, Morenci Basin. There are nine active VRP sites in the planning area. All sites in the Douglas and Morenci basins are associated with mining-related activities.

There are nine active VRP sites in the planning area. All sites in the Douglas and Morenci basins are associated with mining-related activities. The only other site is a fuel oil contamination site at San Simon in the Safford Basin. The VRP is a state administered and funded voluntary cleanup program. Any site that has soil and/or groundwater contamination, provided that the site is not subject to an enforcement action by another program, is eligible to participate. To encourage participation, ADEQ provides an expedited process and a single point of contact for projects that involve more than one regulatory program. (Environmental Law Institute, 2002)

The Apache Powder Superfund site located about 2.5 miles southwest of Saint David in the Upper San Pedro Basin is the only Superfund site in the planning area. Apache Nitrogen Products (ANP) Inc., formerly known as Apache Powder Company, owns and operates a fertilizer and nitric acid manufacturing plant at the site. Soil, groundwater and surface water contamination has occurred due to past manufacturing and disposal practices at the site. Sampling has identified a nitrate plume affecting both groundwater and a short reach of the San Pedro River. Additional contaminants of concern include arsenic, fluoride, perchlorate and metals. Cleanup efforts to date include removal of waste barrels and contaminated soils, and construction of a treatment wetland. A future cleanup schedule has been developed by ANP and remedial activities are being coordinated with the EPA and ADEQ (ADWR, 2005a).

The Klondyke Tailings WQARF site consists of two piles of mine tailings adjacent to Aravaipa Creek approximately 4.5 miles upstream of the Aravaipa Canyon Wilderness Area. ADEQ has completed several studies, groundwater and soil sampling and geophysical surveys to identify the presence of buried tanks or drums at the site. In response to significant flooding in July 2006, ADEQ conducted a floodplain analysis and installed erosion protection and capping of the upper tailings pile in 2008. (ADEQ, 2008)

DOD Installation Restoration Program funding has supported environmental cleanup of contaminated soils at Fort Huachuca in the Upper San Pedro Basin. Groundwater monitoring wells have been installed at the South Range Landfill and East Range Mine Shaft to monitor contamination. Groundwater contamination has not been identified. These sites are part of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) cleanup program. (ADWR, 2005a)

Table 3.0-8 Contamination sites in the Southeastern Arizona Planning Area

SITE NAME	MEDIA AFFECTED AND CONTAMINANT	GROUNDWATER BASIN
Department of Defense (DOD) Sites		
Fort Huachuca	Groundwater and soil – leaking underground storage tanks and solid waste disposal	Upper San Pedro
Safford Military Range	Soil-lead	Safford
Federal National Priority List (Superfund Sites)		
Apache Powder	Groundwater-arsenic, fluoride, nitrate, perchlorate Surface water-dinitoglycerine (DNT) Soil – arsenic, barium, metals, nitrate, vanadium pentoxide, trinitroglycerine (TNT)	Upper San Pedro
Voluntary Remediation Sites		
Arizona Copper Co	Soil – metals and solvents	Morenci
Bisbee Smelter	Soil and groundwater – metals	Douglas
Clifton School – Phelps Dodge	Soil - smelter fallout metals	Morenci
Douglas Parcel 408-18-025C	Soil – arsenic and copper	Douglas
Firebird Fuel Spill	Soil - Benzene, Toluene, Ethyl Benzene, Xylene (BTEX)	Douglas
Jobbing Warehouse	Soil – arsenic, lead and copper	Douglas
Phelps Dodge American Avenue	Soil – metals	Douglas
Shannon Hills Smelter	Soil – mine tailings, arsenic and copper	Morenci
Union Pacific Railroad San Simon Depot	Bunker C fuel oil	Safford
WQARF Sites		
Klondyke Tailings	Groundwater, surface water and soil - metals	Aravaipa Canyon

Sources: ADEQ 2002, ADEQ 2006a, ADEQ 2006b

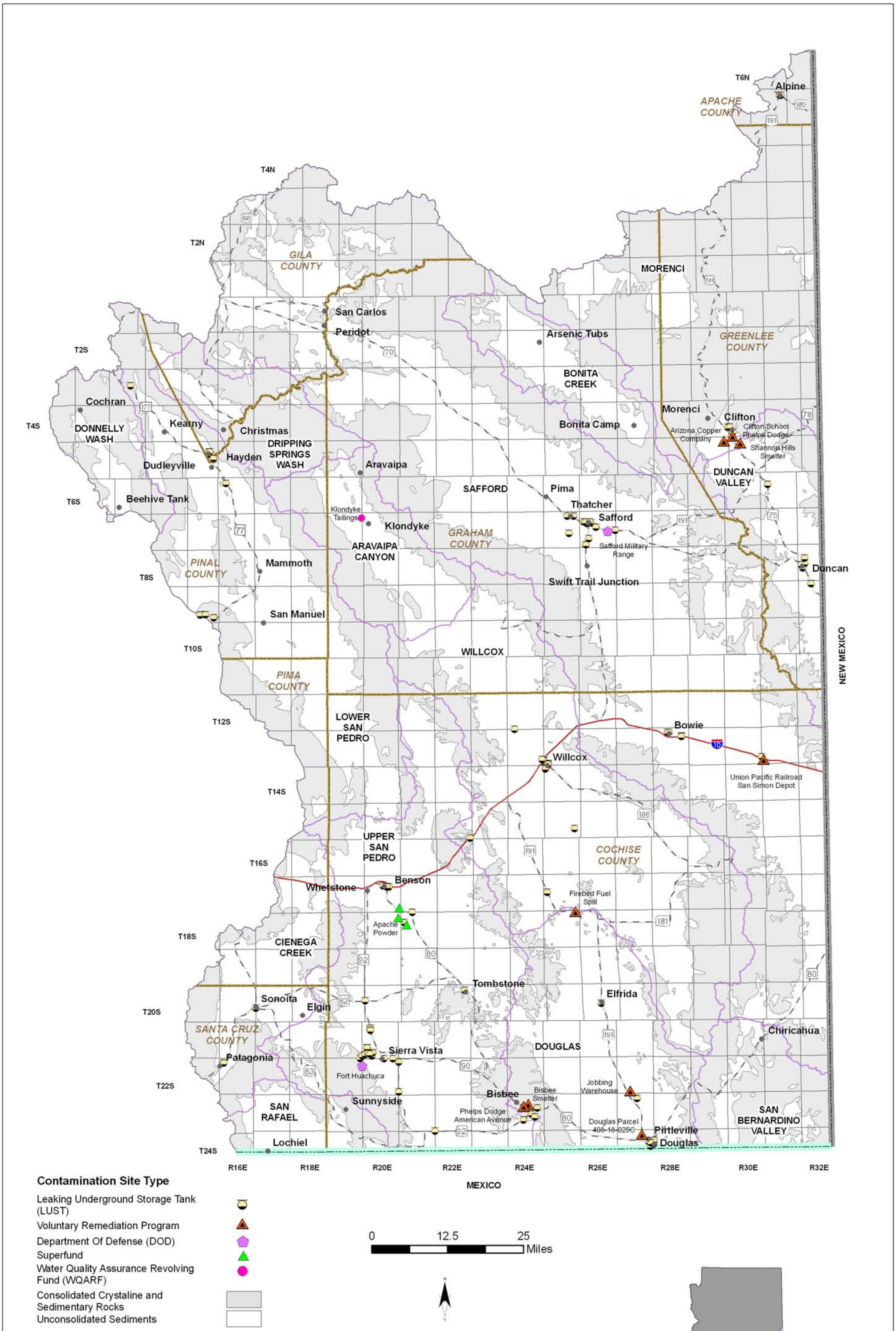


**Figure 3.0-15
Southeastern Arizona
Planning Area
Contamination Sites**

3.0.7 Cultural Water Demand

Total cultural water demand in the Southeastern Arizona Planning Area averaged approximately 515,100 AFA in the period from 2001-2005. The agricultural demand sector is by far the largest water demand sector with over 440,000 acre-feet of demand (see Figure 3.0-16). This is primarily due to agricultural demand in 4 basins Willcox, Safford, Duncan Valley and Douglas, which account for 410,600 acre-feet, or 95% of the agricultural demand. About one-fifth of the agricultural demand is met with surface water.

The volume of municipal water demand and industrial water demand is similar. Municipal demand was approximately 40,500 AFA of primarily groundwater demand during the period from 2001-2005. Only about 1,200 acre-feet of surface water was reported for municipal purposes. Industrial demand, primarily from mining, is about 34,600 AFA. Of this, about 1,100 acre-feet of surface water is used. The demand sector composition varies substantially from basin to basin as shown in the basin cultural demand tables. For example, there is no agricultural irrigation in six of the basins and total demand ranges from less than 300 acre-feet in several basins to almost 205,000 acre feet per year in the Safford Basin. (See Figure 3.0-17)

Provisions of the Arizona Water Rights Settlement Act of 2004 have implications for water use in the planning area. Under Title II of the Act, Congress authorized a 2003 Settlement Agreement concerning the Gila River Indian Community's (GRIC) water rights. The 2003 Settlement Agreement was amended to conform to the Settlement Act and becomes enforceable on or before December 31, 2007. The Settlement Agreement established an Upper Gila River Watershed Maintenance Program that was incorporated into state law in 2005 (H.B. 2728). The program defines a Gila River Maintenance Area that covers much of the planning area except for the Willcox, Douglas and San Bernardino Valley Basins and portions of other basins in Cochise County. There are certain restrictions within the area, subject to specific exemptions, including construction of new dams or enlargement of existing dams and irrigation of land is prohibited unless the land was previously irrigated between January 1, 2000 and August 12, 2005. (ADWR, 2006)

Figure 3.0-16 Cultural Water Demand by Sector in the Southeastern Arizona Planning Area

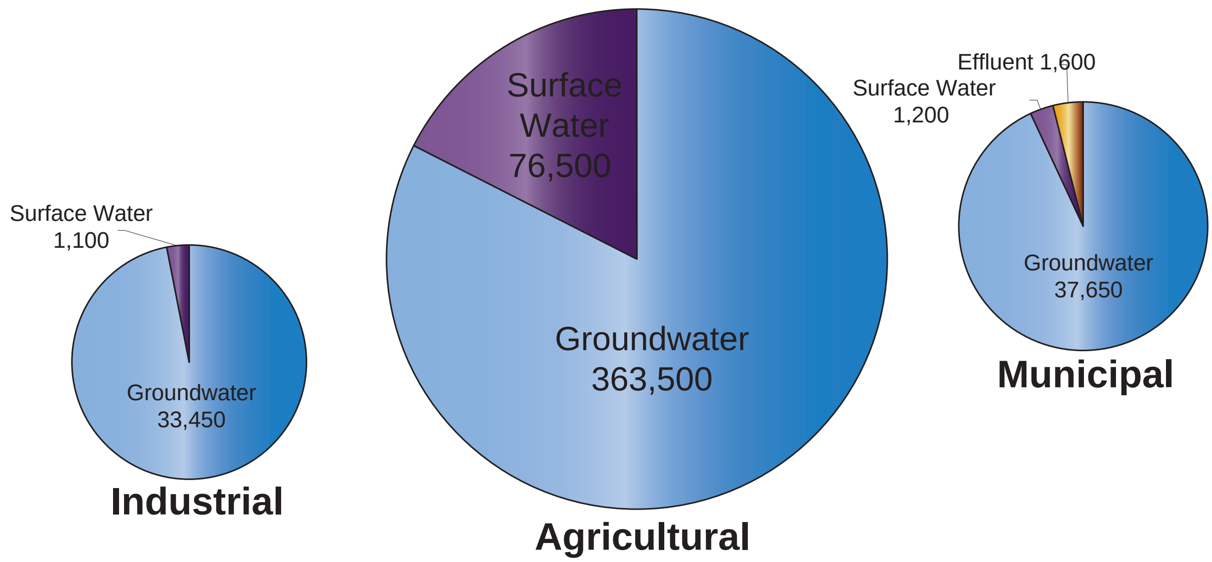
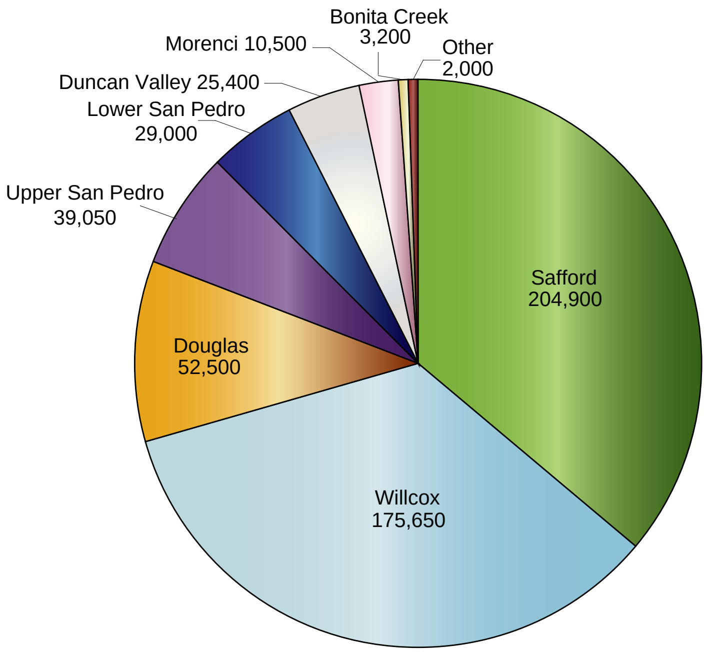


Figure 3.0-17 Cultural Water Demand by Basin in the Southeastern Arizona Planning Area



The settlement agreement also established "Safe Harbor" areas within which the Gila River Indian Community, the San Carlos Irrigation and Drainage District and the United States "agree not to exercise their rights to challenge, object to or call certain water users based on their normal flow rights and stored water rights under the Globe Equity Decree". The Safe Harbor provisions establish three Impact Zones with specific conditions for each. The impact zones are: 1) the San Pedro Ag and New Large Industrial Use Impact Zone, 2) the San Pedro M&I and Domestic Purposes Impact Zone, and 3) the Gila River Impact Zone. These zones are in proximity of the Gila and San Pedro Rivers and include named tributaries. For information on these provisions, refer to the Settlement Agreement and to the Technical Assessment of the Gila River Indian Community Water Rights Settlement. (ADWR, 2006)

Tribal Water Demand

Detailed current information on San Carlos Apache Tribe water demand was not available to the Department. The reservation population in the planning area is approximately 8,300, primarily residing in the communities of San Carlos/Peridot and Bylas/Calva. There is a golf course, hotel and casino complex (Apache Gold) west of the community of San Carlos. Principal economic activities on the reservation include cattle ranching, forestry, recreation, and gemstone mining (San Carlos Apache Nation, 2006). Farming has historically been important. Total cultural use in the Gila River drainage portion of the reservation was estimated at 4,120 acre-feet in a Bureau of Indian Affairs (BIA) report from the early 1970s (BIA, 1974). With population increases since the BIA estimate, construction of the casino complex, and assuming that agricultural, livestock and industrial uses have remained constant, it is estimated that current demand is approximately 5,300 AFA.

Municipal demand on the Reservation is assumed to be relatively small. Community water systems serve the San Carlos-Peridot community and Bylas-Calva, all in the Safford Basin (BIA, 1974). Based on population, a

Talkalai Lake, San Carlos Apache Reservation. Principal economic activities on the reservation include cattle ranching, forestry, recreation, and gemstone mining reasonable municipal demand estimate is 1,000 to 1,250 AFA.

According to a CLIMAS report, several hundred acres of hay irrigation are occurring on the San Carlos Apache Reservation and the tribe has plans for expansion. Farming has been a culturally important activity and was economically important during the early years of the reservation (CLIMAS, 2004). A BIA study (1974), reported that 1,900 acres were historically irrigated although flooding and inundation of lands by filling of the San Carlos Reservoir reduced the amount of irrigable acres. Most of the irrigable acreage was located along the San Carlos and Gila Rivers and was irrigated with surface water, supplemented with well water (Bookman-Edmonston Engineering, Inc., 1979). The Gila Commissioner 2007 Annual Report showed 225 acres planted (Allred, 2007). In October 2008, Department staff observed two cotton fields along the San Carlos River between San Carlos and Highway 70.

Municipal Demand

Groundwater is the primary water supply for municipal use throughout the planning area. Average annual municipal water demand for the period 2001-2005 is summarized by groundwater basin in Table 3.0-9. There is little population or municipal demand in a number of basins in the planning area including Aravaipa Canyon, Bonita Creek, Donnelly Wash, Dripping Springs Wash, San Bernardino Valley and the San Rafael basins. As shown, almost half of the municipal demand in the planning area is in the Upper San Pedro Basin.

Only 13 water providers in the planning area served 450 acre-feet or more in 2006. These providers and their demand in selected years are shown in Table 3.0-10 and discussed below. Municipal gallon per capita per day (gpcd) rates are estimated to be about 125 gpcd in San Manuel, 157 gpcd in the Benson area, 168 gpcd in the Sierra Vista area, 177 gpcd in Safford, and 225 gpcd in Douglas.

Table 3.0-9 Average annual municipal water demand in the Southeastern Arizona Planning Area (2001-2005) in acre-feet

Basin	Groundwater	Surface Water	Effluent[1]	Total
Aravaipa Canyon	<300	0	0	150
Bonita Creek[3]	<300	0	0	150
Cienega Creek	600	0	0	600
Donnelly Wash	<300	0	0	150
Douglas	5,500	0	0	5,500
Dripping Springs Wash	<300	0	0	150
Duncan Valley	600	0	0	600
Lower San Pedro	2,300	300	145	2,745
Morenci	1,400	600	0	2,000
Safford[2]	6,500	0	500	7,000
San Bernardino Valley	<300	0	0	150
San Rafael	<300	0	0	150
Upper San Pedro	17,300	<300	830	18,280
Willcox	2,700	<300	211	3,061
Total Municipal	37,800	<1,500	1,686	40,686

Source: USGS 2007a

Notes: Volume <300 acre-feet assumed to be 150 acre-feet for computation purposes.

[1] Data on effluent demand is taken from effluent us

[2] Shown on Table 3.0-9 is water utilized within the basin. The Cultural Demand Table for Bonita Creek (Table 3.2-5) reflects water withdrawn in the basin. Most of the approximately 3,200 acre-feet withdrawn in the Bonita Creek Basin is conveyed to the Safford Basin.

Table 3.0-10 Water providers serving 450 acre-feet or more per year in 2006 in the Southeastern Arizona Planning Area

Basin /Water Provider	1991 (acre-feet)	2000 (acre-feet)	2006 (acre-feet)
Douglas			
Douglas Water Department	2,999	3,621	3,880
Duncan Valley			
Town of Duncan	176	529	628
Lower San Pedro			
Arizona Water Company San Manuel	855	743	646
Town of Kearny	483	648	483
Morenci			
Morenci Water and Electric	773	1,180	793
Safford			
Gila Resources - Safford	3,748	3,836	4,720[1]
Graham County Utilities, Inc Pima	298	435	416[2]
Upper San Pedro			
Arizona Water Company Bisbee	962	1,003	1,131
Arizona Water Company Sierra Vista	862	1,109	1,262
Bella Vista Water Company Sierra Vista	2,907	3,208	3,594
City of Benson	545	728	876
Pueblo del Sol Water Company - Sierra Vista	360	1,136	1,501
Willcox			
City of Willcox	NA	NA	1,004

Source: USGS 2007a, Community Water System 2006 Annual Reports
[1] Includes 120 acre-feet delivered to Arizona State Prison - San Jose
[2] Includes 62 acre-feet delivered to Eden Water Company

Most of the population in the planning area is served by private water companies. Municipal water utilities have more flexibility in setting water rates than private water companies, which are regulated by the Arizona Corporation Commission. In addition, municipal utilities have the authority to enact water conservation ordinances. These authorities enable municipal utilities to better manage water resources within water service areas. Water provider issues are discussed in section 3.0.8.

Provisions of the Settlement Agreement described above include individual agreements with the City of Safford and with the Towns of Duncan, Kearny, and Mammoth to resolve disputes regarding use of water for municipal and industrial purposes. These agreements set limits on future annual water use although actual use can exceed these limits under certain conditions and/or by implementing mitigation measures. (ADWR, 2006)

City of Douglas

The border community of Douglas has a population of about 17,700 residents and served 3,880 acre-feet of groundwater in 2006. It was founded as a site for a smelter to treat the copper ore mined at Bisbee. Agriculture, ranching and international commerce are important economic activities. Agua Prieta, Sonora is located directly south of Douglas and has a population of over 110,000 residents. Douglas is served by a municipal water utility that operates eight wells. In 2006 it delivered about 3,560 acre-feet to more than 5,000 residential connections and 320 acre-feet to about 450 commercial connections. The Douglas WWTF treats about 1,400 acre-feet of wastewater to secondary standards. The wastewater is discharged to Whitewater Draw just north of the international boundary and flows south into Mexico where it is used for agricultural irrigation. There are no plans to utilize effluent in Douglas due to the quality of the water and the historic commitment to deliver the effluent to Mexico.

Northeast of Douglas, the Bisbee-Douglas International Airport Water system serves about 400 acre-feet of groundwater withdrawn from 2 wells to the Arizona State Prison Complex-Douglas. The facility housed approximately 2,300 inmates in December, 2008 (ADC, 2008).

Town of Duncan

Duncan, with a population of about 800 residents, is located along the Gila River just west of the New Mexico border. Primary economic activities in the area are farming, cattle ranching and mining. Duncan is served by a municipal provider consisting of two systems; Town of Duncan and Town of Duncan-Hunter Water. In 2006 it withdrew a combined total of 628 acre-feet from three wells. Withdrawals are estimated from electrical records and are much higher than the amount of water reported as delivered on Community Water System Reports; 125 acre-feet.

Town of San Manuel

San Manuel is an unincorporated community built in 1953 as a company town to serve the San Manuel copper mine, mill and smelter complex. Both the mine and smelter were permanently closed in 2003. Approximately 4,400 residents resided in San Manuel in 2000. The town is now considered a bedroom community with some commercial businesses (ADOC, 2008a). Arizona Water Company receives water from BHP Copper Company to serve approximately 1,500 residential and 70 non-residential connections. In 2006 it received 646 acre-feet from BHP Copper and delivered 582 acre-feet to customers. Santec Corporation operates Coronado Utilities WWTP that serves the community. Approximately 291 AFA is generated at the facility and discharged to infiltration basins. The 9-hole San Manuel Golf Course uses water pumped from a facility well, not from Arizona Water Company.

Town of Kearny

Located in the northern part of the Lower San Pedro Basin, Kearny was a planned community built in 1958 for workers at the Kennecott Copper Company open pit mine and reduction plant, now operated by the American Smelting and Refining Company, which also operates smelters at Kearny and Hayden. The Town had a population of 2,270 in 2006. It withdrew 126 acre-feet of groundwater and diverted 357 acre-feet of surface water from the Gila River pursuant to the Globe Equity Decree in 2006. In that year it delivered 435 acre-feet of water to 821 residential and 71 commercial connections. The Kearny Water Reclamation Facility generated 190 acre-feet of effluent in 2006. Of this, 145 acre-feet was delivered to the 9-hole Kearny Golf Course and 45 acre-feet to a wetland.

Kearny Golf Course. In 2006 the Town withdrew 126 acre-feet of groundwater, diverted 357 acre-feet of surface water from the Gila River pursuant to the Globe Equity Decree and delivered 145 acre-feet of effluent to the Golf Course

Towns of Clifton/Morenci

Morenci Water and Electric serves the communities of Clifton and Morenci, which were established in the late 1980's as mining towns. These communities had a combined population of 4,306 in 2006 and population is declining due to a decrease in mining activity, the principal economic activity in the area. In 2006, Morenci Water and Electric withdrew 274 acre-feet of groundwater and diverted 519 acre-feet of surface water from Eagle Creek. About three-quarters of its deliveries (559 acre-feet) were to residential customers. Both communities are served by treatment plants but data from the Morenci WWTF was not available (Table 3.9-9).

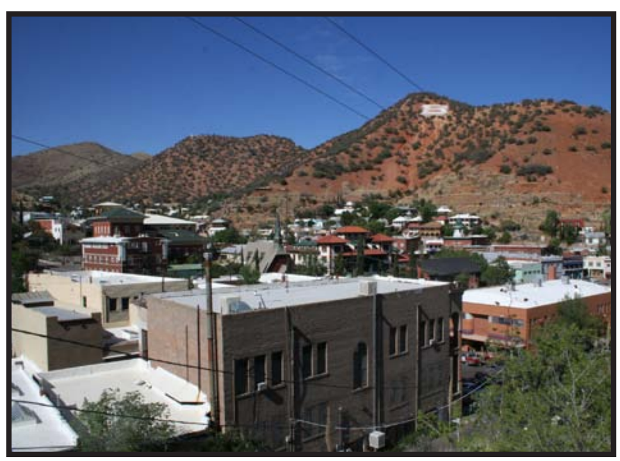
Town of Clifton. In 2006 Morenci Water and Electric withdrew 274 acre-feet of groundwater and diverted 519 acre-feet of surface water from Eagle Creek for the Towns of Clifton and Morenci.

Safford/Thatcher/Pima

These incorporated towns along the Gila River were established in the 1870s and 1880s as farming communities. Agriculture remains the primary economic activity although retail, education, retirement and mining are also important. Safford is the Graham County seat and Thatcher is the location of Eastern Arizona College. The City of Safford Water Utility (formerly Gila Resources) serves both Safford and Thatcher. In 2006, it withdrew 4,720 acre-feet of groundwater from nine wells, of which almost 3,300 was water from Bonita Springs in the Bonita Creek Basin, and served 2,521 residential and 1,180 non-residential connections. The City of Safford WWTP generated 1,226 acre-feet of effluent in 2006 and delivered 483 acre-feet to the Mt. Graham Municipal Golf Course. Graham County Utilities operates two systems; one serves the small community of Fort Thomas and the other serves the community of Pima (pop. 2080). In 2006 the Pima system withdrew 416 acre-feet of groundwater, of which 62 acre-feet was delivered to Eden Utilities. Ninety-two percent of the Pima system deliveries are to residential customers.

City of Bisbee

Arizona Water Company serves the community of Bisbee, the Cochise County seat located in the Mule Mountains that straddles the border of the Upper San Pedro and Douglas basins. A former mining town, Bisbee is a well-known artist's community with preserved historic architecture that makes it a popular tourist destination. Bisbee consists of historic Old Bisbee, Warren, Lowell, and San Jose with a combined 2006 population of 6,355. San Jose is located on the southern side of the Mule Mountains and is the location of the Arizona Water Company well field that serves the community. In 2006 Arizona Water Company withdrew 1,131 acre-feet of water from 4 wells. Approximately 70% of water deliveries are to residential customers. San Jose is also the location of an updated and expanded wastewater treatment plant that consolidated three separate systems (Old Bisbee, Warren and San Jose) in 2006. Prior to consolidation, effluent from Old Bisbee (approximately 130,000 gpd) had been discharged into the Douglas Basin via Mule Gulch. Approximately 4,900 acre-feet of effluent is treated annually at the plant. The Bisbee sewer collection system is also undergoing improvements and a substantial number of residents on septic systems will be connected to the sewer system. Bisbee effluent is slated to be delivered to the Turquoise Valley Golf Course in 2009 and the remainder discharged to Greenbush Draw. The Turquoise Valley Golf Course is an industrial facility.



Old Bisbee. Bisbee consists of Old Bisbee, Warren, Lowell and San Jose.

City of Sierra Vista/Fort Huachuca

Sierra Vista is the population center of southeastern Arizona with an economy closely tied to Fort Huachuca, with more than 11,000 military and civilian employees (ADOC, 2008b). Three large private water companies, as well as several small systems, serve Sierra Vista. The large systems are Arizona Water Company (AWC)-Sierra Vista, Bella Vista Water Company and Pueblo del Sol (PDS) Water Company. The 2006 population of Sierra Vista, which includes Fort Huachuca within its city limits, was 44,870 but the area population is much larger with more than 16,500 residents in the Sierra Vista SE CDP in 2006 (Table 3.0-5). Bella Vista is the largest water provider, consisting of two systems, Bella Vista City and Bella Vista South. The City system withdrew 3,399 acre-feet of groundwater from 18 wells in 2006 and delivered 1,756 acre-feet to residential customers and 1,456 acre-feet to non-residential connections. The South system withdrew 195 acre-feet from 12 wells and delivered 176.5 acre-feet to primarily residential customers. PDS serves primarily residential customers (90% of deliveries) and delivered a small amount of water (11 acre-feet) to the Pueblo del Sol Golf Course in 2006. Most of the irrigation needs at this course are met by facility wells, therefore it is considered an industrial facility. In 2006 PDS withdrew 1,501 acre-feet of groundwater from four wells. AWC –Sierra Vista withdrew 1,262 acre-feet of water from seven wells and delivered almost 1,000 acre-feet to residential customers in 2006. Another 175 acre-feet was delivered to non-residential customers.

The City of Sierra Vista Water Reclamation Facility produces approximately 2,800 AFA. The Facility was permitted in August 2001 to store up to 4,149 acre-feet of effluent per year for 20 years. Located east of the City, recharge is intended to mitigate any impact of groundwater pumping in the Sierra Vista area on the flow of the San Pedro River. Between 2002 and 2007 a total of approximately 10,700 acre-feet of effluent was recharged at the Sierra Vista facility.

City of Sierra Vista recharge facility. Between 2002 and 2007 a total of approximately 10,700 acre-feet of effluent was recharged at the Sierra Vista facility.

Fort Huachuca is a large military installation located at the base of the Huachuca Mountains. Established in 1877, it has a fluctuating population of approximately 8,400. In 2007, 1,414 acre-feet of groundwater was withdrawn from 8 wells to serve the residential and non-residential needs of the installation. The Fort Huachuca WWTP treated 661 acre-feet of effluent in 2007 and delivered 318 acre-feet for landscape and golf course irrigation (Chaffee Parade Field and Mountain View Golf Course) and recharged the remaining 343 acre-feet in a constructed recharge facility. Fort Huachuca and the City of Huachuca City have entered into an Intergovernmental Agreement in which the Fort has agreed to accept wastewater from Huachuca City and to recharge it to the aquifer (USPP, 2007). The annual volume of effluent produced at Huachuca City is approximately 150 acre-feet.

City of Benson

The City of Benson, founded in 1880, began as a transportation center, with a Butterfield Overland Stage station house on the San Pedro River in the 1870s and construction of rail lines that linked Benson to Mexico, California and the East. Copper and silver from the mines at

Bisbee and Tombstone were shipped from the Southern Pacific Railroad station in Benson (City of Benson, 2009). When mining declined and the rail center moved to Tucson, ranching became the predominant industry. Benson is now a growing community and has expanded its city limits and water service area to serve large master-planned residential developments to the southwest.

The City of Benson, with a 2006 population of 4,800, is served by a municipal utility that withdrew 878 acre-feet of groundwater from five wells that year. Most of its deliveries were to non-residential customers (401 acre-feet), with 361 acre-feet delivered to residences. The City of Benson WWTP treated 762 acre-feet of effluent in 2006 and delivered 470 acre-feet of effluent to the 18-hole San Pedro Golf Course.

City of Willcox

Willcox is an agricultural and ranching center established in 1880 and incorporated in 1915. It is served by a municipal water utility that withdrew water from one potable well for domestic deliveries and from several non-potable wells for other uses in 2006. One of the non-potable wells is used for construction purposes due to high fluoride levels. Another well is used for cemetery irrigation and the third is located close to effluent-dependent Cochise Lake and is used to maintain water levels for migratory birds (City of Willcox, 2006). In 2006, 856 acre-feet of water was withdrawn from the potable well and a total of the potable and non-potable withdrawls, 394 acre-feet was delivered to residential customers, 547 acre-feet to commercial customers and 22 acre-feet to turf. From the non-potable wells 148 acre-feet were withdrawn.

The City of Willcox WWTP produced 492 acre-feet of effluent in 2006, of which 197 acre-feet was delivered to the Twin Lakes Golf Course.

There are several golf courses in the planning area that are served from a municipal water supply. They are shown in Table 3.0-11 with estimated demand and source of water. If actual demand was not available, estimates were made that account for the elevation of the facility and duration of the irrigation season. This demand is included in the municipal demand total.

Table 3.0-11 Golf course demand in the Southeastern Arizona Planning Area (c.2008)

Facility	Basin	# of Holes	Demand (acre-feet)	Water Supply
Douglas Municipal Golf Course	Douglas	18	440	Groundwater
Greenlee Country Club*	Duncan	9	211	Groundwater
Hayden Golf Course	Lower San Pedro	9	211	Groundwater
Kearny Golf Course	Lower San Pedro	9	145	Effluent
San Manuel Golf Club*	Lower San Pedro	9	211	Groundwater
Alpine Country Club*	Morenci	18	75	Groundwater
Apache Stronghold Golf*	Safford	18	423	Groundwater
Mt. Graham Municipal Golf Course	Safford	18	483	Effluent
Mountain View Golf Course	Upper San Pedro	18	370	Effluent
Pueblo del Sol Country Club (Sierra Vista)*	Upper San Pedro	18	475	Groundwater
San Pedro Golf Course	Upper San Pedro	18	460/90	Effluent/ Groundwater
Turquoise Hills Country Club (Benson)*	Upper San Pedro	18	500	Groundwater
Turquoise Valley Country Club (Naco)*	Upper San Pedro	18	577	Groundwater
Twin Lakes Municipal Golf Course	Willcox	9	211	Effluent

Source: ADWR 2008c

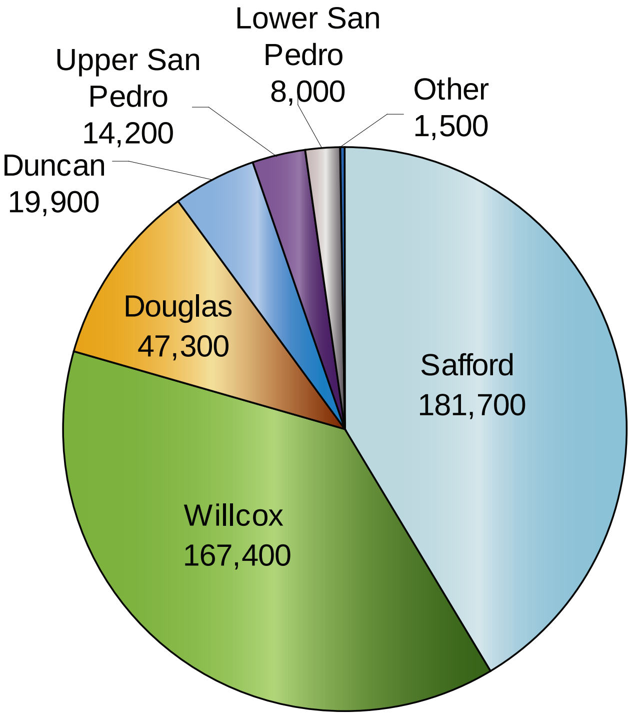
* These golf courses are served by their own wells and, therefore, are considered to be industrial users.

Agricultural Demand

Agriculture is the largest water demand sector and an important segment of the economy in the planning area, particularly in the Safford, Willcox, Douglas and Duncan Valley basins (Figure 3.0-18). Relatively recent declines in irrigated acreage have occurred in some planning area basins, including the Lower San Pedro Basin due in part to land conservation efforts, and in the Upper San Pedro Basin due to the establishment of the SPRNCA, conservation easements, urbanization and economic factors.

Conditions of the GRIC Water Rights Settlement affect agricultural water use in the Duncan Valley and Safford Basins. Several provisions of the Upper Valley Districts (UVD) Agreement affect upper valley irrigators in several basins (and including those in New Mexico) and could potentially impact flows in the Gila River (ADWR, 2006).

Figure 3.0-18 Southeastern Arizona Planning Area average annual agricultural demand 2001-2005 by basin, in acre-feet



Historic and recent agricultural demand is shown in Table 3.0-12. While demand has diminished in several basins, demand has expanded in the Willcox and Douglas basins over the last 15 years, and overall, demand has increased. In the Safford and Duncan Valley Basins, agricultural water demand has decreased since 1991, and the proportion of surface water available for use appears to have declined due to drought, leading to increased well pumpage in both basins. In the Willcox Basin, agricultural demand has declined significantly from the early 1970s when over 300,000 AFA was used. However, demand is now increasing. In 2007 the USGS conducted agricultural surveys of some of the basins in the planning area. Information on the number of active irrigated acres, percentage of crop grown and irrigation method is summarized in Table 3.0-13. As shown, crop type and irrigation method varies significantly between basins. Following is a brief description of agricultural areas, which are listed generally in descending order of water demand.

Willcox Basin

There is significant irrigation throughout the Sulphur Springs Valley in the Willcox Basin. North of the Town of Willcox, extensive orchards of apples and other fruits including U-pick orchards and vegetable farms exist. One of Arizona's few hydroponic tomato nurseries, Eurofresh Farms, a large, year-round producer of greenhouse tomatoes, is located in the northern part of the basin (AZDA, 2005). South of the Town of Willcox, irrigation is principally for alfalfa and corn. As in the Douglas Basin, groundwater withdrawals for agricultural irrigation in the Willcox Basin have resulted in large declines in groundwater levels. These groundwater level declines may have caused land subsidence and surface fissures south of the Town of Willcox (USGS, 2006b). Approximately 50,600 acres are currently irrigated, with an annual average of about 167,000 acre-feet of groundwater demand

Table 3.0-12 Agricultural demand in the Southeastern Arizona Planning Area

	1991-1995 (acre-feet)	1996-2000 (acre-feet)	2001-2005 (acre-feet)
Aravaipa Canyon			
Surface Water	<1,000	<1,000	<1,000
Groundwater	<1,000	<1,000	<1,000
Total	1,000	1,000	1,000
Cienega Creek			
Groundwater	500	500	500
Douglas			
Groundwater	32,800	37,100	47,300
Duncan Valley			
Surface Water	21,500	18,500	9,900
Groundwater	5,900	8,300	10,000
Total	27,400	26,800	19,900
Lower San Pedro			
Surface Water	<1,000	<1,000	<1,000
Groundwater	12,800	11,100	7,500
Total	13,300	11,600	8,000
Safford			
Surface Water	117,000	99,500	61,300
Groundwater	86,000	91,500	120,400
Total	203,000	191,000	181,700
Upper San Pedro			
Surface Water	4,300	4,300	4,300
Groundwater	16,500	15,100	9,900
Total	20,800	19,400	14,200
Willcox			
Groundwater	123,600	123,600	167,400
Total	422,400	411,000	440,000

Source: USGS 2007a, ADWR 2005c
Notes: Volume <1,000 acre-feet assumed to be 500 acre-feet for computation purposes.

during the period 2001-2005. The crop mix is relatively diversified as shown in Table 3.0-13.

Safford Basin
In the Safford Basin, agricultural irrigation occurs along the Gila River where cotton and wheat are the predominant crops and in the San Simon Valley in the southern part of the basin where predominant crops include cotton, alfalfa, corn and nut orchards. The Gila Valley Irrigation District (GVID), incorporated in 1923, encompasses about 35,500 acres along the Gila River from the San Carlos Apache Reservation boundary to about 12 miles east of Safford. There are ten canal companies within the GVID that deliver water to farmers who also irrigate using privately owned wells. Surface water use in the Safford area is pursuant to the Gila River Decree (Globe Equity No. 59 Decree) and when surface water is limited it is allocated to downstream users and not available for irrigation in the area. During the period of 2001-2005, an average of 120,400 acre-feet of groundwater and 61,300 acre-feet of surface water were used annually in the Safford Basin. In 2007 the USGS found 28,300 active irrigated acres in the basin. As shown in Table 3.0-13, cotton is by far the predominant crop and almost all agricultural lands are flood irrigated.

Douglas Basin
Most of the Douglas Basin was designated as an Irrigation Non-Expansion Area (INA) in 1980 and as a result, agricultural irrigation is restricted to lands that were irrigated during the five-year period preceding designation. A requirement within an INA is that groundwater withdrawals for irrigation on more than ten acres must be measured and annually reported to the Department. These reports indicate that from 1984 to 2000, annual groundwater withdrawals fluctuated between about 30,000 AFA to about 45,000 AFA. However, demand is increasing with an annual average of 47,300 acre-feet withdrawn during the period 2001-2005. Groundwater withdrawals for agricultural irrigation have resulted in significant declines in groundwater levels and a large cone of depression has formed in the northern part of the basin (USGS, 2006b). Irrigated acreage is located primarily in the central and northern part of the basin in the Sulfur Springs Valley. Currently, approximately 13,150 acres of predominantly corn and alfalfa are being irrigated. Center-pivot irrigation is the main irrigation method in the basin (Table 3.0-13).

Table 3.0-13 Active irrigation acres, percentage of crops grown and irrigation method in selected basins in the Southeastern Arizona Planning Area, 2007

Basin	Willcox	Safford	Douglas	Duncan	Upper San Pedro	Lower San Pedro
2007 Irrigated Acreage	*50,600 acres*	*28,300 acres*	*13,150 acres*	*3,450 acres*	*1,000 acres*	*600 acres*
Crop Type						
Corn	38%	<1%	52%	15%	1%	NA
Cotton	2%	84%	1%	6%	NA	38%
Orchard	10%	<1%	10%	NA	15%	NA
Pasture (Alfalfa, Hay)	28%	12%	27%	54%	78%	54%
Sorghum	3%	<1%	2%	24%	NA	8%
Vegetables	10%	NA	7%	NA	NA	NA
Wheat	1%	3%	NA	1%	NA	NA
Other	8%	<1%	1%	NA	6%	NA
Irrigation Type						
Center Pivot	79%	1%	85%	2%	2%	17%
Flood	16%	99%	6%	98%	63%	33%
Drip	2%	NA	8%	NA	25%	33%
Sprinkler	3%	NA	1%	NA	10%	17%

Source: USGS 2009

Duncan Valley Basin

Duncan Valley Basin agricultural irrigation is located southeast of the Town of Duncan in the Duncan Valley and northwest of Duncan in the York Valley area. Principal crops include alfalfa, cotton, corn and wheat and there is some commercial vegetable production. The Franklin Irrigation District, also known as the Duncan Valley Irrigation District, serves farmers in the Duncan Valley. The district boundaries extend into New Mexico and irrigation wells in Arizona and New Mexico are used to irrigate lands in both states (Upper Gila Watershed Partnership, 2004). The District was formed in 1922 and encompasses about 4,700 acres of Gila River bottom land. Surface water rights for use within this district are also specified in the Gila River Decree (ADWR, 1998). An average of 10,000 acre-feet of groundwater and 9,900 acre-feet of surface water were used annually during the period 2001-2005. The USGS found 3,450 irrigated acres in 2007 of predominantly pasture and sorghum, almost all flood irrigated (Table 3.0-13).

Upper San Pedro Basin

Almost all the remaining agriculture is in the Benson area in the Upper San Pedro Basin. In 2002, there were an estimated 2,200 acres in the Benson area and 800 acres in the Palominas area were under irrigation with a demand of about 9,900 acre-feet of groundwater and 4,300 acre feet of surface water. In 2006, approximately 500 acres of irrigation in the Palominas area were taken out of production. When the USGS surveyed the basin in 2007, they found only 1,000 acres being actively irrigated. Pasture was by far the predominant crop grown with smaller amounts of orchard, grapes and corn. Flood irrigation is the predominant irrigation method with drip irrigation of grapes and pecans observed.

Two irrigation providers in the Benson area delivered surface water from the San Pedro River: the Saint David Irrigation District (SDID) and the Pomerene Water Users Association (PWUA). Approximately 39% of the irrigated lands in the Benson area were served by one of these two districts in 2005. When insufficient surface water is available, SDID delivers groundwater pumped from two district wells (ADWR, 2005a). The PWUA diversion structure suffered repeated damage over the years from flooding and significant repairs were last preformed in 2003. Subsequent flooding damaged the diversion gate and eroded the banks. Diversions and canal maintenance have since ceased. The Arizona Corporation Commission administratively dissolved the PWUA in 2005 for failure to file an annual report.

The PWUA did not operate groundwater wells to supplement the surface water supply although members used the canal system to deliver their own pumped water to their fields. It is not known if this is still the case.

Lower San Pedro Basin

Agricultural demand in the Lower San Pedro Basin averaged about 8,500 AFA during the period 2001-2005. Irrigated acreage is located along the San Pedro River throughout the length of the basin but primarily in the northern and southern portions. The USGS estimated that approximately 600 acres were irrigated in 2007. Groundwater is the primary water supply for irrigation. Surface water diversions from the San Pedro River account for less than 1,000 AFA of the total water supply. In 2007, approximately 600 acres of primarily pasture and cotton were irrigated. A variety of irrigation methods are used including the highest percentage of drip irrigation in the planning area (Table 3.0-13).

Cienega Creek Basin

Irrigation in the Cienega Creek basin is limited but expanding and is largely vineyards under drip irrigation. These lands are located east of Sonoita in the Elgin area. Based on an informal survey conducted in 2008, it is estimated that between 200 and 300 acres are under cultivation.

Vineyard in the Cienega Creek Basin.

Industrial Demand

Industrial water demand in the planning area includes mining, electrical power generation, dairies and feedlots, and golf course irrigation served by a facility water system. This demand is summarized in Table 3.0-14 for selected years. Mining is the largest industrial user in the planning area, primarily due to activities in the Lower San Pedro and Morenci basins.

The Morenci Mine in the Morenci Basin is North America's largest producer of copper and one of the largest open pit mines in the world. The mine property covers about 60,000 acres and includes five pits, three of which are currently in operation, and SX/EW (solution extraction/ electrowinning) facilities. Reportedly, almost all of the water used at Morenci is recycled, some of it many times (InfoMine, 2006). Most of the water utilized by the mine and by the Morenci Water & Electric Company (a subsidiary of Phelps Dodge) is diverted from the Black River in the Salt River Basin and transported into the basin, or is from the Upper Eagle Creek Well Field. Water diverted from Gila River tributaries typically accounts for about 10% of the total (ADWR, 2005c). Phelps Dodge has a 50-year lease agreement with the San Carlos Apache Tribe pursuant to the San Carlos Apache Tribe Water Rights Settlement Act of 1992, as amended in 1997, to lease up to 14,000 AFA of its allocation of CAP water by means of an exchange at the Black River Under the 1944 Horseshoe Exchange Agreement, Phelps Dodge also is entitled to diversions of up to 250,000 acre-feet from the Black River (ADWR, 2005c). As of the beginning of 2009, Phelps Dodge had used almost 102,500 acre-feet of Horseshoe Reservoir credits (SRP, Personal Communication). Water from recovery wells installed in the mine area for dewatering purposes is also used at the mine, as is effluent from the Morenci Water & Electric Company.

Table 3.0-14 Industrial Demand in the Southeastern Arizona Planning Area

	1991-1995	1996-2000	2001-2005
Type/Basin	**Water Use (acre-feet)**		
Mining Total	**48,195**	**47,085**	**25,831**
Cienega Creek			
Groundwater	<300	<300	<300
Lower San Pedro			
Groundwater	30,800	26,100	15,700
Morenci			
Surface Water	2,425	2,105	1,141
Groundwater	13,700	17,800	8,100
Safford			
Groundwater	650	500	370
Upper San Pedro			
Groundwater	170	200	210
Willcox			
Groundwater	300	230	160
Power Plant Total	**6,000**	**5,200**	**5,700**
Willcox			
Groundwater	6,000	5,200	5,700
Golf Course Total	**1,596**	**1,806**	**2,316**
Duncan Valley			
Groundwater	210	210	210
Lower San Pedro			
Groundwater	211	211	211
Morenci			
Groundwater	75	75	75
Safford			
Groundwater	0	210	420
Upper San Pedro			
Groundwater	1,100	1,100	1,400
Dairy/Feedlot Total	**262**	**272**	**502**
Duncan Valley			
Groundwater	100	100	100
Upper San Pedro			
Groundwater	42	42	42
Willcox			
Groundwater	120	130	360
Other Total	**290**	**290**	**290**
Upper San Pedro			
Groundwater	290	290	290
Total	56,343	54,653	34,639

Sources: ADWR 2008d, USGS 2007a

Notes: Volume <300 acre-feet assumed to be 150 acre-feet for computation purposes.

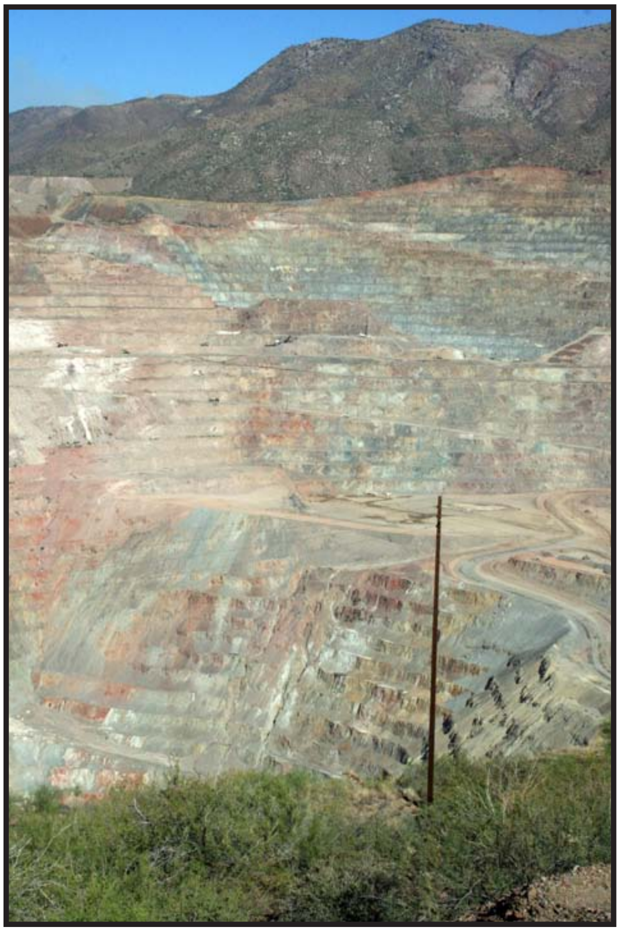
In the Lower San Pedro Basin, the ASARCO Ray Complex includes a 250,000 ton/day open pit mine northwest of Kearny, a SX/EW operation and a smelter at Hayden.

Two large copper mines in the planning area are currently out of production. The BHP Billiton Base Metals in-situ copper leaching operations at San Manuel in the Lower San Pedro Basin closed in early 2002 and underground mining at the site ceased in August 1999. In February 2002, Pima County approved BHP's request to redesignate some of its property for uses other than mining. (ADWR, 2006)

The Phelps Dodge Copper Queen mine in the Upper San Pedro and Douglas Basins currently consists of a small dump leaching and precipitation operation at the Lavender pit (Arizona Mining Association, 2006). Open pit mining started in 1917 and continued, with some interruptions, at the Sacramento pit and Lavender pit until 1974. All active mining stopped in 1984. Considerable dewatering of the mine workings was necessary with long-term groundwater production of about 4,000 AFA (Southwest Groundwater Consultants, Inc., 2004).

Phelps Dodge Corporation began full operation of a large open pit mining operation in the Safford Basin in 2008. Located eight miles north of the town of Safford, the 3,400 acre Safford (Dos Pobres) operation includes two open pits, one heap leach pad, one process solution pond, one evaporation pond, a SX/EW process plant and other infrastructure and support facilities (InfoMine, 2008; ADEQ, 2006c). Average annual groundwater demand by the mine is projected to be about 5,500 AFA (ADWR, 2006).

The only power plant in the planning area is the Arizona Electric Power Cooperative (AEPCO) Apache Station Generation Plant located in the Willcox Basin in Cochise, southwest of Willcox. The plant is a gas-fired combined cycle plant built in 1963 that generates 520 megawatts of electric energy for its cooperative members



Ray Mine, Lower San Pedro Basin. Mining is the largest industrial user in the planning area, primarily due to activities in the Lower San Pedro and Morenci basins.

located throughout Arizona and California (AEPCO, 2006). Average annual demand during the period 2001-2005 was slightly lower than the average annual demand during the priod 1991-1995 but annual demand can vary considerably, from a low of 4,100 acre-feet in 1996 to a high of 6,600 acre-feet in 1991.

There are seven industrial golf courses in the planning area, which are defined as those courses with their own facility water supply. They are shown in Table 3.0-11, along with municipally served golf courses, with estimated demand and source of water.

Three dairies and two feedlots have been identified in the planning area. There is a small, approximately 350 animal dairy north of Benson in the Upper San Pedro Basin (Cliff's Dairy), a large dairy of about 5,400 animals near Kansas Settlement (Faria Dairy) in the Willcox Basin that began operation in 2004, and an approximately 855 animal dairy in the Duncan Basin (Lunt's Dairy). Demand is about 42 acre-feet, 588 acre-feet and 120 acre-feet respectively. There are also two feedlots in the Willcox Basin with a combined total of about 4,000 animals and a demand of about 130 acre-feet in 2005. Development of dairies and feedlots typically results in increased agricultural irrigation for feed.

The Apache Nitrogen Products facility is an ammonium nitrate manufacturing plant located south of Benson in the Upper San Pedro Basin. The facility has made efforts to reduce its water consumption, and in 2005 used an estimated 289 acre-feet of groundwater, a reduction of about 250 acre-feet since 1991.
A number of sand and gravel facilities are located throughout the planning area. Some of these are identified on the cultural demand maps for each basin. However, not all are identified in the source data used for the maps. Water is used for aggregate washing, dust control, vehicle washing and equipment cooling. Typically, there is relatively little water consumed at these sites since most facilities recycle wash water. The Department estimated that a typical sand and gravel facility in the Upper San Pedro Basin uses less than 50 AFA (ADWR, 2005a).

Faria Dairy, Willcox Basin. There are three dairies and two feedlots in the Southeastern Arizona Planning Area

3.0.8 Water Resource Issues in the Southeastern Arizona Planning Area

Population growth and associated concerns about sustainable water supplies, water level declines, increased agricultural demand and environmental protection activities have resulted in groundwater studies, regional planning actions, establishment of conservation easements and other activities in the planning area.

Water resource issues have been identified in the Southeastern Arizona Planning Area by community watershed groups, through the distribution of surveys, and from other sources. Primary issues identified are the lack of sufficient data to make informed water management decisions, legal issues related to surface water availability and the legal nature of water supplies, endangered species act implications, and concerns about whether there will be sufficient water supplies to meet future demand. A number of water systems have reported concerns about aging infrastructure and the lack of financial resources to make capital improvements.

Watershed Groups

Several watershed groups have formed in the planning area to address water resource concerns. Groups currently active within the planning area are the Middle San Pedro Watershed Partnership, the Eagle Creek Partnership, the Gila Watershed Partnership, the Lower San Pedro Watershed Partnership, the Upper San Pedro Partnership and the Willcox Playa Watershed Group. A complete description of participants, activities and issues is found in Appendix D. Primary issues identified by these groups are summarized as follows:

Growth:
- Excessive growth in some areas
- Unregulated lot splits
- Desire to maintain rural setting, including agriculture, at current levels in Gila Valley

Water Supplies and Demand:
- Limited groundwater data
- Pumping impacts by Mexico on the San Pedro River and downstream users
- Large volume of overdraft in Willcox Basin
- Increased agricultural production in some basins

Legal:
- Unresolved Indian water rights settlements
- Unresolved surface water adjudication
- Potential impact of adjudication court subflow definition
- Interbasin transfer prohibition
- Mandatory water adequacy required for all new subdivisions in Cochise County

Water Quality:
- Poor quality groundwater and surface water in some areas
- Ability to meet new arsenic standard
- Concern about Superfund site and poor quality groundwater conditions

Environmental:
- Endangered Species Act (ESA) issues, critical habitat designation and mitigation efforts
- Impact of invasive species (Tamarisk) on surface water supply
- Lawsuits from environmental groups
- Potential impacts on riparian areas by continuation of current pumping

Funding:
- Limited funding resources for planning, projects, infrastructure and studies
- Extremely high cost of water augmentation projects

Drought:
- Drought impacts on surface water supplies, agriculture and cattle ranching

Other:
- Different perceptions of issues and goals in Benson community
- Difficulty in getting principle players to the table to discuss water

- Several high hazard unsafe dams in Gila Valley area
- Regular flooding in the Duncan-Virden area
- Opposition to government assistance to obtain groundwater information
- Potential loss of Fort Huachuca due to water/ESA issues
- Federal mandate to achieve sustainability by 2011 in the Sierra Vista subwatershed
- Political obstacles to potential water augmentation projects
- Potential for subsidence

Two of the partnerships in the planning area, the Gila Watershed Partnership in the Safford, Duncan Valley and part of the Morenci basin and the Upper San Pedro Partnership (USPP) in the Upper San Pedro Basin, have been organized for a number of years and have completed many projects. The Upper Gila Watershed Partnership initiated a Fluvial Geomorphology Study of the Upper Gila River that was funded through the Department's Water Protection Fund Program (98-054WPF), Graham County and the Bureau of Reclamation. The study area was of the Gila River from the boundary of the San Carlos Apache Reservation to the New Mexico Border. Its purpose was to demonstrate ways to manage the river, taking into account the geomorphic processes that dominate the fluvial systems (USBOR, 2004). It also produced a study on current and projected water demand for the watershed.

A number of water management practices have been implemented in the Sierra Vista subwatershed portion of the Upper San Pedro Basin. These include groundwater recharge, direct effluent use, water conservation ordinances, municipal conservation programs, water management and land use policies.

The USPP annually adopts and updates a water management and conservation plan for the Sierra Vista portion of the Basin. In addition, beginning in 2004, the Partnership must annually prepare a report (referred to as the "321 Report") on water use management and conservation measures that have been implemented and are needed to restore and maintain the sustainable yield of the regional aquifer by September 30, 2011 (Public Law 108-136).

On March 21, 2006 the Cochise County Board of Supervisors adopted the Sierra Vista Sub-watershed Water Conservation and Management Policy Plan (Plan) to guide development in the unincorporated areas of the subwatershed.[5]

San Pedro River. Water management practices such as groundwater recharge, direct effluent use, water conservation ordinances and municipal conservation programs have been implemented in the Sierra Vista subwatershed portion of the Upper San Pedro Basin.

[5] The Cochise County Comprehensive Plan also includes a Water Conservation Goal and Policies section. This portion of the Comprehensive Plan is almost identical to elements within the Sierra Vista Sub-watershed Water Conservation and Management Policy Plan, however, the Comprehensive Plan applies to all Cochise County.

According to the Plan, development density will be no greater than one unit per acre unless the subdivider incorporates water saving measures that mitigate any increase in usage over the current zoning, and effluent is recharged or densities are transferred from elsewhere in the subwatershed. The Plan also prohibits increasing densities within two miles of the SPRNCA. (USGS, 2007) Many of the Plan's policies are carried out through the Sierra Vista Sub-watershed Overlay District and other changes to the code that went into effect on January 5, 2007. The overlay district provides water use restrictions, in addition to those already required in the county, on new development within the subwatershed; it does not change the underlying zoning.[6] (Cochise County Code § 1802.2) Concurrent with the passage of the overlay district, the Cochise County zoning regulations were amended to encourage transfer of development rights from the area within two miles of the SPRNCA boundary and one mile of the Babocomari River to other portions of Cochise County. (Cochise County Code § 2208.3) In addition to the Plan the Babocomari Area Plan adopted in 2005 indicates that future upzoning should not increase groundwater withdrawals beyond the current assumed impact of one unit per four acres. The plan also discourages new wells in the 100-year floodplain of the Babocomari River. (Cochise County, 2006)

The USPP and its members have initiated many conservation programs including the Water Wise program, a toilet rebate program and water conservation ordinances. Cochise County has a Water Conservation Office and Sierra Vista and Bisbee have incorporated water conservation into their zoning codes, which are as strict, or stricter than those required by Cochise County. Fort Huachuca, a partnership member, has implemented aggressive conservation efforts at the Fort that have reduced on-post water consumption by almost 45% since 1993. The USPP is also evaluating water augmentation options including the costs and feasibility of constructing a pipeline to transport Central Arizona Project Water to the area.

Because the Upper San Pedro groundwater basin extends into Mexico, the Partnership is pursuing research and cooperative efforts with Mexico. Conservation efforts in the Mexican portion of the basin have been underway, including establishment of the Ajos-Bavispe National Forest and Wildlife Refuge and a 10,000 acre private reserve in the watershed (Sierra Vista Herald, 2006). (See the Upper San Pedro Partnership website for more information at www.usppartnership.com.)

In 2006, Congress passed the U.S.- Mexico Transboundary Aquifer Assessment Act (U.S. Public Law 109-448) that authorized $50M over 10 years for the study of four transboundary aquifers including the Santa Cruz and San Pedro aquifers in Arizona. Plans are underway to identify and pursue scientific and informational studies, in particular the creation of a physically-based hydrologic model of each binational basin.

In response to concerns of water planners, local citizens and environmental groups about the impacts of groundwater development, the Department, in collaboration with the USGS and funding from local partners, began conducting hydrogeologic investigations in 2005 to improve the understanding of water resources in two areas within the planning area: 1) the middle San Pedro Basin, which includes the Benson subwatershed and a portion of the Lower San Pedro Basin and 2) the Willcox and Douglas Basins. These investigations will assess the existing data collection networks and examine the current state of knowledge of the groundwater system, quantify the water budget

[6] Examples of the overlay conservation requirements include: gray water plumbing in all new construction, humidity sensors on any new installation or replacement of outdoor sprinkler systems and a moratorium on decorative water features not fed solely by rainwater.

Santa Cruz River, San Rafael Basin. In 2006, Congress passed the U.S.- Mexico Transboundary Aquifer Assessment Act that authorized $50M over 10 years for the study of four transboundary aquifers including the Santa Cruz and San Pedro aquifers in Arizona.

for the area, including total water in storage, and establish a hydrologic monitoring network for on-going assessment of the aquifer. The San Pedro investigation was expected to take seven years and result in a groundwater flow model. The Willcox/Douglas investigations were scheduled for three years and include establishment of a monitoring network for each basin, an inventory of agricultural groundwater pumpage in each basin, and a preliminary assessment of subsidence in the Willcox Basin (USGS, 2006b). Recent State budget cuts will delay completion of these studies. In 2008, the Department produced a Water Level Change Map report for the Willcox Basin as part of the Willcox/Douglas study.

Finally, state legislation passed in 2007 (HB 2300) authorizes formation of an Upper San Pedro Water District whose purpose is to maintain the aquifer and base flow conditions needed to sustain the upper San Pedro river and to help meet the water supply needs and water conservation requirements for the communities within the district. The legislation allows the District and a District Board to be established if approved by qualified voters of the District. A District Organizing Board has been formed to prepare organizational, financial and election plans for the District. If approved, the District could acquire water supplies and water rights and operate augmentation projects. It could issue revenue bonds, impose fees and other taxes and receive loans or grants from the Water Infrastructure Finance Authority to finance necessary projects. The date of the election has not yet been scheduled.

Issue Surveys

The Department conducted a rural water resources survey in 2003 to compile information for the public and help identify the needs of growing communities. This survey was also intended to gather information on drought impacts for incorporation into the Arizona Drought Preparedness Plan, adopted in 2004. Questionnaires were sent to almost 600 water providers, jurisdictions, counties and tribes. The Department completed a report of the findings from the survey in 2004 (ADWR, 2004).

There were 29 water provider and jurisdiction respondents in the Southeastern Arizona Planning Area, and 14 numerically ranked issues. Respondents were asked to rank eighteen issues. Infrastructure issues, which include well capacity problems and inadequate capital to pay for infrastructure improvements, were ranked among the top five issues by half of respondents. Future water supply concerns also ranked relatively high (Table 3.0-16). In a separate question, about half of respondents noted at least one drought impact. Primary drought impacts noted were increased demand, increased peak demand and lowered groundwater levels.

The Department conducted another, more concise survey of water providers in 2004. This was done to supplement the information gathered in the previous year in support of developing the Arizona Water Atlas, and to reach a wider audience by directly contacting each water provider. Through this effort, 55 water providers in the planning area, with a total of approximately 46,900 service connections, were willing to participate and provide information on water supply, demand, infrastructure and to rank a list of seven issues.

Water providers were asked to rank issues from 0 to 4 with 0 = no concern, 1 = minor concern, 2 = moderate concern and 3 = major concern. Of the 55 water providers that responded to the survey, 44 ranked issues. These respondents include many of the largest water providers in the planning area including Bella Vista Water Company (Sierra Vista), City of Benson, City of Douglas, Gila Resources/Safford, Town of Kearny, Pueblo del Sol Water Company (Sierra Vista) and the City of Willcox.

Although responses to the 2003 questionnaire are not directly comparable to the 2004 survey due to differences in the form and wording of the surveys, responses to issues are similar as shown in Table 3.0-16. The 2004 responses indicate that inadequate capital for infrastructure improvements is an overwhelming concern in the planning area. Other infrastructure issues and drought also ranked high.

Table 3.0-16 Water resource issues ranked by survey respondents in the Southeastern Arizona Planning Area

Issue	Percent of 2003 respondents that ranked issue as one of the top 5 (of 18)	Percent of 2004 respondents reporting issue was a moderate or major concern
Inadequate storage capacity to meet peak demand	21%	34%
Inadequate well capacity to meet peak demand	50	25
Inadequate water supplies to meet current demand	14	20
Inadequate water supplies to meet future demand	36	32
Infrastructure in need of replacement	36	41
Inadequate capital to pay for infrastructure improvements	50	61
Drought related water supply problems	29	39

Source: ADWR 2004

Note: 2003 respondents consist of 12 water providers and 2 jurisdictions. 2004 respondents included 44 water providers

3.0.9 Groundwater Basin Water Resource Characteristics

Sections 3.1 through 3.14 present data and maps on water resource characteristics of the fourteen groundwater basins in the Southeastern Arizona Planning Area. A description of the data sources and methods used to derive this information is found in Appendix A of Volume 1 of the Atlas. This section briefly describes general information that applies to all of the basins and the purpose of the information. This information is organized in the order in which the characteristics are discussed in Sections 3.1 through 3.14.

Geographic Features

Geographic feature maps are included to provide general orientation to principal land features, roads, counties and cities, towns and places in the groundwater basin.

Land Ownership

The distribution and type of land ownership in a basin has implications for land and water use. Large amounts of private land typically translate into opportunities for land development and associated water demand, whereas public lands are typically maintained for a specific purpose or multi-use with little associated water use. State owned land may be sold or traded, and is often leased for grazing and farming. The State Enabling Act of 1910 and the Act that established the Territory of Arizona in 1863 set aside sections 2, 16, 32 and 36 in each township to be held in trust by the state for specified purposes, which are identified for each basin (ASLD, 2006).

Climate

Climate data including temperature, rainfall, evaporation rates and snow are critical components of water resource planning and management. Averages and year to year variability, seasonality of precipitation and long-term trends are all important factors in demand and supply planning.

Surface Water Conditions

Depending on physical and legal availability, surface water may be an important water supply in some basins. Stream gage, flood gage, reservoir, stockpond and runoff contour data provide information on physical availability of this supply. Seasonal flow information is relevant to seasonal supply availability. Annual flow volumes provide an indication of potential volumetric availability.

Criteria for including stream gage stations in the basin table are that there is at least one year of record, and annual streamflow statistics are included only if there are at least three years of record. There are different types of stations and those that only serve repeater functions were not included.

Flood gage information is presented to direct the reader to areas where flooding has been or may be a problem. Large reservoir storage information includes data on the amount of surface water stored in large reservoirs, its uses and ownership. The number and capacity of small reservoirs is also provided as well as the number of stockponds in each basin. The number of stockponds is a general indicator of small-scale surface water capture and livestock demand. Runoff contours reflect the average annual runoff that can be expected in tributary streams over a particular area.

Perennial and Intermittent Streams and Major Springs

A map of perennial and intermittent streams is provided for each basin. For some basins, more than one source of information was used. Stream designations may not reflect current conditions in some cases. Spring data was compiled from a number of sources in an effort to develop as comprehensive a list as possible. Spring data is important to many researchers and to the environmental community due to their importance in maintaining habitat, even from small discharges.

Groundwater Conditions

Several indicators of groundwater conditions are presented for the basin. Aquifer type can be a general indicator of aquifer storage potential, accessibility of the supply, aquifer productivity, water quality and aquifer flux. Well yield information for large diameter wells is provided and is generally measured when the well is drilled and reported on completion reports. It was assumed that large diameter wells were drilled to produce a maximum amount of water and, therefore, their reported pump capacities are indicative of the aquifer's potential to yield water to a well. However, many factors can affect well yields including well design, pump size and condition and the age of the well. Reported well yields are only a general indicator of aquifer productivity and specific information is available from well measurements conducted as part of basin investigations.

Natural recharge is typically the least well known component of a water budget. Many of the estimates in the Atlas are derived from studies of larger geographic areas and all deserve further study. Similarly, estimates of storage are based on rough estimates and considerably more studies are needed in most basins. Components of storage include aquifer depth and specific yield.

Water level data is from measured wells, usually collected during the period when the wells were not actively being pumped or only minimally pumped. Depth to water measurements are shown on mapped wells if there was a measurement taken during 2003-2004. The basin hydrographs show water-level trends for selected wells over the 30-year period from January 1975 to January 2005. Not all basins have a sufficient number of representative hydrographs.

The flow directions that are shown generally reflect long-term, regional aquifer flow in the basin and are not meant to depict temporary or local-scale conditions. However, flow directions in some basins indicate how localized pumping has altered regional flow patterns.

Water Quality

Water quality conditions impact the availability of water supplies. Water quality data was compiled from a variety of sources as described in Volume 1, Appendix A. The data indicate areas where water quality exceedences have previously occurred, however additional areas of concern may currently exist where water quality samples have not been collected or sample results were not reviewed by the Department (e.g. samples collected in conjunction with the ADEQ Aquifer Protection Permit programs). It is important to note also that the exceedences presented may or may not reflect current aquifer or surface water conditions.

Cultural Water Demand

Cultural water demand is an important component of a water budget. However, without mandatory metering and reporting of water uses, accurate demand data is difficult to acquire. Municipal demand includes water company and domestic (self-supplied) demand estimates. Basin demand information is from several sources in order to prepare as accurate an estimate as possible. Annual demand estimates have been averaged over a specific time period. This provides general trend information without focusing on potentially inaccurate annual demand estimates due to incomplete data.

Locations of major cultural water uses are primarily from a 2004 USGS land cover study using older satellite imagery that may not represent recent changes. The cultural demand maps provide only general information about the location of water users.

Effluent generation data was compiled from several sources to provide an estimate of how much of this renewable resource might be available for use. However, effluent reuse is often difficult both logistically and economically since a potential user may be far from the wastewater treatment plant.

Water Adequacy Determinations

Information on water adequacy and inadequacy determinations for subdivisions, with the reason for the inadequacy determination provides information on the number and status of subdivision lots. Listing the reason for the inadequacy identifies which subdivisions have a demonstrated physical or legal lack of water or may have elected not to provide the necessary information to the Department. Briefly, developers of subdivisions outside of AMAs are required to obtain a determination of whether there is sufficient water of adequate quality available for 100 years. If the supply is determined to be inadequate, lots may still be sold, but the condition of the water supply must be disclosed in promotional materials and in sales documents.

In addition to these subdivision determinations for which a water adequacy report is issued, water providers may apply for adequacy designations for their entire service area. If a subdivision is to be served water from one of these water providers, then a separate adequacy determination is not required. (See Section 3.0-5)

Developers of large, master-planned communities outside of AMAs may apply for an Analysis of Adequate Water Supply (AAWS). This type of application is generally used to prove that water will be physically available for the master-planned community. AAWS are issued based on the development plan or plat. If an AAWS is issued for groundwater, it reserves a specific volume of water for 10 years (for purposes of further adequacy reviews) only for the specific property that is the subject of the AAWS.

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