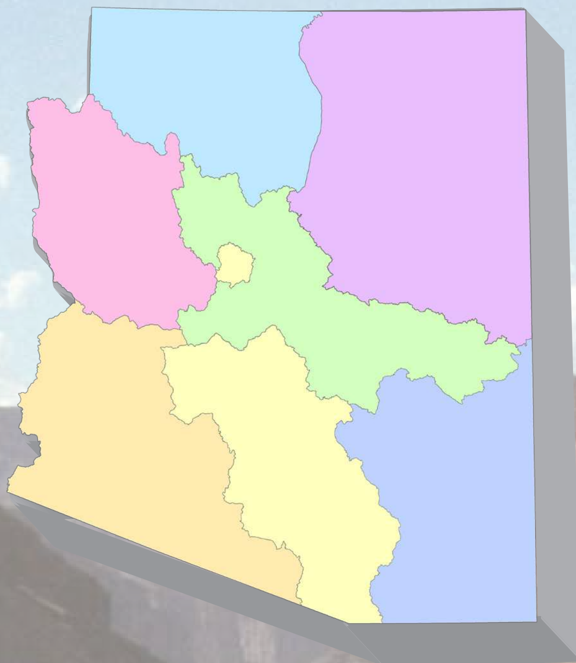
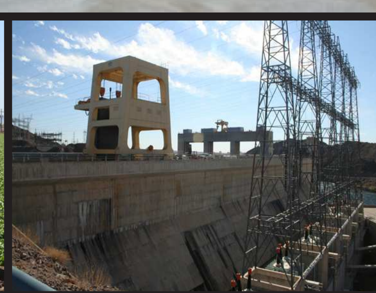
Arizona Department
of Water Resources
September 2010

ARIZONA WATER ATLAS

Volume 1

Executive Summary





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VOLUME 1 – EXECUTIVE SUMMARY

1.0 Atlas Purpose and Scope

Considerable investment in water resource development and planning has occurred in many parts of Arizona, particularly within the State's active management areas (AMAs) where major water supplies, regulations imposed by the Arizona Groundwater Code and large metropolitan areas with significant financing capabilities exist. Outside of the AMAs, smaller communities may lack financial capacity for water supply development and mandatory water management provisions do not exist. Nevertheless, a number of non-AMA communities have recognized the need for water resource planning and have developed renewable water supplies, conservation programs and water management plans. However both within and outside the AMA, the need for planning, management and comprehensive and updated water resource data is ongoing.

The purpose of the Arizona Water Atlas (Atlas) is to support water planning and development efforts by providing water-related information on a local, regional and statewide level. The Atlas is also an educational resource for the general public intended to be updated on a regular basis. In addition, the Atlas project has resulted in development of a statewide water resources data repository by the Arizona Department of Water Resources (Department).

The Atlas divides Arizona into seven planning areas (Figure 1-1). "Planning areas" are composed of groundwater basins and are an organizational concept that provide for a regional perspective on water supply, demand and resource issues. There is a separate Atlas volume for each planning area (Volumes 2-8), this executive summary (Volume 1) and a water sustainability assessment (Volume 9). Volume 9 is anticipated to be completed in 2011. All completed volumes are posted on the Department's website (http://www.azwater.gov). Figure 1-1 shows the planning areas and groundwater basins and should be referenced in subsequent sections of this volume.

Included in this volume is a discussion of the organization of the Atlas, an overview of water management and planning in Arizona, a discussion on water budgets for planning purposes, a summary of water resource characteristics for the State and several appendices that describe data sources and methods of analysis, provide information on water law, management and programs, and Indian water rights claims and settlements. Atlas data and information have been compiled from a number of sources. New investigations, except as noted, were not undertaken. This volume summarizes the content of the planning area volumes, which should be consulted for more detailed information on specific planning areas, groundwater basins and communities.

1.1 Atlas Organization

Each Atlas planning area volume contains an overview of the planning area and a separate water resource characteristics section for each

Navajo Generating Station, Eastern Plateau Planning Area.

groundwater basin or AMA within the planning area. A groundwater basin is a relatively hydrologically distinct body or related bodies of groundwater. A.R.S. § 45-402(13) The overview section of each volume includes a discussion of planning area geography, hydrology, climate, environmental conditions, population and growth, water supply, cultural water demand and water resource issues. Each basin or AMA section includes maps and tables that display a variety of water resource characteristics including; geography, land ownership, climate, surface water conditions, perennial/intermittent streams and major springs, groundwater conditions, water quality, cultural water demand and assured or adequate water supply determinations. References and supplemental readings are provided as well as appendices that contain a list of Arizona Water Protection Fund projects, Community Water System annual report data with a list of systems that have submitted System Water Plans, information on surface water right and adjudication filings, and a summary of rural watershed partnership issues. Appendix A of this volume contains a detailed list of the content of the planning area volumes. Appendix B contains a discussion of the data sources and methods for each of the water resource characteristics included in the Atlas.

Section 1.4 of this volume is organized similarly to that of the planning area volumes and summarizes the data and information in them at a statewide level. This volume also contains supporting background information and is intended to be a companion volume to the planning area volumes. The concluding volume of the Atlas (Volume 9) will use data from Atlas Volumes 1-8 as well as from other studies and stakeholder input to conduct a water resource sustainability assessment for the state. This assessment will identify current and future water resource vulnerabilities such as drought sensitive water supplies and the impact of current and projected growth on water supply availability.

Agriculture in the Douglas INA.

1.2 Arizona Water Management and Planning Overview

Water management in Arizona involves a complex system of rules and management authorities that differ by legally defined water type and area. The system is summarized here and described in more detail in Appendix C. A fundamental component is that laws governing surface water are distinct from those governing groundwater. Surface water is subject to the doctrine of prior appropriation, based on the tenet of "first in time, first in right." Two general stream adjudications are in progress covering the Gila River and Little Colorado River systems to determine the nature, extent and priority of surface water uses and rights.

Rights to groundwater are subject to the beneficial use doctrine. Outside of the AMAs there is essentially no restriction on withdrawing groundwater as long as it is put to reasonable and beneficial use. The only exception is within three areas designated as Irrigation Non-Expansion Areas (INAs), where irrigation of new agricultural lands is restricted to prevent further groundwater declines. Within the AMAs the authority to withdraw groundwater is subject to a system of rights and permits pursuant to the Arizona Groundwater Management Act. A.R.S. § 45-401 et seq. (Code). The Code was adopted in 1980 to settle disputes among groundwater users, to secure federal funding for the Central Arizona Project (CAP), and to mitigate severe

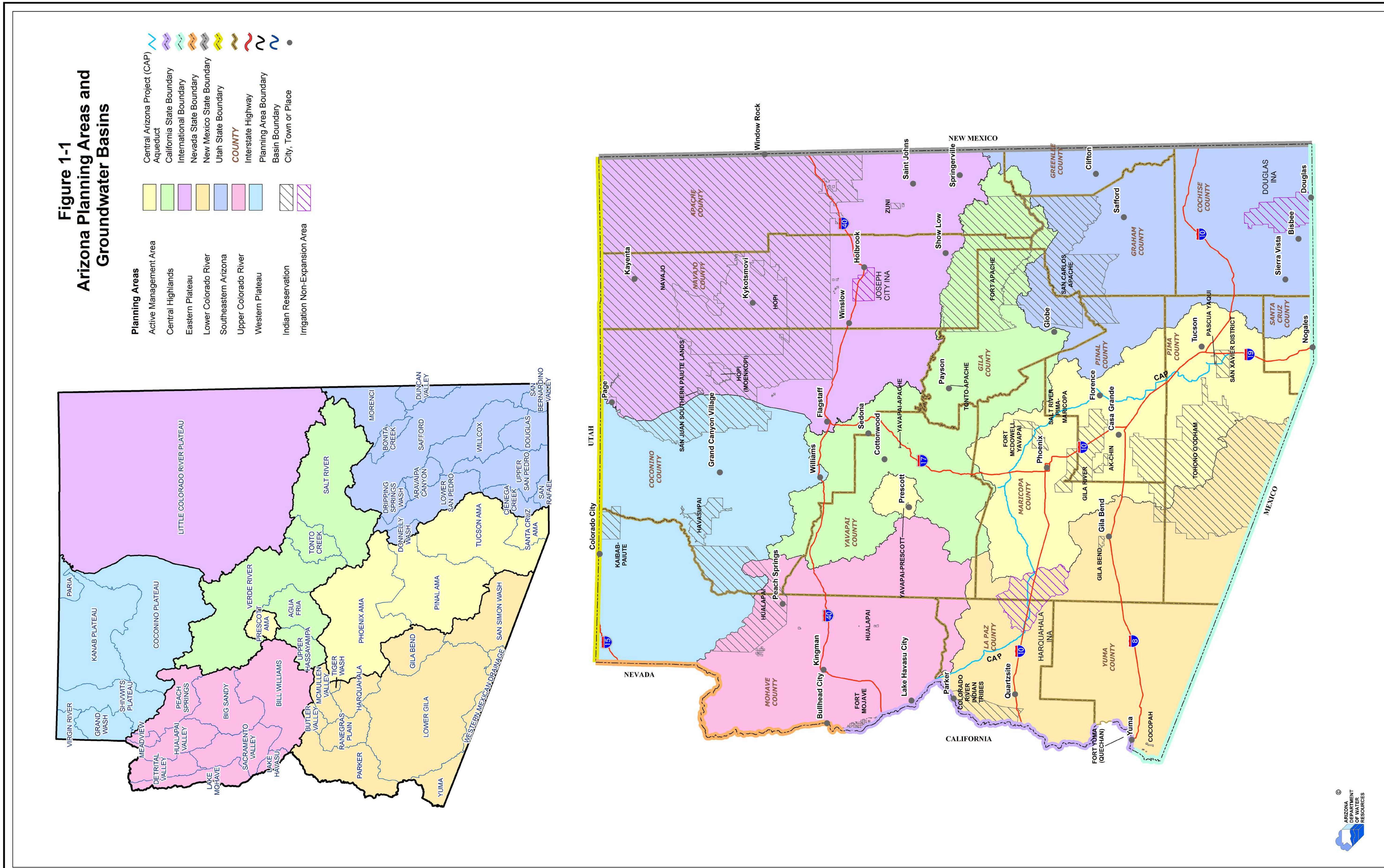


Figure 1-1
Arizona Planning Areas and Groundwater Basins

overdraft conditions in several parts of the state.[1] The Code established management goals for each AMA, a data reporting system, mandatory conservation requirements, and 100-year assured water supply requirements for new subdivisions in the AMAs.

The Phoenix, Prescott and Tucson AMAs have a management goal of safe-yield by 2025. A.R.S. § 45-562(A). The management goal of the Pinal AMA is to allow development of non-irrigation uses and to preserve existing agricultural economies for as long as feasible. A.R.S. § 45-562(B). The goal of the Santa Cruz AMA is to maintain a safe-yield condition and prevent local water tables from experiencing long-term declines. A.R.S.§ 45-562(C). (See Appendix C).

Within the AMAs, mandatory water metering and reporting requirements for groundwater rightholders has resulted in the systematic collection of water use data, which is compiled in AMA management plans. A series of five consecutive management plans are statutorily required for each AMA. A.R.S.§§ 45-564 through 568. The management plans contain conservation requirements for the agricultural, municipal and industrial water use sectors, as well as water use data, and provide the framework for the day-to-day implementation of Code mandates and Department policies for each AMA.

The Code also contains provisions that address water supplies for subdivided lands. Within the AMAs new subdivisions are subject to Assured Water Supply (AWS) provisions. A.R.S. §§ 45-576 et seq. The Code and associated AWS Rules prohibit the sale or lease of subdivided land without demonstration of a 100-year assured water supply. Water use must also be consistent with the AMA management goal, which requires use of renewable (non-groundwater) supplies or replenishment of groundwater use as well as other requirements. Local governments cannot approve a subdivision plat and the Arizona Department of Real Estate (ADRE) cannot issue a public report for the sale of lots without an AWS determination. Developers must obtain a Certificate of AWS or demonstrate that the subdivision will be served by a water provider whose service area has been issued a designation of an AWS.

Outside of the AMAs, A.R.S.§ 45-108 requires subdivision developers to obtain a Water Adequacy Report that demonstrates that sufficient water of adequate quality is available for at least 100 years, demonstrate that the subdivision will be served by a municipal provider that has been designated as having an adequate water supply, or disclose any “inadequate” determination (to the initial buyer) in the public report and all promotional materials. The ability to market lots without demonstrating an adequate water supply is an issue in a number of rural areas where water supplies are stressed. However, legislation adopted in June 2007 (SB 1575) authorizes a county board of supervisors to adopt a provision requiring a new subdivision to have an adequate water supply in order to be approved by the platting authority. If the county does not adopt the provision, the legislation allows a city or town to adopt a local ordinance that requires a demonstration of adequacy. As of June 2010, Cochise County, Yuma County, the Town of

Cochise County, Southeastern Arizona Planning Area. As of June, 2010, only Cochise County, Yuma County, the Town of Clarkdale and the Town of Patagonia had adopted the provisions of SB 1575.

[1] Overdraft is a condition where groundwater withdrawals exceed recharge to the aquifer

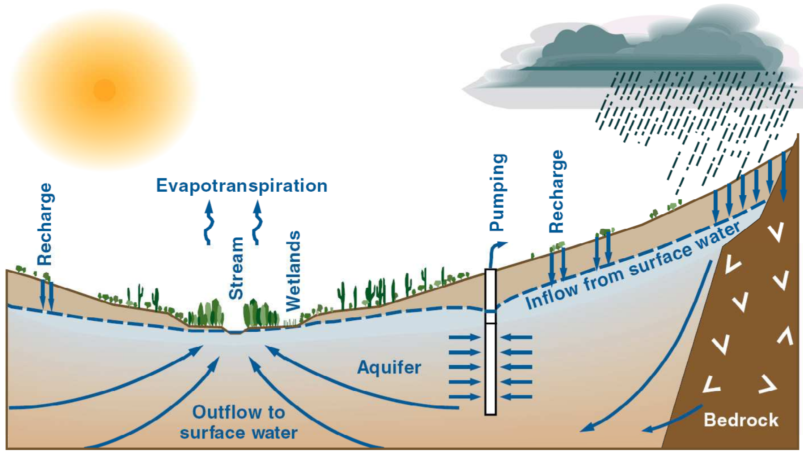
Clarkdale and the Town of Patagonia had adopted the provisions of SB 1575.

Developers also have the option to obtain an Analysis of AWS (within an AMA) or an Analysis of Adequate Water Supply (outside an AMA). An Analysis is for master-planned communities that are typically developed in phases. An Analysis verifies that one or more of the requirements to obtain a Certificate of AWS or a Water Adequacy Report are met. As each phase is developed, either a Certificate of AWS or a Water Adequacy Report is required, but the work that has already been completed for the Analysis can be used. If the Analysis has proven physical availability of the water supply, that demonstrated volume of water can be withdrawn for subsequent Certificates of AWS or Water Adequacy Reports within a ten year period.

Groundwater cannot be transported between groundwater basins outside of the AMAs or from a groundwater basin outside an AMA into an AMA, except for specific transfers as specified in statute. A.R.S. §§ 45-544 and 45-551. These statutes are designed to protect hydrologically distinct sources of groundwater and the economies in rural areas by ensuring the groundwater is not depleted in one groundwater basin to benefit another.

A number of statewide efforts have supported water resource planning, information needs and management efforts outside the AMAs. These include establishment of the Rural Watershed Initiative Program (1998), adoption of the 2004 Arizona Drought Plan and associated legislation (H.B. 2277) (see Section 1.4.5), initiation of the Statewide Water Conservation and Drought Program, establishment of a Rural Water Legislative Study Committee (2005-2007), and formation of a Statewide Water Advisory Group (SWAG) focused on programs for water resources development and management programs outside of AMAs (2006). In August 2009, Governor Brewer established the Blue Ribbon Panel on Water Sustainability to improve the long-term sustainability of Arizona's water supplies through increased conservation and recycling statewide with a focus on challenges to increasing wastewater reuse. Legislation passed in 2010 (H.B. 2661) established the Water Resource Development Commission (WRDC), tasked with assessing current and future water needs in Arizona including identification of future supplies and financing mechanisms for water supply acquisition and infrastructure. The WRDC must prepare a report including recommendations and suggested legislation by October 2011. (See Section 1.4.8)

Figure 1-2 Schematic of a Water Budget
(Source: Leake and others, 2000)



1.3 Water Budgets

A water budget is a key component in water planning and management. The water resource data discussed in Section 1.4 and found in the planning area volumes can be used to help construct a water budget, which is an accounting of inflows and outflows of water from a basin over a specified period of time, shown in Figure 1-2. A water budget can include natural processes such as precipitation and evaporation as well

Table 1-1 Typical components of a water budget

Inflow	Outflow
Surface Water	
• Precipitation** • Streamflow from precipitation events and snowmelt** • Baseflow from groundwater* • Irrigation return flow • Effluent discharge*	• Evaporation* • Evapotranspiration (e.g., riparian vegetation*) • Streamflow exiting basin* • Surface water diversions (agricultural, municipal, industrial, stock water)**
Groundwater	
• Natural Recharge (mountain front and stream channel from precipitation and basin underflow)** • Artificial and incidental recharge*	• Evapotranspiration (e.g., riparian vegetation*) • Underflow exiting the basin • Baseflow to surface water*

* related or cursory data are presented in the Atlas
** detailed data is presented in the Atlas

as those processes influenced by development such as diversions and effluent discharge. Typical surface water and groundwater components of inflow and outflow are listed in Table 1-1. Streamflow and groundwater recharge are often the largest components of inflow to a basin. Cultural water demand and ET are often the largest component of outflow from a basin. In the Atlas, the term "cultural" water demand refers to the quantity of water diverted from streams and reservoirs, pumped from wells or treated and delivered for municipal, industrial and agricultural purposes. This term should not be confused with "consumptive use", which refers to the amount of cultural water demand that is lost from the hydrologic system. For example, not all surface water diverted to irrigate crops is permanently lost; a portion of the water applied to fields may flow back to streams (return flow) or infiltrate to underlying aquifers (incidental recharge).

Estimates of natural groundwater recharge, streamflow, precipitation and cultural water demands are presented by basin in Volumes 2-8. Other components of outflow and inflow are not well quantified in the Atlas or are not quantified at all due to lack of data Those not quantified are often difficult to estimate but should be considered when constructing a water budget. These include incidental recharge, irrigation return flow, baseflow, evapotranspiration, evaporation and underflow.

Incidental recharge is water that percolates to the aquifer after human use such as excess water applied to irrigate agricultural lands or turf facilities, effluent discharge to water courses or septic tank emissions. The amount of incidental recharge is affected to a large extent by population, the population not served by a centralized wastewater treatment facility, irrigation efficiency and the method of effluent discharge. Artificial recharge is water (other than groundwater) that is stored in an aquifer for future use via Underground Storage Facilities (USFs) (see Appendix C).

Water is often lost from municipal and agricultural water distribution systems due to leaks and breaks from water lines and storage tanks, illegal connections and evaporation. These may be components of incidental recharge or cultural demand. In some cases water line losses can be significant. One third of the respondents to a system water loss question in the 2003 Rural Water Resources Questionnaire (ADWR, 2004) reported losses of over 10% with losses of up to 60% reported. Within the AMAs, there are system water loss requirements for municipal, agricultural and industrial water users. Reducing system losses eliminates unnecessary pumping and related costs and may postpone or eliminate the need to secure other supplies to meet system water demands.

Evapotranspiration, primarily from riparian vegetation, has been difficult to quantify accurately over large areas but may represent a large water demand "sector" in some basins, such as in the Upper San Pedro Basin. This demand has not been evaluated on a statewide basis and has not been quantified in the Atlas, however maps showing riparian vegetation associated with streams are presented in the Atlas.

Evaporation from reservoirs and ponds is significant and varies widely across the state. Evaporation rates range from less than 3 feet/year in the mountains of central Arizona to greater than 8 feet/year along the Colorado River in western Arizona (Farnsworth and others, 1982). Regardless of the variability, the total quantity of water lost to evaporation from these sources is substantial. Average evaporative losses from reservoirs and ponds in Arizona were estimated to total 221,400 acre-feet in 2000. An additional 1,993,000 acre-feet of evaporative losses was estimated from Lakes Powell, Mead, Mohave and Havasu on the Colorado River. (BOR, 2004) Evaporative losses are also associated with uncovered water conveyance systems and irrigation.

1.4 Water Resource Characteristics Summary

Summarized in this section are data and information on a number of water resource characteristics discussed in detail in the planning area volumes of the Atlas. The appropriate planning area volume should be consulted for more detailed information.

1.4.1 Geography

Arizona covers about 114,000 square miles of land with great geographical diversity. There are three main physiographic regions in the state. The regions and their relationship to the planning areas are shown in Figure 1-3.

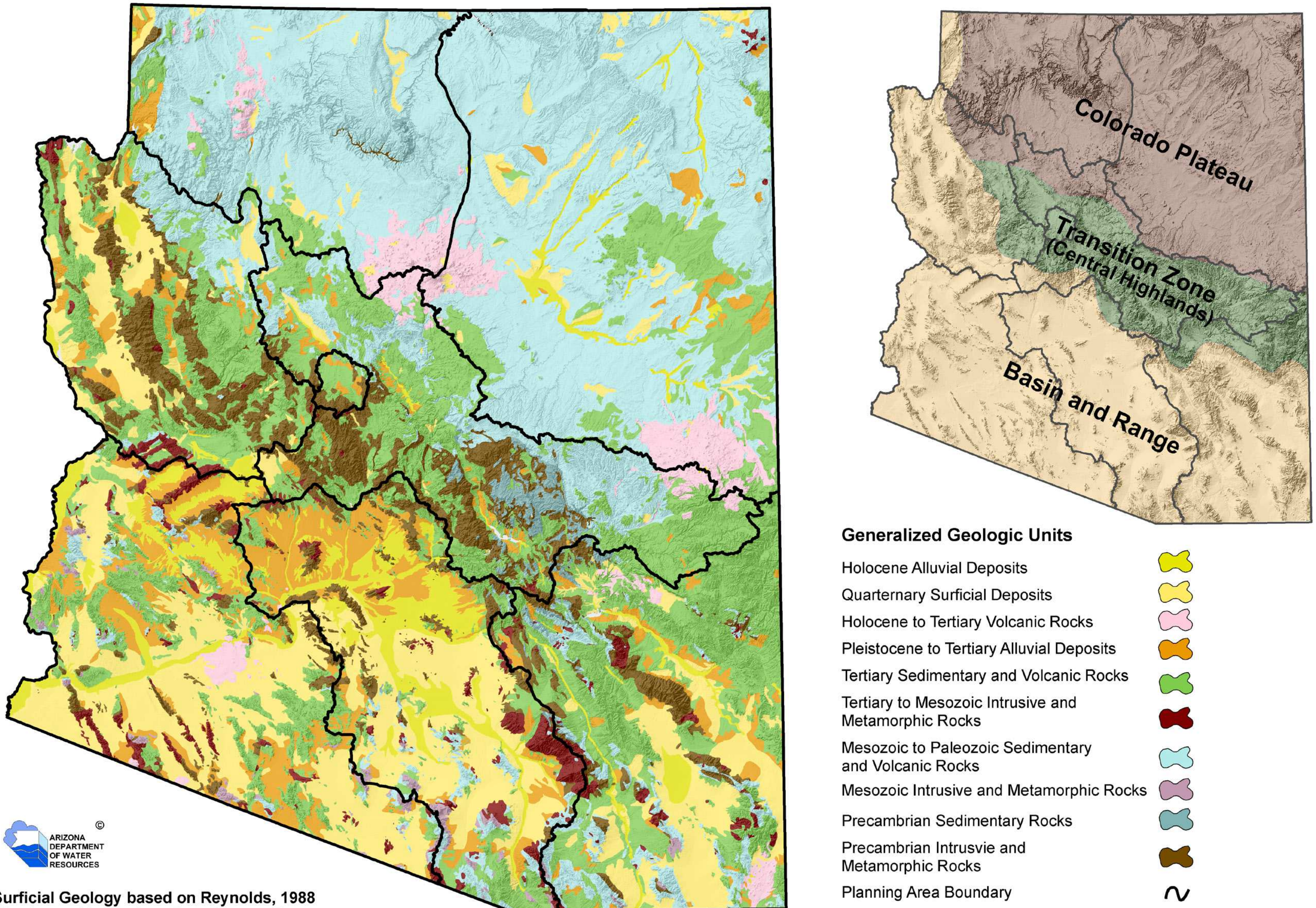
Physiographic Regions

The Basin and Range Province of southern and western Arizona is characterized by long, broad, alluvial valleys separated by north-south trending mountain ranges. Thick, productive regional aquifers are found in the basins of this province. The Upper Colorado River, Lower Colorado River, Southeastern Arizona and AMA (except Prescott AMA) planning areas are primarily within this province.

The Colorado Plateau Province covers the northern portion of the state and is characterized by sedimentary rocks that have eroded into canyons and plateaus. The Colorado Plateau Province includes the Eastern Plateau, Western Plateau and small parts of the Central Highlands and Upper Colorado River planning areas. This province contains regional aquifers within sandstone and limestone layers and relatively thin deposits of alluvium form unconfined aquifers along some streams.

The Central Highlands transition zone is located between the two provinces and includes most of the Central Highlands Planning Area, the easternmost part of the Upper Colorado River Planning Area, the Prescott AMA and the northern part of the Southeastern Arizona Planning Area. It is characterized by a relatively narrow band of mountains and most of the state's perennial streams. Groundwater is found in alluvial deposits, layered sedimentary rocks, thin alluvial deposits along major streams and fractured crystalline, sedimentary and volcanic rocks (ADWR, 1994a,b). Much of this region has minimal water storage capabilities and high runoff compared to the Basin and Range Province.

Figure 1-3
Surficial Geology and Physiographic Regions of Arizona



Surficial Geology based on Reynolds, 1988
Physiographic Regions Data Source: Fenneman and Johnson, 1946

Planning Areas

The Eastern Plateau Planning Area occupies the northeastern quarter of Arizona and consists of one groundwater basin. Its southern boundary is defined by the Mogollon Rim, an escarpment almost 2,000 feet high in some places, that extends from central Arizona to the Mogollon Mountains in New Mexico. Relatively high elevation plateaus and mountains, volcanic cinder cones and peaks, steep cliffs, and deeply incised sandstone canyons characterize the planning area geography. Few perennial or intermittent streams occur, except at higher elevations.

The Southeastern Arizona Planning Area encompasses 14 geographically diverse groundwater basins in the southeastern corner of the state. A unique feature of the planning area is mountain ranges, known as "sky islands" that are isolated from each other by valleys of desert grasslands and desertscrub. Most of the planning area is within the Mexican Highland section of the Basin and Range Province; a higher elevation area with valleys ranging from 2,500 to 4,000 feet above sea level and mountains and valleys covering about equal areas. The planning area includes drainages of the San Pedro and upper Gila rivers and the headwaters of the Santa Cruz River.

Nine groundwater basins compose the Upper Colorado River Planning Area, located in the northwestern portion of Arizona south of the Colorado River. Arizona's three physiographic regions are found in the planning area. The planning area includes portions of the Colorado River and associated lakes (Mead, Mohave and Havasu) impounded by several dams that influence cultural uses, groundwater conditions and habitat in a significant portion of the planning area.

The Central Highlands Planning Area, composed of five groundwater basins, stretches across most of central Arizona. The planning area contains diverse topography and a large el-

Headwaters of the Santa Cruz River, Southeastern Arizona Planning Area. The planning area includes drainages of the San Pedro and upper Gila rivers and the headwaters of the Santa Cruz River.

evational range (from 1,500 feet to over 12,600 feet), resulting in a wide diversity of vegetation types and ecosystems, the greatest of any planning area. Topography varies from desert basins to deeply incised canyons to high elevation mountains. Because of the high elevations and associated higher precipitation, this planning area contains the state's greatest concentration of perennial streams and its most productive water producing watersheds, the Salt and Verde.

The Western Plateau Planning Area covers the northwestern corner of Arizona and includes six groundwater basins. It includes the Grand Canyon, incised by the Colorado River and its tributaries, with an average depth of 4,000 feet. South and east of the Colorado River, the Coconino Plateau marks the southwestern edge of the Colorado Plateau. In the northwest corner of the planning area, the Virgin River cuts through the Beaver Dam Mountains creating the Virgin River Gorge. Other significant geographic features are numerous high plateaus, steep cliffs, deeply incised canyons and few surface water features.

Eleven groundwater basins compose the Lower Colorado River Planning area, located in southwestern Arizona. The planning area is relatively low elevation - generally less than 3,500 feet- and is very arid; a condition that has shaped its topography and surface water characteristics. Its geography consists primarily of widely-scattered, small mountain ranges of mostly barren rock and broad, flat valleys (or plains). With the exception of the Colorado River, there are no perennial streams; broad sandy washes are the main surface water feature, flowing only in response to significant precipitation events.

The AMA Planning Area extends from the international border through central Arizona to the northern boundary of Maricopa County. The northernmost AMA, the Prescott AMA, is discontiguous from the other four AMAs. Because of its geographic extent and location in the state, this planning area exhibits a wide range of geographic features, from low elevation, broad, semi-arid Sonoran desert valleys to mountain ranges with summits over 9,000 feet. The topographic variability results in broad variations in the amount of precipitation, temperature range and vegetation type.

The distribution and type of land ownership in planning areas has implications for land and water use. Large areas of private land typically provide opportunities for land development and associated water demand, whereas federal lands are typically maintained for a purpose with little associated cultural water demand. State owned land may be sold or traded, and is often leased for grazing and farming. The percentage of land ownership types statewide and for each planning area are listed in Table 1-2. Land ownership maps for each basin are found in the planning area volumes of the Atlas.

1.4.2 Hydrology

<u>Groundwater Hydrology</u>

Anderson and others (1992) divided the alluvial groundwater basins of south-central Arizona into five categories based on similar hydrologic and geologic characteristics, summarized in Table 1-3. This table includes similar information for the Plateau basins that were not included in their study as well as typical groundwater responses to well pumpage. General groundwater characteristics for each planning area are described briefly in this section. Groundwater data including major aquifers, well yields, natural recharge estimates and water in storage are summarized in Table 1-4 for each groundwater basin within the planning areas and referenced to the basin categories.

Figure 1-3 shows a surficial geology map of Arizona. Well yields generally reflect aquifer composition and productivity. Aquifers composed of coarse grained alluvium often yield more water to wells than fine grained alluvium or crystalline and sedimentary rocks. Well yields measured across the state are shown on Figure 1-4.

Table 1-2 Land ownership in Arizona (Source: ALRIS 2004)

Land Ownership Type	Planning Area							Statewide %
	Eastern Plateau %	Southeastern Arizona %	Upper Colorado River %	Central Highlands %	Western Plateau %	Lower Colorado River %	Active Management Areas %	
Bureau of Land Management	1.11	14.23	34.38	3.68	29.62	24.67	10.36	16.86
Forest Service	10.38	17.09	2.30	46.76	13.64	0.00	8.10	14.04
Indian Reservation	63.93	14.96	7.58	22.40	17.24	16.66	18.62	23.06
Local/State Parks	0.01	0.08	0.07	0.02	0.00	0.02	1.39	0.23
Military	0.00	1.05	0.22	0.29	0.00	23.30	0.42	3.61
National Parks	1.46	0.25	6.34	0.02	16.23	2.99	0.81	4.01
Other	0.14	0.27	0.13	0.26	0.00	0.88	0.44	0.30
Private	14.75	22.95	25.56	0.11	10.95	7.45	34.64	18.15
State Trust	8.03	25.80	16.68	6.26	8.92	6.09	21.30	13.30
Wilderness (USFS/BLM)	0.18	3.30	6.22	9.52	3.40	3.79	2.72	4.16
Wildlife Refuge	0.00	0.02	0.51	0.00	0.00	14.15	1.20	2.27

Table 1-3 Generalized Basin Hydrogeology [1,2]

		BASIN CATEGORY					
		Central	**Colorado River**	**Highland**	**Plateau [3]**	**Southeast**	**West**
GEOLOGY OF MAJOR AQUIFERS	**Recent Stream Alluvium**	Up to 300 feet in thickness of coarse material along major streams	Deposited in channels cut into basin fill	Common beneath floodplains	Sand and gravel along major streams	Relatively thin layers of sand and gravel	Limited to areas along the lower Gila River
	Basin Fill and Younger Volcanics	Upper Basin Fill -Typically less than 1,000 feet of fine- to course-grained deposits becoming courser near the basin margins and at land surface Lower Basin Fill -Up to 5,000 feet of fine-grained sediments that include evaporite deposits and become coarser near the basin margins	Older alluvial deposits underlain by marine estuarine sediments (Bouse Formation)	Up to 500 feet of sediment that may include consolidated lake deposits (e.g. Verde Formation); limited in areal extent	Basaltic lava flows found locally in some basins [4]	Upper Basin Fill - typically about 300 feet of lacustrine silt and clay Lower Basin Fill - typically greater than 1,000 feet of coarse- to fine-grained sediment becoming coarser near the basin margins	Upper Basin Fill - thin and heterogeneous Lower Basin Fill - coarse- to fine-grained sediment becoming coarser near basin margins
	Pre-Basin and Range Sediments	Occur at significant depths with relatively little known of their extent or character; include conglomerate	Primarily cemented sandy gravel (fanglomerate)	Not a major aquifer	Sandstone, siltstone and conglomerate interbedded with volcanic rocks in a few basins (e.g. Cottonwood Wash and Muddy Creek formations)	Moderately thick conglomerate	Conglomerate, sandstone and volcanic rock occurring at relatively shallow depths (e.g. Muddy Creek Formation)
	Older Consolidated Rocks	Not a major aquifer	Not a major aquifer	Coconino Sandstone (C Aquifer), Redwall Limestone (R Aquifer), and volcanic, igneous and metamorphic rocks locally	Coconino, Dakota, and Navajo sandstones (C, D, and N Aquifers), Muav and Redwall limestones (R Aquifer), and other sedimentary rocks (Bidahochi, Chinle, Kayenta, Mesa Verde, Moenave, and Moenkopi formations) [5]	Not a major aquifer	Not a major aquifer
HYDROLOGIC CHARACTERISTICS	**Natural Aquifer Inflows**	Mostly stream infiltration with some underflow and mountain-front recharge	Mostly stream infiltration with very minor underflow and mountain-front recharge	Mostly stream infiltration and underflow with some mountain-front recharge	Mostly mountain-front recharge where sandstones and limestones outcrop, with minor to some leakage between units	Mostly mountain-front recharge and stream infiltration with minor underflow	Mostly stream infiltration with some underflow and mountain-front recharge
	Natural Aquifer Outflows	Mostly evapotranspiration with some underflow and minor baseflow	Mostly evapotranspiration with minor baseflow and very minor underflow	Mostly baseflow and evapotranspiration with very minor underflow	Mostly discharge to springs and baseflow with minor to some leakage between units	Mostly evapotranspiration with some baseflow and minor underflow	Mostly evapotranspiration with some underflow and minor baseflow
	Direction of Groundwater Flow	From areas of recharge along basin perimeter toward central basin axis and then down valley	Away from the Colorado River toward its floodplain where evapotranspiration occurs; also some flow parallel to the river and locally towards the river where irrigation has reversed the flow gradient	From areas of recharge along basin perimeter toward central basin axis	Downgradient from permeable outcrops, along bedding planes and locally along faults and solution channels	From areas of recharge along basin perimeter toward central basin axis	Down valley
	Pressure Conditions	Locally confined due to fine-grained deposits of basin fill; otherwise, unconfined	Confined in the fanglomerate; otherwise unconfined	Typically unconfined	Can be confined over relatively large areas by overlying siltstone and claystone layers	Aquifer in lower basin fill is often confined; otherwise unconfined	Typically unconfined
	Depth to Ground Water	From land surface to as much as 700 feet bls near the mountain fronts	From land surface to a few hundred feet bls	From land surface to a few tens of feet bls; hundreds of feet or more bls for sandstone and limestone aquifers	Typically several hundred feet to over 3,000 feet bls in some areas	Above land surface (flowing wells) to more than 500 feet bls at basin perimeter	Few feet to more than 1,300 feet bls near the mountain fronts
GROUNDWATER RESPONSES TO DEVELOPMENT (WELL PUMPING)		Mostly loss of water from storage and, near major rivers, may eventually decrease baseflow and evapotranspiration and locally increase stream infiltration. Groundwater level declines expected but locally may rise or stabilize where irrigation return flows are significant	Most well water derived from the river; may locally decrease evapotranspiration and increase stream infiltration, but not cause much loss of water from storage	Over time may increase stream infiltration and decrease baseflow and evapotranspiration; could eventually lead to groundwater level declines	Mostly a loss of water from storage with relatively large groundwater level declines possible; over time may decrease spring discharge and baseflow	Initial loss of water from storage; may eventually decrease baseflow and evapotranspiration and increase stream infiltration	Mostly a loss of water from storage; near the Gila River, may eventually decrease evapotranspiration and increase stream infiltration

Notes:
[1] Primary source - Anderson and others (1992); secondary sources - ADWR (1994b), USGS (1984) and Anderson and Freethy (1995)
[2] Actual hydrogeologic conditions may vary considerably within individual basins and basin categories. Table 1-4 specifies which basins are grouped in each category.
[3] The Hydrologic Characteristics and Responses to Well Development listed for the Plateau basin category apply to the regional sandstone and limestone aquifers which are the primary sources of water.
[4] Gravel beds and lake deposits are important in the Aubrey and Truxton valleys, respectively, of Peach Springs Basin.
[5] The D Aquifer also includes the Cow Springs and Entrada Sandstones; the N Aquifer also includes the Wingate Sandstone; and the C Aquifer also includes the Kaibab Limestone and Upper Supai Formation.

Table 1-4 Summary of basin groundwater data

BASIN	AREA (in square miles)	BASIN CATEGORY [1]	MAJOR AQUIFER(S) [2]	MEDIAN WELL YIELDS [3] (in gallons per minute)		ESTIMATED NATURAL RECHARGE [4] (in 1000 acre-feet/year)	ESTIMATED WATER IN STORAGE [4] (in million acre-feet)	NUMBER OF ADWR INDEX WELLS [5]	LAST ADWR WELL SWEEP [5]	
				Measured	Reported				Year	# of Wells Measured
Eastern Plateau Planning Area										
Little Colorado River Plateau	26,700	Plateau	Recent Stream Alluvium, Volcanic Rock (Lakeside-Pinetop Aquifer) and Sedimentary Rock (Bidahochi Formation, C, D, N, Springerville, and White Mountain Aquifers)	95 (85 wells)	500 (386 wells)	319 (C Aquifer), 5.4 (D Aquifer), 2.6 to 20.2 (N Aquifer)	413 (C Aquifer), 15 (D Aquifer), 526 (N Aquifer)	94	2001	932
Southeastern Arizona Planning Area										
Aravaipa Canyon	517	Southeast	Recent Stream Alluvium and Basin Fill	---	350 (36 wells)	7 to 16.7	5 to 5.1 (to 1,200 feet)	3	1996	60
Bonita Creek	457	Southeast	Recent Stream Alluvium, Basin Fill and Volcanic Rock	---	1,145 (14 wells)	9	1 to 2 (to 1,200 feet)	0	NA	NA
Cienega Creek	606	Southeast	Recent Stream Alluvium and Basin Fill	---	250 (35 wells)	8.5 to 25.5	5.1 to 11 (to 1,200 feet)	14	2005	117
Donnelly Wash	293	Southeast	Basin Fill	---	63 (4 wells)	3	0.14 to 2 (to 1,200 feet)	0	1996	25
Douglas	949	Southeast	Basin Fill, locally interbedded with Volcanic Rock	718 (64 wells)	600 (656 wells)	15.5 to 22	26 to 32 (to 1,200 feet)	27	2004	356
Dripping Springs Wash	378	Southeast	Recent Stream Alluvium and Sedimentary Rock (Gila Conglomerate)	---	395 (12 wells)	3 to 9	0.15 (to 1,200 feet) to <1	2	1996	34
Duncan Valley	550	Southeast	Recent Stream Alluvium and Sedimentary Rock (Gila Conglomerate)	---	850 (165 wells)	6 to 14.2	9 to 19 (to 1,200 feet)	11	1987	182
Lower San Pedro	1,624	Southeast	Recent Stream Alluvium and Basin Fill	1,295 (10 wells)	1,000 (181 wells)	24 to 29	11 (to 1,200 feet) to >27	19	2006	205
Morenci	1,599	Southeast	Recent Stream Alluvium and Volcanic Rock	---	600 (53 wells)	15	3 (to 1,200 feet)	4	1978	6
Safford [6]	4,747	Southeast	Recent Stream Alluvium and Basin Fill	772 (52 wells)	600 (1,494 wells)	105	>27 to 69 (to 1,200 feet)	50	1997	559
San Bernardino Valley	387	Southeast	Recent Stream Alluvium and Volcanic Rock	---	450 (3 wells)	9	1.6 to 2 (to 1,200 feet)	4	2007	70
San Rafael	229	Southeast	Recent Stream Alluvium and Basin Fill	---	145 (12 wells)	5	4 to 5 (to 1,200 feet)	10	2005	36
Upper San Pedro	1,825	Southeast	Recent Stream Alluvium and Basin Fill	335 (39 wells)	600 (353 wells)	35.8	19.8 to 59 (to 1,200 feet)	59	2006	688
Willcox	1,911	Southeast	Recent Stream Alluvium and Basin Fill	622 (64 wells)	750 (1,007 wells)	15 to 47	42 to 59 (to 1,200 feet)	47	2005	845
Upper Colorado River Planning Area										
Big Sandy	1,988	Highland / Southeast	Recent Stream Alluvium, Basin Fill and Sedimentary Rock (R Aquifer)	---	300 (87 wells)	22	9.5 to 21 (to 1,200 feet)	18	2008	104
Bill Williams	3,350	Highland / West	Recent Stream Alluvium, Basin Fill and Volcanic Rock	2 (3 wells)	280 (195 wells)	32	10 to 23 (to 1,200 feet)	24	1979	117
Detrital Valley	892	West	Recent Stream Alluvium, Basin Fill and Sedimentary Rock (Muddy Creek and Chemehueve Formations)	32 (6 wells)	35 (3 wells)	1	1 to 7 (to 1,200 feet)	11	2006	82
Hualapai Valley	1,212	West	Basin Fill, Sedimentary Rock (Muddy Creek and Chemehueve Formations) and Volcanic Rock	967 (10 wells)	900 (33 wells)	2 to 3	3 to 21 (to 1,200 feet)	16	2006	101
Lake Havasu	252	Colorado River	Basin Fill	---	1,500 (17 wells)	35	1 to 2 (to 1,200 feet)	1	1998-99	30
Lake Mohave	980	Colorado River	Recent Stream Alluvium	---	1,000 (96 wells)	183	1.2 to 8 (to 1,200 feet)	3	NA	NA
Meadview	190	West	Sedimentary Rock (Muddy Creek Formation)	33 (5 wells)	---	4	0.06 (to 700 feet) to 1 (to 1,200 feet)	1	2006	16
Peach Springs	1,409	Plateau	Basin Fill and Sedimentary Rock (R Aquifer)	---	250 (7 wells)	NA	1 (to 1,200 feet) to >4	3	1995	34
Sacramento Valley	1,587	West	Basin Fill and Volcanic Rock	167 (9 wells)	100 (36 wells)	1 to 4	3.6 to 14 (to 1,200 feet)	16	2006	177
Central Highlands Planning Area										
Agua Fria	1,263	Central / Highland	Basin Fill and Sedimentary Rock (Conglomerate)	---	300 (49 wells)	9	0.6 (to 1,200 feet) to 3.5	7	2008	207
Salt River	5,232	Highland	Recent Stream Alluvium, Volcanic Rock (Pinetop-Lakeside Aquifer) and Sedimentary Rock (Gila Conglomerate and C and R Aquifers)	---	170 (140 wells)	178	>8.7 (to 1,200 feet)	1	NA	NA
Tonto Creek	955	Highland	Basin Fill and Sedimentary Rock (C and R Aquifers)	---	120 (51 wells)	17 to 37	2 to 9.4 (to 1,200 feet)	13	2008	216
Upper Hassayampa	787	West	Basin Fill	---	125 (61 wells)	8	1 to 1.1 (to 1,200 feet)	5	2004	101
Verde River	5,661	Highland	Recent Stream Alluvium, Basin Fill interbedded with Volcanic Rock, Sedimentary Rock (Verde Formation and C and R Aquifers) and Igneous and Metamorphic Rocks	102 (55 wells)	260 (262 wells)	107 to >148	13 to 28 (to 1,200 feet)	130	2009	269

Table 1-4 Summary of basin groundwater data (cont)

BASIN	AREA (in square miles)	BASIN CATEGORY [1]	MAJOR AQUIFER(S) [2]	MEDIAN WELL YIELDS [3] (in gallons per minute)		ESTIMATED NATURAL RECHARGE [4] (in 1000 acre-feet/year)	ESTIMATED WATER IN STORAGE [4] (in million acre-feet)	NUMBER OF ADWR INDEX WELLS [5]	LAST ADWR WELL SWEEP [5]	
				Measured	Reported				Year	# of Wells Measured
Western Plateau Planning Area										
Coconino Plateau	5,812	Plateau	Volcanic Rock, Basin Fill, and Sedimentary Rock (Moenkopi and Chinle Formations and C and R Aquifers)	---	45.5 (16 wells)	NA	3	2	NA	NA
Grand Wash	959		Recent Stream Alluvium, Basin Fill interbedded with Volcanic Rock and Sedimentary Rock (Cottonwood Wash and Muddy Creek Formations)	---	---	NA	NA	2	NA	NA
Kanab Plateau	4,247		Recent Stream Alluvium and Sedimentary Rock	---	70 (10 wells)	NA	NA	3	NA	NA
Paria	408		Sedimentary Rock (N Aquifer)	---	520 (3 wells)	NA	1.5 (to 1,200 feet)	1	NA	NA
Shivwits Plateau	1,821		Recent Stream Alluvium	---	5 (17 wells)	NA	NA	0	NA	NA
Virgin River	434	West	Basin Fill and Sedimentary Rock (Muddy Creek Formation)	---	650 (53 wells)	>30	1.7 (to 1,200 feet)	6	1991	65
Lower Colorado River Planning Area										
Butler Valley	288	West	Basin Fill	1,590 (5 wells)	2,200 (17 wells)	<1 to 1.1	2 (to 1,200 feet) to 20 (to 1,000 feet)	13	2004	24
Gila Bend	1,284		Basin Fill	2,221 (107 wells)	2,700 (242 wells)	10 to 37	17 to 61 (to 1,200 feet)	31	2008	241
Harquahala	766		Basin Fill	1,614 (84 wells)	1,620 (157 wells)	<1 to <1.2	13 to 27 (to 1,200 feet)	34	2004	115
Lower Gila	7,309		Recent Stream Alluvium and Basin Fill	1,824 (56 wells)	1,600 (597 wells)	>9 to 88	100 (to 1,200 feet) to 246	33	1992	589
McMullen Valley	649		Basin Fill	1,132 (90 wells)	1,500 (167 wells)	1	14 to 15.1 (to 1,200 feet)	25	2004	118
Parker	2,229	Colorado River	Recent Stream Alluvium and Sedimentary Rock (Bouse Formation)	---	100 (75 wells)	241	14 to 24 (to 1,200 feet)	6	1995-97	348
Ranegras Plain	912	West	Basin Fill	1,994 (14 wells)	1,150 (68 wells)	<1 to 6.1	9 to 27 (to 1,200 feet)	19	2004	124
San Simon Wash	2,284		Basin Fill	---	---	11	6.7 to 45 (1,200 feet)	0	NA	NA
Tiger Wash	74		Basin Fill	---	---	<1	0.7 to 2 (to 1,200 feet)	2	2004	5
Western Mexican Drainage	610		Basin Fill	---	50 (3 wells)	1	3 to 4.1 (to 1,200 feet)	1	2004	6
Yuma	792	Colorado River	Basin Fill	5,098 (3 wells)	2,456 (327 wells)	213	34 to 49 (to 1,200 feet)	11	1992	587
Active Management Areas										
Phoenix [7]	5,646	Central	Recent Alluvium, Basin Fill with and without interbedded basalt, and Sedimentary Rock (conglomerate)	1,470 (2,354 wells)	1,280 (2,397 wells)	24.1	80.4 (to 1,000 feet)	442	2009	795
Pinal [8]	4,000		Recent Stream Alluvium and Basin Fill	1,010 (1,342 wells)	1,000 (1,582 wells)	82.8	35.2 (to 1,000 feet)	163	2007	1,066
Prescott	485	Highland	Basin Fill and Igneous and Metamorphic Rock	644 (137 wells)	763 (78 wells)	7	3 (to 1,000 feet)	93	2009	103
Santa Cruz	716	Central	Recent Stream Alluvium and Basin Fill	628 (97 wells)	800 (115 wells)	61.1	0.16	52	2005	186
Tucson	3,866		Recent Stream Alluvium and Basin Fill (Fort Lowell Formation and Tinaja Beds)	630 (879 wells)	520 (1,063 wells)	60.8	61 to 70	137	2005	1,065

Notes:
NA = Not Available
[1] See Table 1-3 for generalized hydrogeologic characteristics of basin categories and response to well development.
[2] Primarily from ADWR (1994b). See 'Groundwater Hydrology' section in overview of Atlas Volumes 2 through 8 for additional information and sources on major aquifers.
[3] Measured well yields from ADWR's GWSI and reported well yields from Wells55 for large (>10-inch) diameter registered wells.
[4] See basin groundwater data tables in Atlas Volumes 2 through 8 for recharge and storage estimate data sources. Data sources for AMA storage estimates described in overview of Atlas Volume 8 (Section 8.0.2).
[5] Current as of 2008.
[6] In 2007, water levels in 338 wells were measured in a sweep of the San Simon Valley Sub-basin of the Safford Basin.
[7] Storage estimates do not include Carefree, Fountain Hills, Lake Pleasant and Rainbow Valley sub-basins.
[8] Storage estimates do not include Aguirre Valley and Santa Rosa sub-basins.

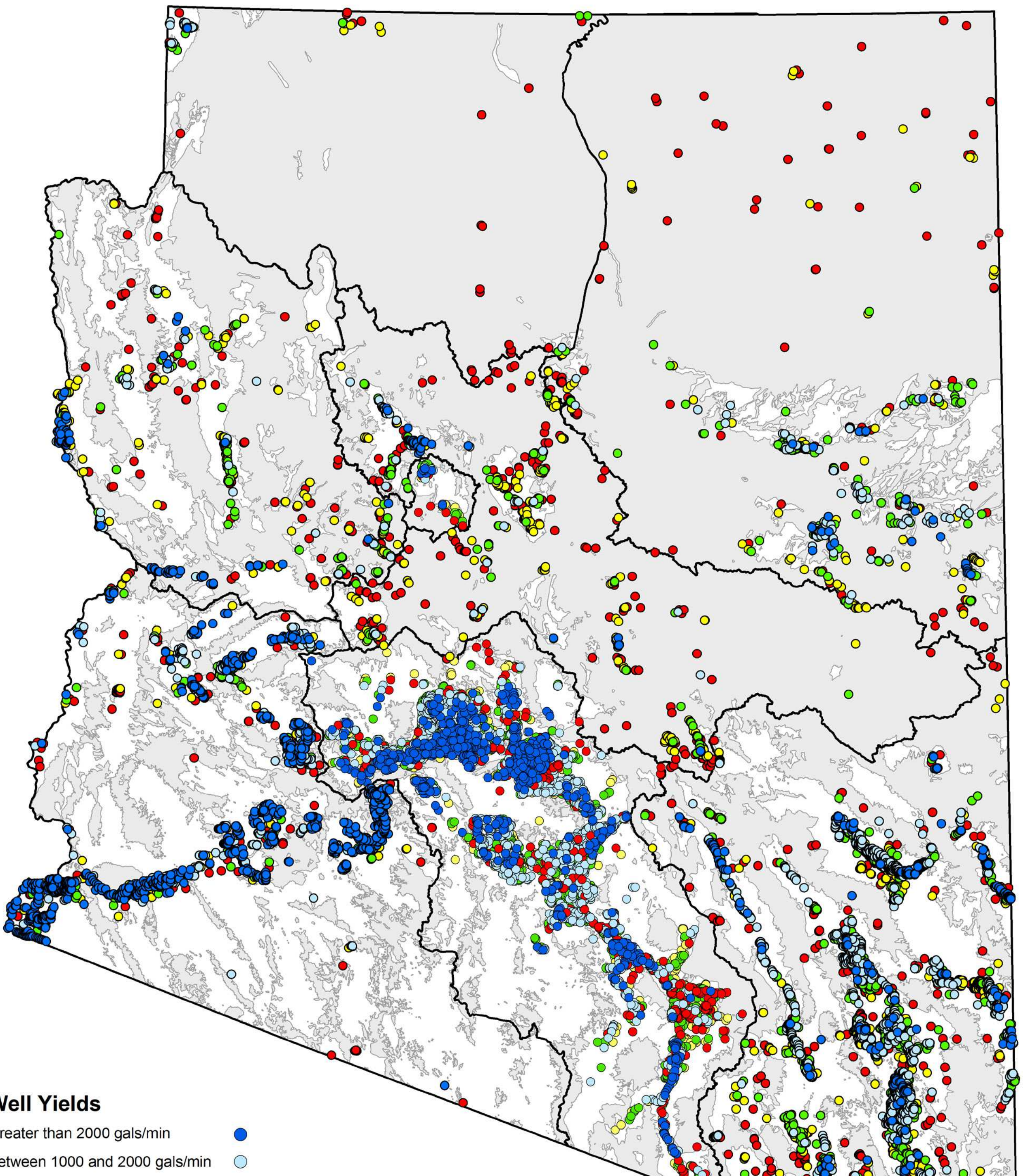


Figure 1-4
Measured Well Yields in Arizona

Source: ADWR GWSI database

The planning area volumes contain a groundwater hydrology summary in the overview section and water level and well yield maps and water level hydrographs for each groundwater basin in the planning area.

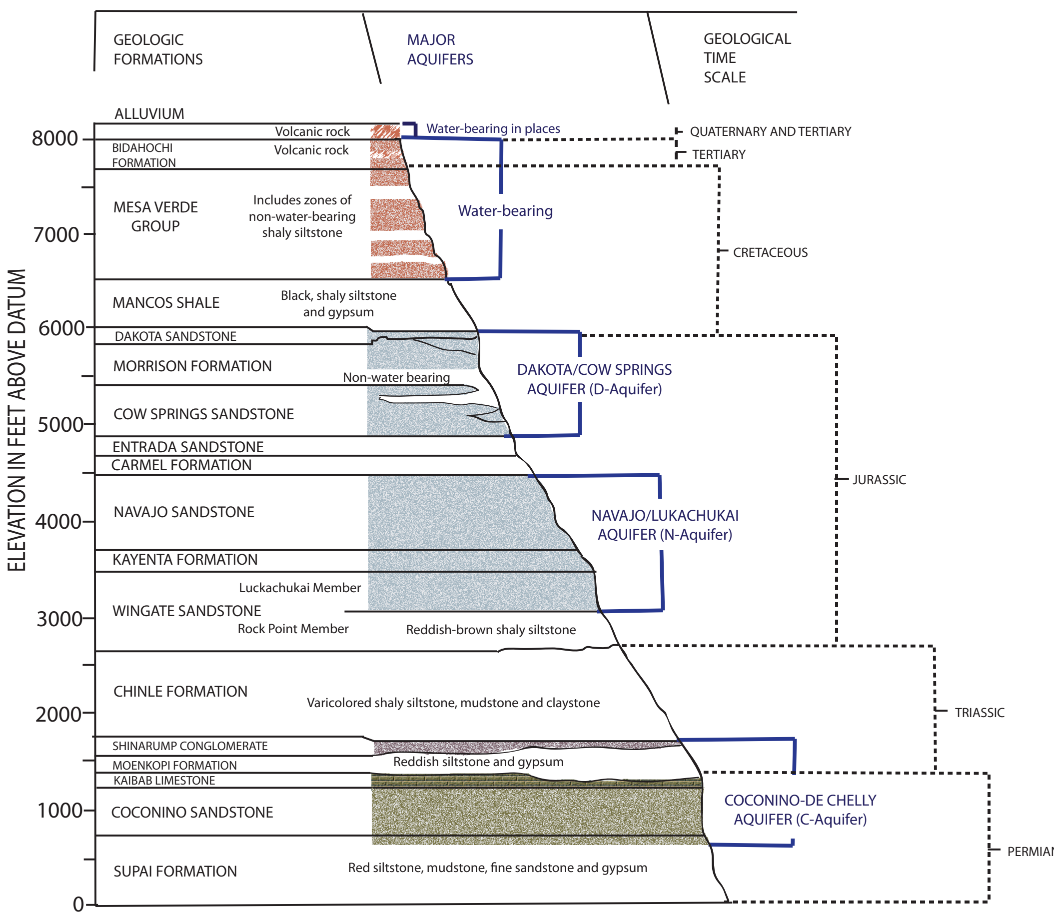
Eastern Plateau

A significant portion of the Eastern Plateau Planning Area is underlain by Mesozoic to Paleozoic sedimentary and volcanic rocks that form the area's regional aquifers (Figure 1-3). The sedimentary rocks include sequences of sandstones and limestones generally separated by low permeability shales and siltstones. The three largest regional aquifers are the C-, D-, and N-aquifers but several local aquifers are also important water sources. Figure 1-5 shows a generalized cross-section of most of the planning area's water-bearing formations. Major groundwater recharge areas are located along the planning area's southern and eastern boundary. Discharge from the regional aquifers is primarily to springs and baseflow to streams. Groundwater in storage for the Little Colorado River Plateau basin aquifers is estimated to exceed 500 million acre-feet (maf) (ADWR, 1990).

Southeastern Arizona

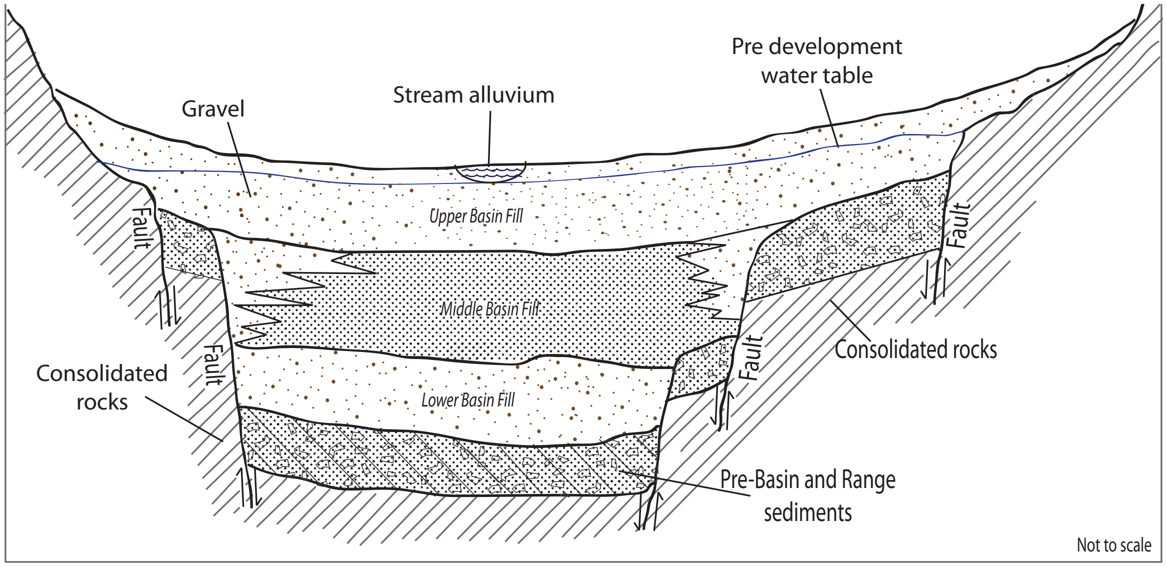
The Southeastern Arizona Planning Area is generally characterized by alluvial basins with relatively large reserves of groundwater in gently sloping valleys separated by mountain ranges (Figure 1-6). The principal water-bearing deposits in the southeast basins consist of moderately thick sediments which were deposited prior to, and during the formation of the Basin and Range province. Basin-fill sediments include fine-grained clays and silts to coarser-grained

Figure 1-5 Generalized Cross-section of Water Bearing Formations in the Eastern Plateau Planning Area



Source: ADWR, 1989

Figure 1-6 Generalized Geologic Cross-Section for the Basin and Range Province



Source: ADWR, 1993

sand and gravels. The major groundwater inflow components are mountain front recharge and stream infiltration and potentially underflow from adjacent basins. Groundwater outflow consists of evapotranspiration, pumpage, discharge to streams as baseflow and underflow to basins, including into Mexico. Estimates of the total groundwater in storage for the 14 groundwater basins that comprise the planning area range from about 150 to 250 maf.

Upper Colorado River

The Upper Colorado River Planning Area is characterized by semi-arid to arid alluvial basins with few perennial streams. As shown in Figure 1-3, there are extensive outcrops of sedimentary and volcanic rocks of varying ages throughout the planning area. Large areas of basin fill covered by alluvial and surficial deposits are found in the western part of the planning area, primarily in the west basins. Most basins are categorized as West or Colorado River basins (Table 1-4). Groundwater inflow from streambed infiltration during runoff events, and outflow to spring discharge and pumpage, is relatively small in the west basins of the planning area. In the Colorado River basins, groundwater inflow is from infiltration of Colorado River water and outflow is primarily from pumpage and evapotranspiration. Estimates of the total groundwater in storage for the nine groundwater basins that comprise the planning area range from about 30 to 100 maf.

Central Highlands

The Central Highlands Planning Area is characterized by a band of mountains consisting of igneous, metamorphic and sedimentary rocks (Figure 1-3). High elevations, steep topography, relatively high runoff and small water storage capabilities are unique to this planning area as compared to the alluvial basins located in the southern part of the State. Numerous springs occur where permeable water-bearing formations overlie lower permeability formations or bedrock (Figure 1-7). Alluvial and surficial deposits are relatively limited, occurring primarily in the western part of the planning area and along parts of the Verde and Salt river drainages. Groundwater inflow is from streambed infiltration, underflow and mountain front recharge. Outflow is primarily evapotranspiration, spring discharge and baseflow. Estimates of the total groundwater in storage for the five planning area basins range from about 25 to 50 maf.

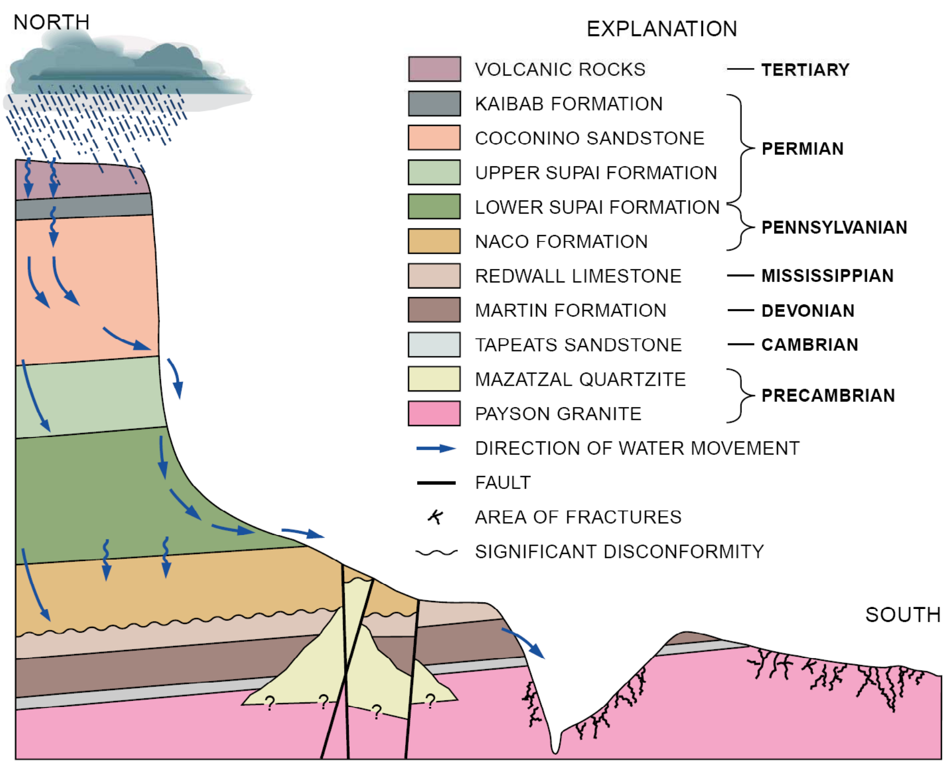
Western Plateau
The Western Plateau Planning Area is characterized by relatively flat-lying, alternating sequences of sandstones, limestones and shales. As shown in Figure 1-3, Mesozoic to Paleozoic sedimentary and volcanic rocks cover most of the planning area. Faults and folds in these rocks affect groundwater movement along a regional gradient. The westernmost basins contain basin-fill sediments that consist of silt, sand and gravel. Groundwater data for the planning area is limited due to its relatively small population and associated lack of water development. Groundwater inflow is generally from mountain front recharge and baseflow and outflow is to spring discharge. Estimates of groundwater in storage for three of the six groundwater basins that comprise the Western Plateau Planning Area total about 6 maf.

Lower Colorado River
The groundwater basins of the Lower Colorado River Planning Area contain alluvial valleys with significant volumes of groundwater in storage. As shown in Figure 1-3, much of the basin is covered by Quaternary surficial deposits and Holocene to Tertiary alluvial deposits. The basin fill can have very productive water-bearing units. With the exception of infiltration of Colorado River water, and stream infiltration along the Gila River drainage, groundwater inflow is minimal due to the aridity of the area. Groundwater outflow is primarily due to well pumpage and evapotranspiration. Estimates of the total groundwater in storage for the nine groundwater basins that comprise the planning area range from about 200 to 520 maf.

Active Management Areas
With the exception of the Prescott AMA, a large portion of the AMA Planning Area is located in the Basin and Range physiographic province. Basin-fill deposits are the principal water-bearing sediments in these basins. The basins are characterized by relatively small to moderate amounts of mountain-front recharge and streamflow infiltration while underflow in and out of the basins can be significant. Groundwater pumping is a large outflow component. The aquifer system of the Prescott AMA is composed of basin-fill deposits that include thick sequences of productive volcanic rocks. Natural recharge occurs via surrounding consolidated rock and from streamflow infiltration. The estimated groundwater in storage for the entire planning area (which does not include estimates for six sub-basins) ranges from 180 to 189 maf.

Water levels in wells, and changes in water levels over time, can vary substantially in the basins depending on well location and local hydrogeologic conditions. Detailed water level data for each basin are presented in the planning area volumes.

Figure 1-7 Generalized Hydrologic Cross-Section from the Mogollon Rim to the Town of Payson
(Source: Parker and Flynn, 2000)



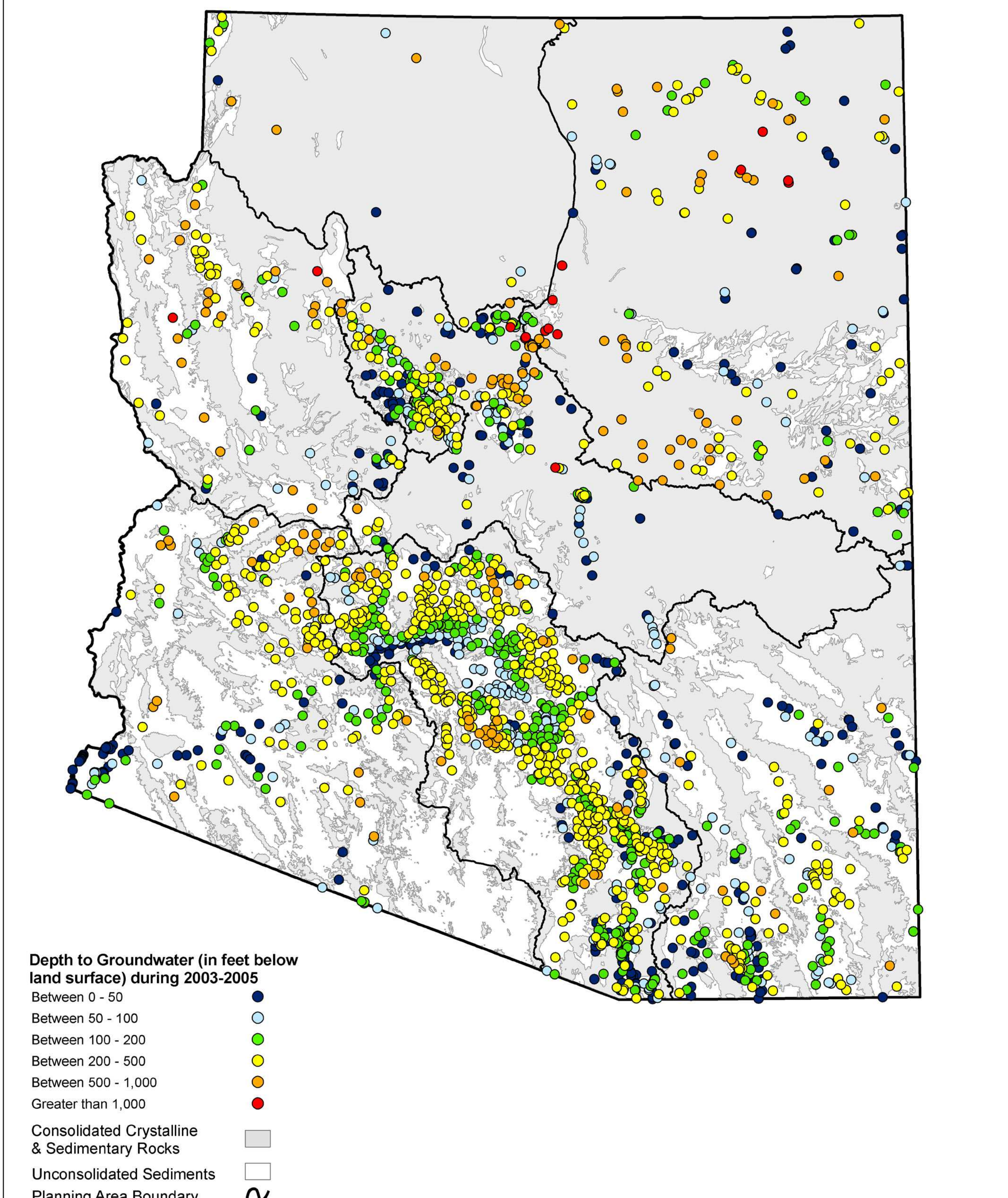


Figure 1-8
Recent Depths to Groundwater in Arizona

Note: Deeper occurrence of groundwater shown where 2 or more wells at same general location.

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Source: ADWR and USGS GWSI databases

Areas of significant groundwater level decline exist in the AMAs and within agricultural areas of the Southeastern Arizona Planning Areas.

Depths to groundwater data across the state are displayed in Figure 1-8. As shown, water levels can be quite deep in the sedimentary rocks of the eastern plateau and relatively shallow along watercourses that drain the basins. Groundwater level changes across the state over an approximately ten-year period are shown on Figure 1-9. Significant groundwater level rises in some parts of the AMA Planning Area are primarily due to use of CAP water instead of groundwater and cessation of agricultural pumping. However, areas of significant groundwater level decline also exist in the AMAs and within agricultural areas of the Lower Colorado River and Southeastern Arizona planning areas.

<u>Surface Water Hydrology</u>

The U.S. Geological Survey (USGS) divides the United States into successively smaller hydrologic units based on surface hydrologic features. A 6-digit code corresponds to accounting units, which are used by the USGS for designing and managing the National Water Data Network. Figure 1-10 shows watersheds in Arizona at the accounting unit level as well as the location large reservoirs (>500 af or >50-acre surface area) and USGS streamflow gages. All or parts of 18 accounting unit watersheds are found in Arizona. Detailed information on these and other surface water features are found in the planning area volumes.

Streamflow data for major Arizona streams are listed in Table 1-5 and associated gage locations are mapped in Figure 1-11 along with the location of major (>20,000 acre-feet) reservoirs. The general location of intermittent and perennial streams and major springs (>10 gallon per minute [gpm] discharge rate) across Arizona are shown on Figure 1-12. More precise locations and data for these surface water features are included in planning area volumes of the Atlas.

Eastern Plateau Planning Area

Portions of five watersheds occur in this planning area. The largest are the Little Colorado River Watershed, which occupies the southern two-thirds of the planning area, and the Lower San Juan River Watershed drained primarily by Chinle Creek, which flows north to the San Juan River, a tributary to the Colorado River. The Little Colorado River was formerly perennial throughout its length but is now intermittent in many reaches. A number of perennial and intermittent streams occur at higher elevations in the Little Colorado River Watershed (Figure 1-12).

Upper Little Colorado River, Eastern Plateau Planning Area. The Little Colorado River was formerly perennial throughout its length but is now intermittent in much of the middle and lower reaches.

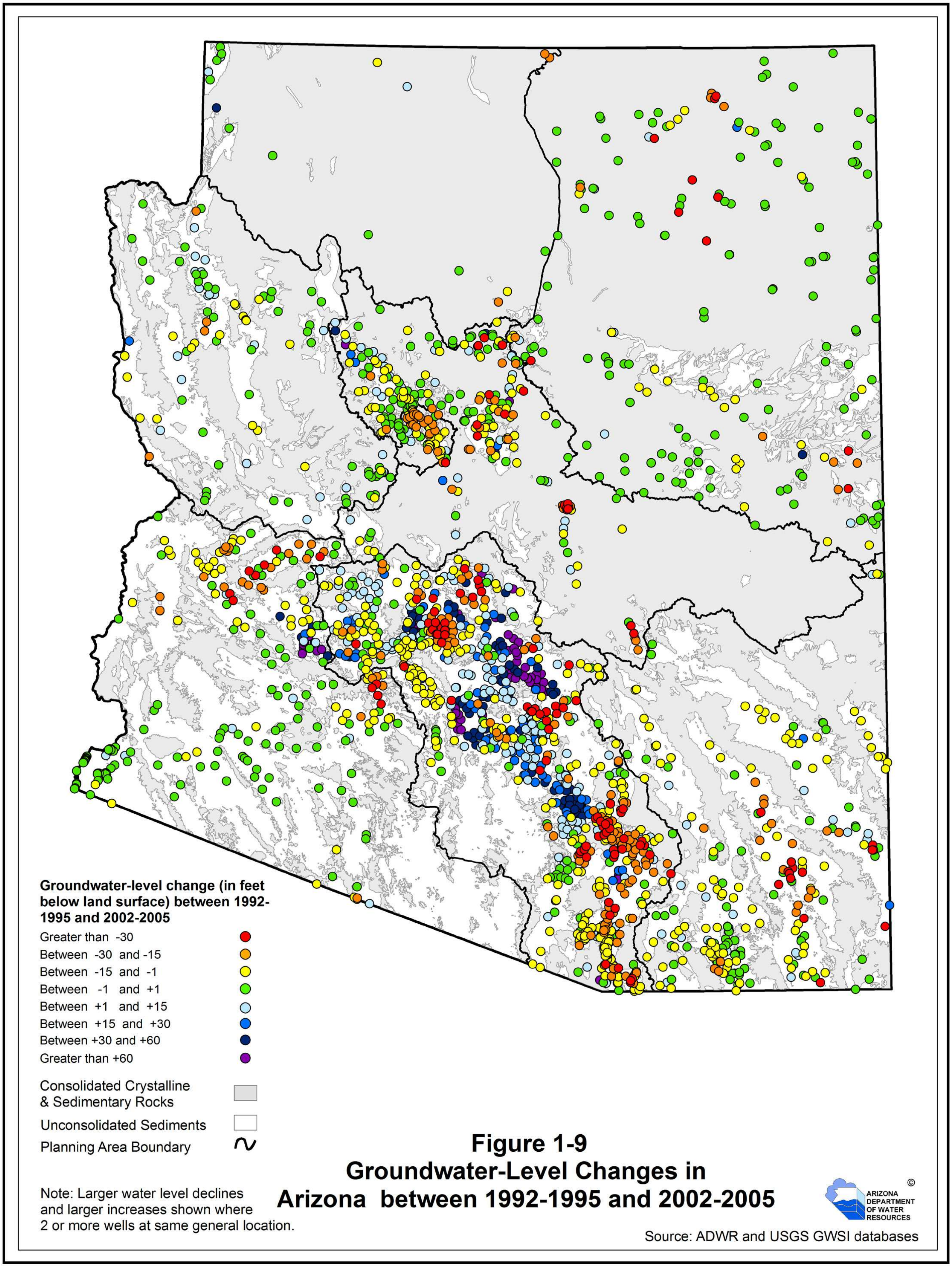

Figure 1-9
Groundwater-Level Changes in Arizona between 1992-1995 and 2002-2005

Source: ADWR and USGS GWSI databases

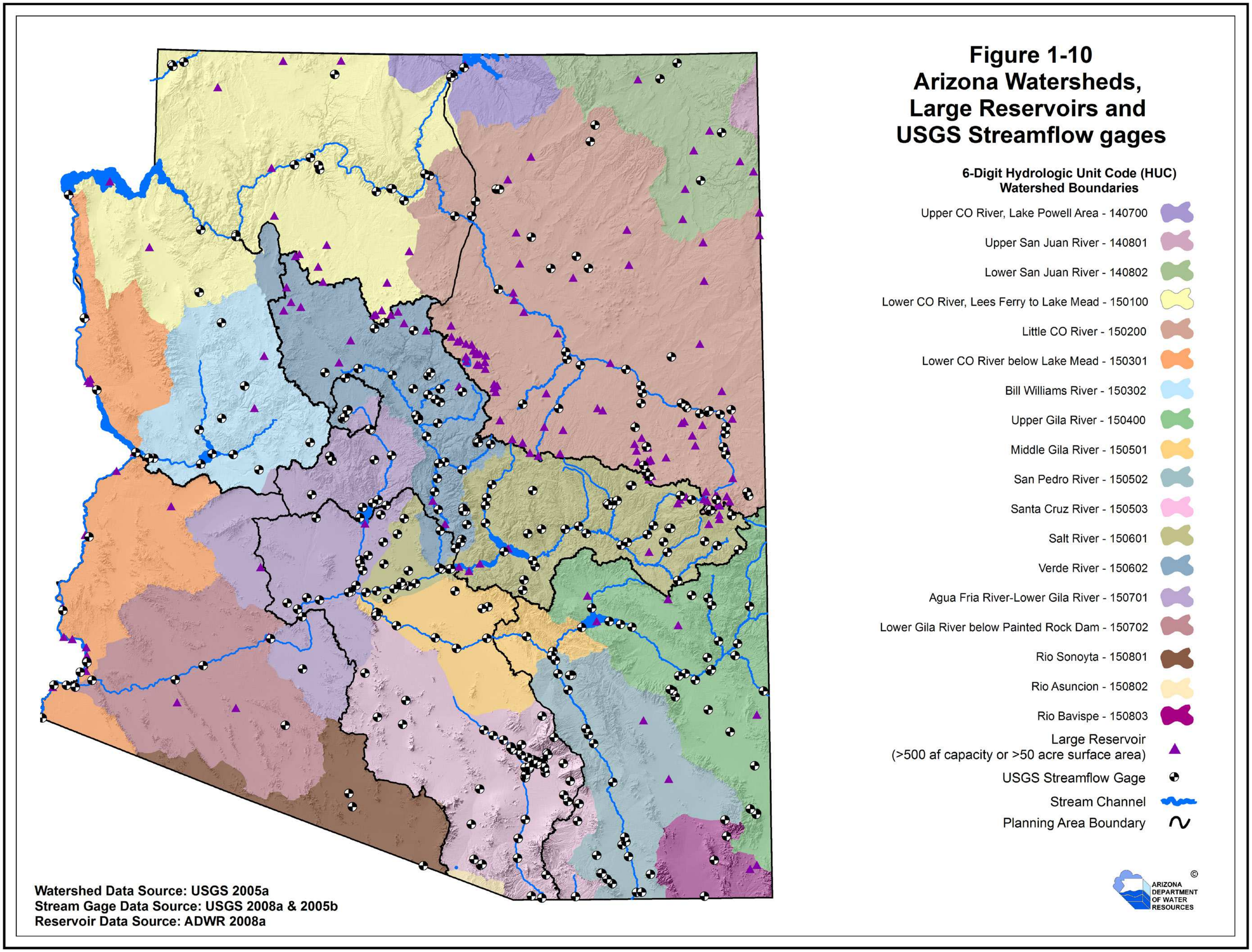
Figure 1-10
Arizona Watersheds, Large Reservoirs and USGS Streamflow gages
6-Digit Hydrologic Unit Code (HUC) Watershed Boundaries
Upper CO River, Lake Powell Area - 140700
Upper San Juan River - 140801
Lower San Juan River - 140802
Lower CO River, Lees Ferry to Lake Mead - 150100
Little CO River - 150200
Lower CO River below Lake Mead - 150301
Bill Williams River - 150302
Upper Gila River - 150400
Middle Gila River - 150501
San Pedro River - 150502
Santa Cruz River - 150503
Salt River - 150601
Verde River - 150602
Agua Fria River-Lower Gila River - 150701
Lower Gila River below Painted Rock Dam - 150702
Rio Sonoyta - 150801
Rio Asuncion - 150802
Rio Bavispe - 150803
Large Reservoir (>500 af capacity or >50 acre surface area)
USGS Streamflow Gage
Stream Channel
Planning Area Boundary
Watershed Data Source: USGS 2005a
Stream Gage Data Source: USGS 2008a & 2005b
Reservoir Data Source: ADWR 2008a
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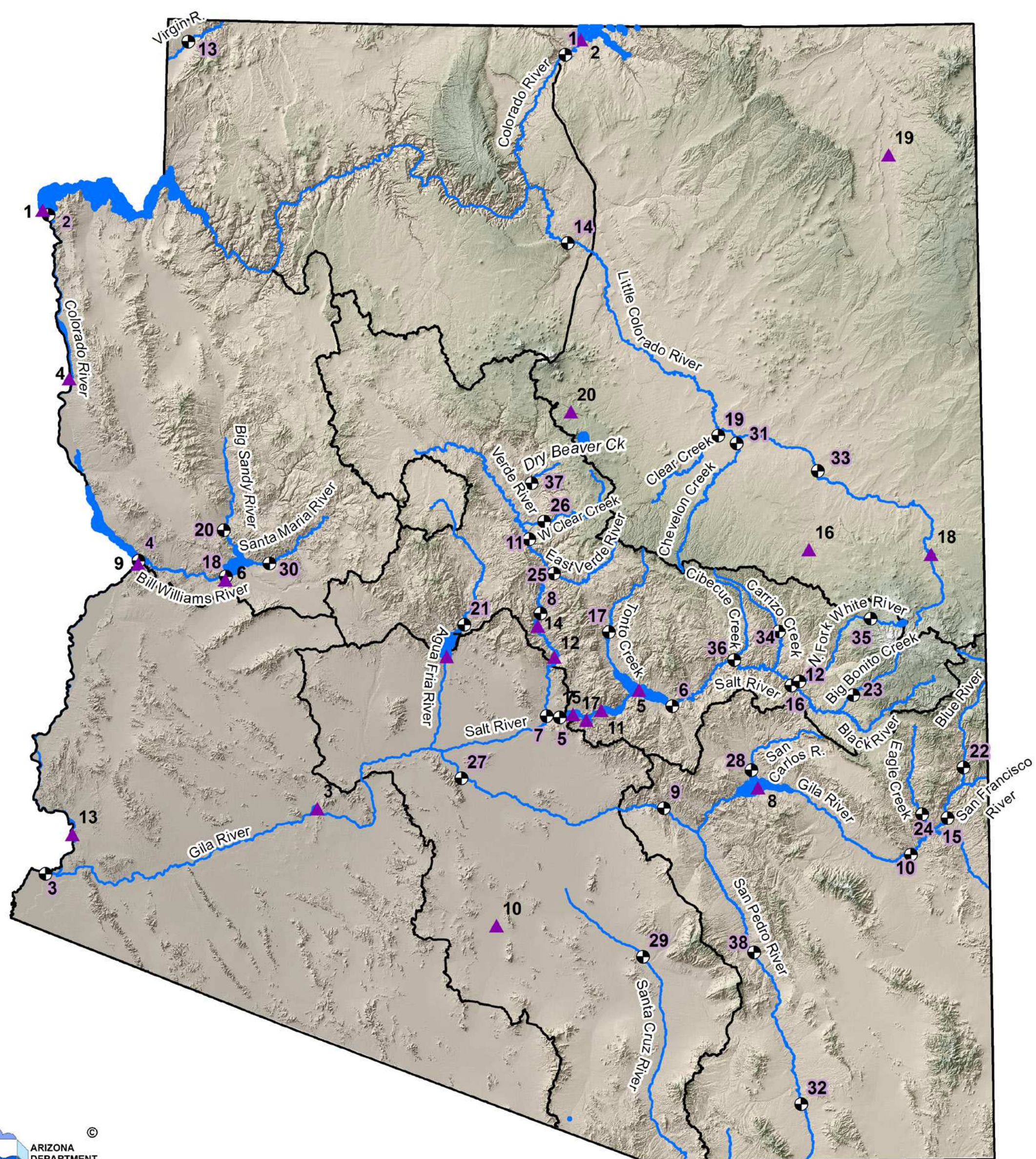
Figure 1-11
Major Streams and Reservoirs in Arizona



Major Stream
USGS Streamflow Gage (Table 1-5)
Major Reservoir
Planning Area Boundary

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Stream Location Data Source: ALRIS, 2005

Major (>20,000 af capacity) Reservoirs in Arizona

Map Key	Reservoir/Lake Name	Dam name, if different	Max Storage (in 1000 af)
1	Lake Mead	Hoover Dam	29,755
2	Lake Powell	Glen Canyon Dam	28,035
3	Painted Rock Reservoir		4,832
4	Lake Mohave	Davis Dam	1,818
5	Roosevelt Lake		1,653
6	Alamo Reservoir		1,409
7	Lake Pleasant	New Wadell Dam	1,109
8	San Carlos Reservoir	Coolidge Dam	1,073
9	Lake Havasu	Parker Dam	651
10	Lake Saint Clair		375
11	Apache Lake	Horse Mesa Dam	245
12	Bartlett Reservoir		178
13	Imperial Reservoir		160
14	Horseshoe Reservoir		132
15	Saguaro Lake	Stewart Mountain Dam	69
16	Schoens Lake		62
17	Canyon Lake	Mormon Flat Dam	58
18	Lyman Lake		45
19	Many Farms		33
20	Upper Lake Mary		21

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Table 1-5 Flow characteristics of major Arizona streams[a]

STREAM	USGS STATION				LOCATION		PERIOD OF RECORD	AVERAGE SEASONAL FLOW (% of annual flow)[d]				ANNUAL FLOW/YEAR (in acre-feet)[e]				YEARS OF ANNUAL FLOW RECORD
	No.	Name	Drainage Area (in mi^2)	Map Key[b]	Basin	Planning Area		Winter	Spring	Summer	Fall	Minimum	Median	Mean	Maximum	
Colorado River	9380000	at Lees Ferry	111,800	1	Little Colorado River Plateau	Eastern Plateau	10/1921-current (real time)	16	44	24	16	1,383,521 (1963)	9,375,509	10,885,307	20,322,048 (1984)	83
Colorado River	9421500	below Hoover Dam	171,700	2	Lake Mohave	Upper Colorado River	4/1934-current (real time)	24	29	26	21	5,919,516 (1934)	9,183,655	10,109,870	21,350,096 (1984)	70
Colorado River	9521000	at Yuma	242,900	3	Yuma	Lower Colorado River	1/1904-11/1983 (discontinued)	17	44	25	14	682,711 (1961)	9,628,539	10,090,123	25,969,073 (1909)	60
Colorado River	9427520	below Parker Dam	182,700	4	Parker	Lower Colorado River	11/1934-current (real time)	23	28	28	20	5,534,256 (1993)	7,229,140	8,918,956	20,409,560 (1984)	61
Salt River	9502000	below Stewart Mountain Dam	6,232	5	Phoenix AMA	Active Management Areas	10/1934-current (real time)	24	33	34	9	114,962 (2003)	585,878	711,279	3,276,254 (1993)	65
Salt River	9498500	near Roosevelt	4,306	6	Salt River	Central Highlands	1/1913-current (real time)	41	31	13	15	152,798 (2002)	518,499	644,942	2,422,315 (1916)	89
Verde River	9511300	near Scottsdale	6,615	7	Phoenix AMA	Active Management Areas	3/1961-current (real time)	45	22	15	18	96,980 (2002)	298,074	454,965	1,794,415 (1993)	44
Verde River	9508500	below Tangle Creek above Horseshoe Dam	5,858	8	Verde River	Central Highlands	8/1945-current (real time)	51	17	11	20	131,073 (2002)	294,733	409,875	1,583,014 (1993)	57
Gila River	9474000	at Kelvin	18,011	9	Lower San Pedro	Southeastern Arizona	1/1911-current (real time)	31	23	32	14	56,398 (1961)	324,351	370,675	2,375,969 (1993)	93
Gila River	9448500	at head of Safford Valley near Solomon	7,896	10	Safford	Southeastern Arizona	10/1920-current (real time)	41	18	20	22	48,953 (1956)	273,008	337,069	1,559,116 (1993)	77
Verde River	9506000	near Camp Verde	5,009	11	Verde River	Central Highlands	4/1934-current (real time)	59	17	11	14	99,934 (2002)	222,679	299,621	990,650 (1993)	24
Black River	9490500	near Fort Apache	1,232	12	Salt River	Central Highlands	11/1912-current (real time)	42	35	9	15	45,188 (2002)	233,904	280,932	818,301 (1993)	45
Virgin River	9415000	at Littlefield	5,090	13	Virgin	Western Plateau	10/1929-current (real time)	32	33	15	20	73,140 (1977)	141,935	174,502	506,912 (1983)	72
Little Colorado River	9402000	near Cameron	26,459	14	Coconino Plateau	Western Plateau	6/1947-current (real time)	34	26	27	14	10,215 (2000)	138,315	162,519	816,449 (1973)	55
San Francisco River	9444500	at Clifton	2,766	15	Morenci	Southeastern Arizona	10/1910-current (real time)	41	20	16	22	30,415 (1951)	91,606	146,532	678,755 (1915)	79
White River	9494000	near Fort Apache	632	16	Salt River	Central Highlands	10/1917-current (real time)	28	48	12	12	27,446 (2002)	149,177	144,517	345,424 (1993)	45
Tonto Creek	9499000	above Gun Creek near Roosevelt	675	17	Tonto Creek	Central Highlands	12/1940-current (real time)	61	12	8	19	2,853 (2002)	66,297	113,232	469,256 (1978)	62
Bill Williams River	9426000	below Alamo Dam	4,633	18	Bill Williams	Upper Colorado River	10/1939-current (real time)	54	16	16	14	1,275 (1975)	33,963	82,317	701,711 (1993)	63
Clear Creek	9399000	near Winslow	621	19	Little Colorado River Plateau	Eastern Plateau	6/1906-9/2007 (discontinued)	39	49	2	9	3,852 (1967)	46,697	60,719	183,890 (1978)	51
Big Sandy River	9424450	near Wikieup	2,742	20	Bill Williams	Upper Colorado River	3/1966-current (real time)	80	5	4	10	2,448 (2002)	27,011	58,901	421,461 (1993)	36
Agua Fria River	9512800	near Rock Springs	1,111	21	Agua Fria	Central Highlands	1/1970-current (real time)	75	7	7	11	1,528 (1975)	19,692	57,664	360,541 (1992)	31
Blue River	9444200	near Clifton	506	22	Morenci	Southeastern Arizona	11/1967-current (real time)	39	22	14	25	9,487 (2002)	38,091	50,373	176,695 (1983)	30
Big Bonito Creek	9489700	near Fort Apache	119	23	Salt River	Central Highlands	10/1957-9/1981 (discontinued)	29	49	11	12	13,828 (1961)	41,267	49,530	102,805 (1979)	23
Eagle Creek	9447000	above pumping plant near Morenci	622	24	Morenci	Southeastern Arizona	4/1944-current (real time)	49	14	15	22	12,311 (1953)	34,398	48,850	405,530 (1993)	58
East Verde River	9507980	near Childs	331	25	Verde River	Central Highlands	9/1961-current (real time)	59	16	10	15	1,499 (2002)	34,036	46,674	208,558 (1993)	38
West Clear Creek	9505800	near Camp Verde	241	26	Verde River	Central Highlands	12/1964-current (real time)	54	20	8	18	11,152 (2002)	34,542	45,858	133,245 (1993)	38
Gila River	9479500	near Laveen	20,615	27	Pinal AMA	Active Management Areas	1/1940-9/1994 (discontinued)	67	6	13	15	0 (1969)	9,420	45,227	1,189,109 (1993)	52
San Carlos River	9468500	near Peridot	1,026	28	Safford	Southeastern Arizona	4/1914-current (real time)	61	5	13	21	4,070 (2002)	28,677	43,480	296,181 (1993)	73
Santa Cruz River	9486500	at Cortaro	3,503	29	Tucson AMA	Active Management Areas	10/1939-current (real time)	27	10	39	24	1,706 (1956)	38,655	41,897	182,136 (1993)	53
Santa Maria River	9424900	near Bagdad	1,129	30	Bill Williams	Upper Colorado River	4/1966-current (real time)	74	6	5	15	0 (1996, 2002)	15,063	40,551	168,005 (1980)	32
Chevelon Creek	9398000	near Winslow	785	31	Little Colorado River Plateau	Eastern Plateau	1/1906-12/2006 (discontinued)	49	33	6	11	10,715 (1956)	32,651	38,756	99,909 (1952)	44
San Pedro River	9471000	at Charleston	1,234	32	Upper San Pedro	Southeastern Arizona	3/1904-current (real time)	14	5	65	16	6,778 (2002)	33,203	38,636	152,798 (1914)	84
Little Colorado River	9394500	at Woodruff	8,072	33	Little Colorado River Plateau	Eastern Plateau	3/1905-current (real time)	27	12	46	15	5,524 (2000)	26,860	35,839	165,791 (1919)	74
Carrizo Creek	9496500	near Show Low	439	34	Salt River	Central Highlands	6/1951-current (real time)	28	49	10	13	3,758 (1956)	22,232	35,030	124,556 (1993)	41
North Fork White River	9491000	near McNary	78	35	Salt River	Central Highlands	6/1945-9/1985 (discontinued)	15	57	16	13	12,673 (1951)	32,442	34,855	73,140 (1983)	31
Cibecue Creek	9497800	near Chrysotile	295	36	Salt River	Central Highlands	5/1959-current (real time)	45	17	18	21	10,066 (1961)	23,535	32,597	128,176 (1993)	43
Dry Beaver Creek	9505350	near Rimrock	142	37	Verde River	Central Highlands	10/1960-current (real time)	61	21	3	15	253 (1996)	21,978	31,271	105,727 (1978)	42
San Pedro River	9472000	near Redington	2,927	38	Lower San Pedro	Southeastern Arizona	6/1943-9/1995 (discontinued)	19	2	64	16	297 (1997)	21,399	31,033	131,073 (1955)	50

Sources: USGS 2008a & 2005b

Notes:
[a] Streams considered major if calculated median or mean annual flows exceed 20,000 and 30,000 acre-feet, respectively.
[b] Representative stations, listed in order of largest mean flows. See Figure 1-11. Other stations exist on some streams, but are not included here.
[c] Period of record current as of November 2008; all other data retrieved from USGS in 2005 or 2007 (AMAs only).
[d] Seasonal flows based on average monthly values and may not sum to 100% due to rounding.
[e] Annual flows are for calendar years and only listed if stations have at least 20 complete years of record.

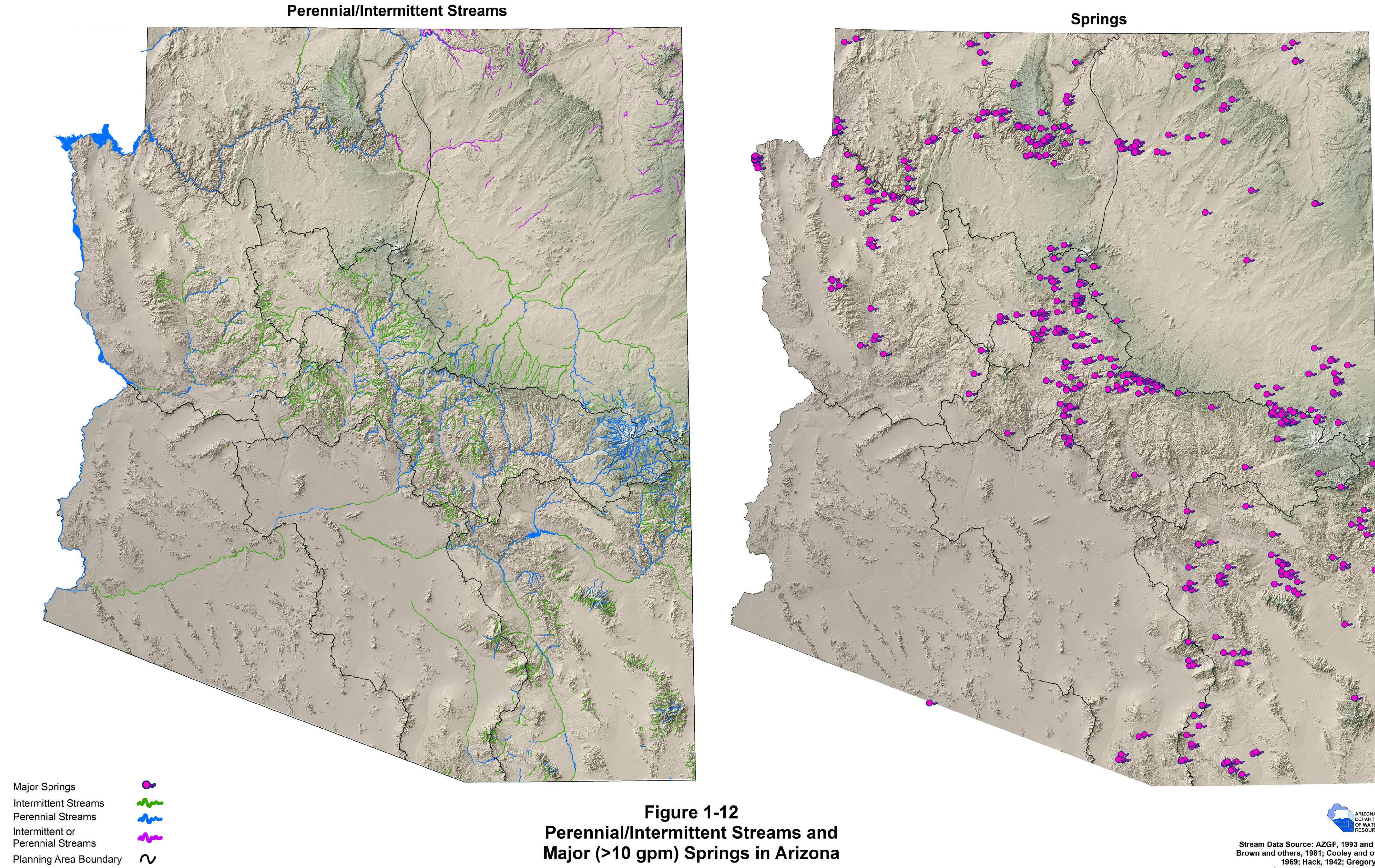


Figure 1-12
Perennial/Intermittent Streams and Major (>10 gpm) Springs in Arizona

Stream Data Source: AZGF, 1993 and 1997; Brown and others, 1981; Cooley and others, 1969; Hack, 1942; Gregory, 1916
Spring Data Source: ADWR, 2008b

Lake Powell, Eastern Plateau Planning Area. Recent storage volumes in Lake Powell are much below average due to drought and continued releases of water for downstream storage and use.

The Colorado River forms the extreme northwestern boundary of the planning area with a mean flow of 10.9 maf measured at a gage at Lees Ferry below Glen Canyon Dam (Table 1-5, Figure 1-11). Changes in reservoir storage in Lake Powell, much of which is located in Utah, are shown on Figure 1-13. As shown, recent storage volumes are much below average due to drought and continued releases of water for downstream storage and use. Ninety-three other large reservoirs are located in the planning area.

Seventy-seven major springs have been identified in the planning area, primarily clustered near Tuba City, in the vicinity of Pinetop-Lakeside and in the Saint Johns-Concho area. The largest is Silver Spring northeast of Show Low with a measured discharge of over 3,600 gpm.

Southeastern Arizona Planning Area

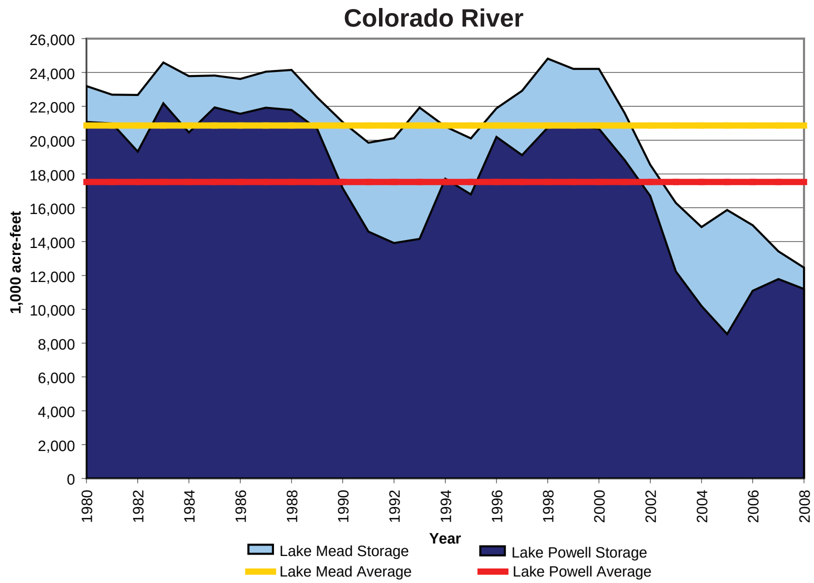
Portions of five watersheds are found in the Southeastern Arizona Planning Area. Major drainages are the Gila River and its major tributary in the planning area, the San Pedro River. The Gila River is perennial from the New Mexico border to the Safford Valley but becomes intermittent east of Safford due to irrigation diversions and seasonal flow variations. Gila River flows are impounded in San Carlos Reservoir behind Coolidge Dam at the boundary of the Middle Gila and Upper Gila watersheds. Reservoir releases maintain an average of about 260,000 acre-feet per year (AFA) of flow in the Gila River below the dam. Portions of the San Pedro River and other watercourses are perennial (Figure 1-12). The Rio de Bavispe Watershed in the southeast part of the planning area drains south into Mexico. A portion of the Santa Cruz Watershed including the headwaters of the Santa Cruz River is found in the southwest corner of the planning area. The Santa Cruz River flows southward into Mexico before turning north and reentering the U.S. east of Nogales, Arizona in the Santa Cruz AMA.

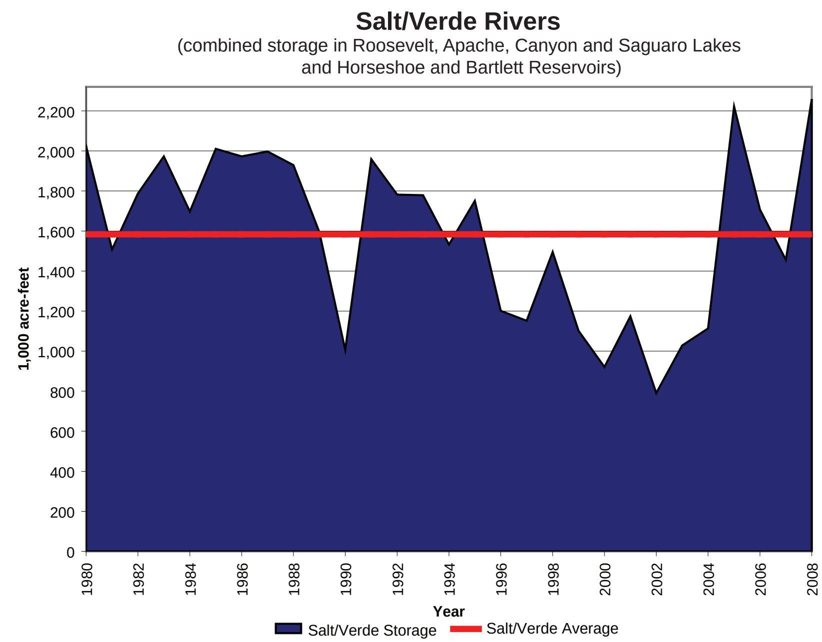
There are 21 active streamgages in the planning area; the highest mean flow, 370,675 AFA, was measured at a gage on the Gila River at Kelvin, located below the confluence with the San Pedro River (Table 1-5). Storage volumes in San Carlos Reservoir are shown in Figure 1-13 and indicate wide fluctuations during the 1980-2008 time period. There are 21 other large reservoirs in the planning area, with 12 located in the Safford Basin.

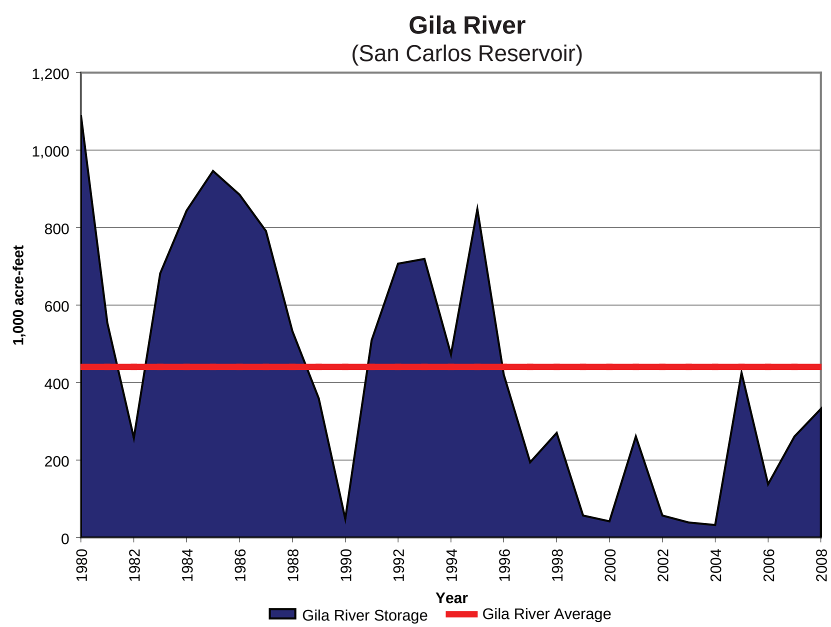
The largest of the 69 major springs in the planning area is Warm Springs, located at the headwaters of the San Carlos River, with a measured discharge of almost 3,400 gpm. A number of

Gila River, Southeastern Arizona Planning Area. The Gila River is perennial from the New Mexico border to the Safford Valley.

Figure 1-13 May 1st Reservoir Storage on the Colorado, Gila and Salt/Verde Rivers on May 1st, 1980-2008







Data sources: BOR 2010a, SRP 2008
and Gila Commisioner (various dates)

Bill Williams River, Upper Colorado River Planning Area. With the exception of the Bill Williams River, the major tributaries to the Colorado River in the planning area are ephemeral and contribute little to its flow.

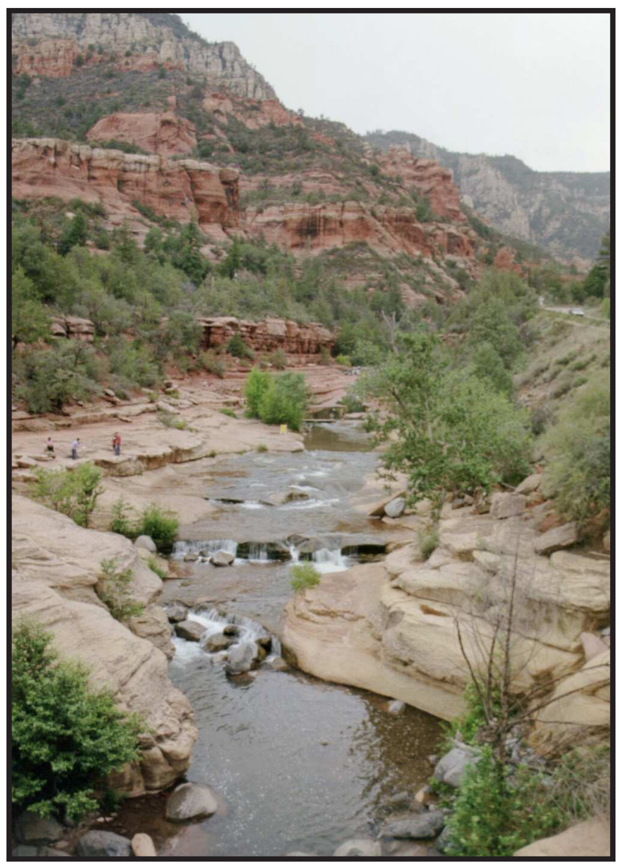
large springs also occur downstream of the Town of Pima near the Gila River.

Upper Colorado River Planning Area
The Bill Williams Watershed as well as portions of four others occur in the Upper Colorado River Planning Area. With the exception of the Bill Williams River, the major tributaries to the Colorado River in the planning area are ephemeral and contribute little to its flow. Lake Mead, created by Hoover Dam, and the reservoirs impounded by Parker and Davis dams further downstream, store large volumes of Colorado River water for downstream users (Figure 1-11). There are six other large reservoirs in the planning area. Historic storage volumes in Lake Mead are shown in Figure 1-13.

The Bill Williams Watershed is drained by the Bill Williams River and its major tributaries, the Big Sandy and Santa Maria rivers and by Burro Creek. A number of perennial and intermittent streams exist in the watershed (Figure 1-12). Construction of Alamo Dam on the Bill Williams River in 1968 significantly impacted streamflow below the dam, which historically had produced some of the largest floods in Arizona history (Webb and others, 2007). Mean annual streamflow at gages along the Colorado River exceed 10 maf and are controlled by releases from dams. Other than these controlled releases, the largest mean annual flow (over 82,000 acre-feet) in the planning area was recorded at a gage on the Bill Williams River located below Alamo Dam (Table 1-5).

There are 61 major springs in the planning area including several located below Hoover Dam and others in the vicinity of Kingman. The largest is Spencer, located in north-central Peach Springs Basin with a measured discharge of 1,730 gpm.

Central Highlands Planning Area
Included in the Central Highlands Planning Area are portions of three watersheds: the Agua Fria-Lower Gila River, Salt and Verde. The Salt and Verde watersheds are the major water producing watersheds in the state. The Agua Fria-Lower Gila River Watershed is drained by the Agua Fria and Hassayampa rivers, neither of which are perennial throughout their lengths.



Oak Creek, Central Highlands Planning Area

The Salt River Watershed is drained by the Salt River and its many tributaries including Tonto Creek. The Salt River originates in the high elevations of the White Mountains and is perennial throughout the planning area. There are numerous perennial streams particularly in the high elevation eastern portion of the Watershed including the Black and White rivers (Figure 1-12). The Salt River is impounded behind four dams in its lower reaches – Roosevelt, Horse Mesa, Mormon Flat and Stewart Mountain, which provide water supply storage and flood control for the Phoenix metropolitan area.

The Verde River Watershed is drained by the Verde River, which is perennial throughout its length. Almost all the major perennial tributaries to the Verde River drain areas to its north and east and include Oak Creek, West Clear Creek, and the East Verde River. The Verde River is impounded in its lower reach behind Bartlett and Horseshoe dams, which store water for use in the Phoenix area. Changes in the combined storage volume of the Salt and Verde reservoirs are shown in Figure 1-13, which illustrate the effects of prolonged drought from the late-1990s through the mid-2000s. There are another 19 large reservoirs in the planning area including Lake Pleasant, which stores primarily CAP water for use in the CAP service area of Maricopa, Pima and Pinal counties (Appendix C).

Over ten streamflow gages in the planning area report annual mean flows in excess of 30,000 acre-feet (Table 1-5). The largest flow in the planning area was measured on the Salt River near Roosevelt with an average mean flow of over 644,900 acre-feet. There are 143 major springs in the planning area (Figure 1-12), primarily located along upper and lower Oak Creek, south of Camp Verde, below the Mogollon Rim north of Payson and near McNary. The highest measured discharge rate is 21,647 gpm at Fossil Creek Springs in the Tonto Creek Basin.

Virgin River, Western Plateau Planning Area. Average annual flow on the Virgin River measured at the Littlefield gage is about 174,500 AFA.

Western Plateau Planning Area

Portions of three watersheds occur in this planning area: Upper Colorado River-Lake Powell; Little Colorado River; and Lower Colorado River, Lees Ferry to Lake Mead. The Colorado and Little Colorado rivers are the major drainages in the area. Perennial streams include the Colorado River, Virgin River, a 13-mile stretch of the Little Colorado River below Blue Springs, the Paria River, and Havasu and Diamond creeks.

Flow in the Colorado River downstream from Lake Powell is controlled by releases from Glen Canyon Dam, which has significantly impacted flow volumes and historic seasonal variations in flow. Prior to construction of Glen Canyon Dam, flow in the Colorado was highly unpredictable with wide year-to-year variability and spring flooding. This is reflected in seasonal flow records at the gage at Lees Ferry (Table 1-5). Average annual flow on the Virgin River measured at the Littlefield gage is about 174,500 AFA, and about 162,500 AFA on the Little Colorado River near Cameron (Table 1-5). In addition to Lake Powell and the easternmost part of Lake Mead, there are 16 large reservoirs, most located in the Coconino Plateau Basin.

Seventy-eight major springs have been identified in the planning area. The largest by far is the Blue Springs area with an estimated discharge of over 101,000 gpm. A number of major

Colorado River, Lower Colorado River Planning Area

springs issue from limestones and sandstones in the vicinity of the Colorado River including Havasu Springs (28,500 gpm) and Tapeats Spring (18,700 gpm). Estimated discharge from the Littlefield Springs along the Virgin River is 8,980 to 22,400 gpm. A group of major springs with discharge rates between 11 and 90 gpm are also found in the north-central part of the Kanab Plateau Basin.

Lower Colorado River Planning Area

The entire Lower Gila River below Painted Rock Dam Watershed and the Rio Sonoyta Watershed (in the U.S.) and portions of the Lower Colorado River below Lake Mead and Agua Fria River-Lower Gila River watersheds are found in the planning area. Major surface water drainages are the Colorado River, Gila River, San Cristobal Wash, Centennial Wash and San Simon Wash, which flows south to the Rio Sonoyta in Mexico. The area is extremely arid and the Colorado River is the only perennial stream. Drainages to the Colorado River are ephemeral and contribute little to flow with the exception of the Gila River during flood events. This section of the Gila River flows only in response to precipitation events, irrigation return flow or releases from upstream dams. In the planning area it is impounded behind Painted Rock Dam, primarily a flood control structure that is normally dry. Dams on the Colorado River in the planning area include Imperial, Laguna and Morelos. In total, there are 15 large reservoirs in the planning area. Dam construction and diversions, including major diversions from Imperial Dam to California and Arizona, have fundamentally altered the character and the volume of flow in the Colorado River. The United States is obligated by treaty to allow 1.5 maf of water to flow annually to Mexico from the Colorado River (Appendix D).

Average seasonal and annual flows at two Colorado River gages in the planning area are listed in Table 1-5. Mean annual flow at the Yuma gage is over 10 maf. Major and minor (1-10 gpm) springs only occur in the Rio Sonoyta Watershed in the Western Mexican Drainage Basin. The only major spring, Quitobaquito Springs, has a combined discharge of 28 gpm.

Active Management Area Planning Area

The AMA planning area encompasses portions of six watersheds. From north to south they are: the Verde River, the Agua Fria River-Lower Gila River, the Salt River, the Middle Gila River, the Santa Cruz River and the Rio Asuncion.

The Verde River Watershed is drained by the Verde River, which is perennial and joins the Salt River below Stewart Mountain Dam. The Agua Fria River-Lower Gila River is drained by the largely ephemeral Agua Fria River and Hassayampa rivers and the Gila River. The Agua

Salt River, AMA Planning Area.

Fria River is impounded by New Waddell Dam at the northern boundary of the Phoenix AMA and only flows below the dam when water is released during major flood events. The Gila River enters the Pinal AMA, flows through the Middle Gila Watershed and becomes part of the Agua Fria River – Lower Gila River Watershed below its confluence with the Salt River. The Gila River is now primarily ephemeral due to upstream diversions except the reach downstream of the confluence of the Salt River where discharge from the City of Phoenix 23rd and 91st Avenue wastewater treatment plants and return flow from agricultural areas maintains perennial flow in both the Gila and Salt rivers. Upstream of the treatment plants, the Salt River, which drains the Salt River Watershed, is ephemeral below Granite Reef Diversion Dam.

AMA Planning Area, Granite Reef Diversion Dam. The Salt River is ephemeral below Granite Reef Diversion Dam.

A large portion of the AMA Planning Area falls within the Santa Cruz River Watershed, drained by the Santa Cruz River, which flows north from Mexico to the Gila River. It is largely ephemeral with two segments of perennial flow due to wastewater discharges. A small part of the Rio Asuncion Watershed is located along the international border. This watershed drains southwest to the Sea of Cortez and contains a perennial stream, Sycamore Creek.

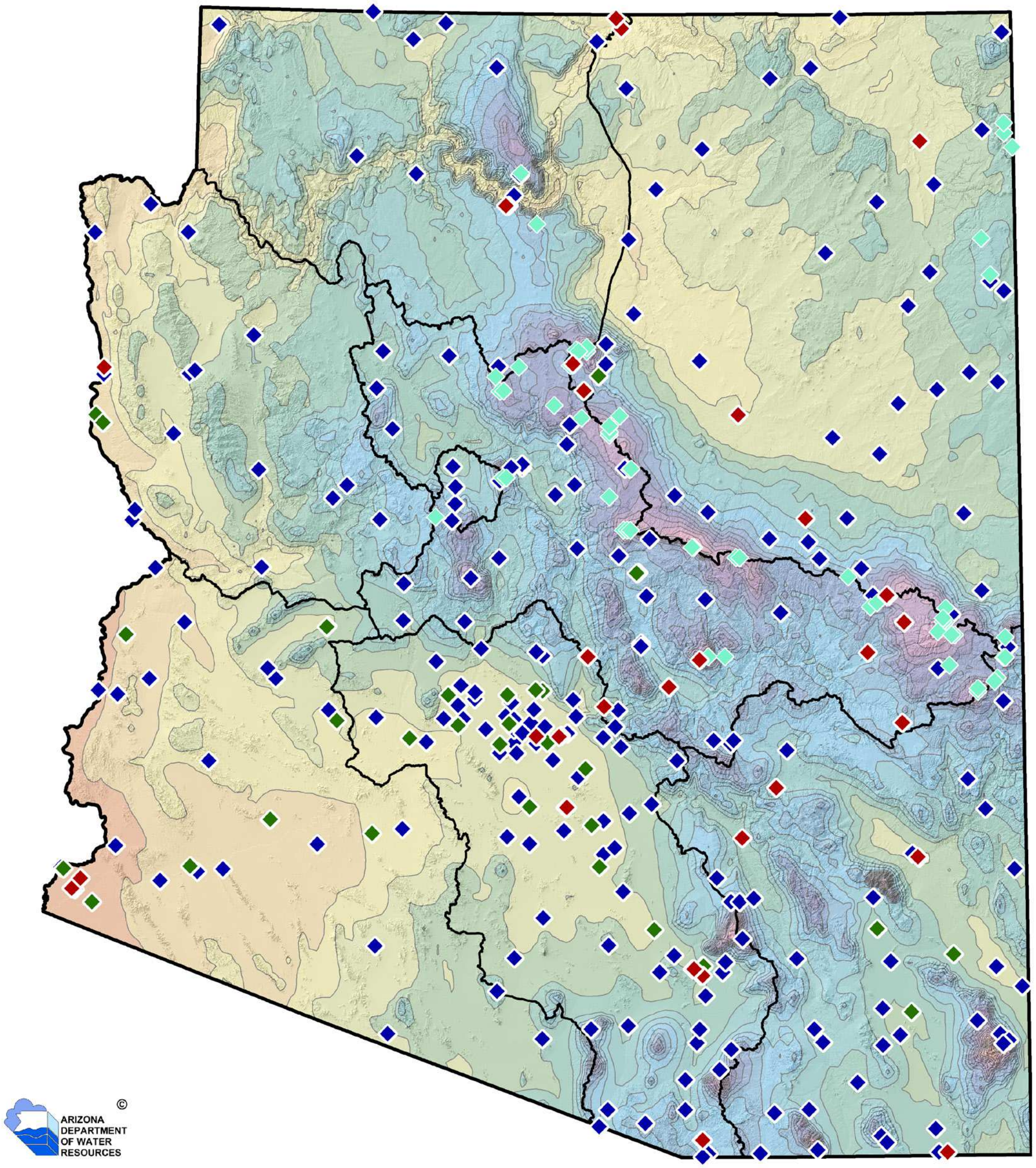
In addition to the perennial streams mentioned previously, non-effluent dependent perennial reaches in the planning area include: Seven Springs Wash and Camp, Cave, Sycamore, Queen and Arnett creeks in the Phoenix AMA; Sabino, Romero, Cienega and Rincon creeks in the east central part of the Tucson AMA; and Sonoita Creek in the Santa Cruz AMA. Seasonal and annual flows at gages on the Salt, Verde, Gila and Santa Cruz rivers are listed in Table 1-5. Of these, the largest mean flow was measured on the Salt River below Stewart Mountain Dam at almost 711,300 AFA. There are a total of 16 large reservoirs in the planning area. Relatively few major springs (13) have been identified with most located in the Tucson AMA. The largest spring is Del Rio Spring in the northern part of the Prescott AMA with a discharge of 874 gpm.

1.4.3 Climate

Climate is a critical factor in water resource planning and management. A more detailed discussion of Arizona's climate is found in Appendix E. Arizona's climate can be characterized by five features: warm temperatures, aridity, and strong seasonality, year-to-year (interannual) variability and decade-to-decade persistence in precipitation. Elevational differences result in significant climate variability across the state. State precipitation variability and the location of meteorological stations are shown in Figure 1-14. Data for these stations and precipitation maps are presented in Volumes 2-8 for each basin.

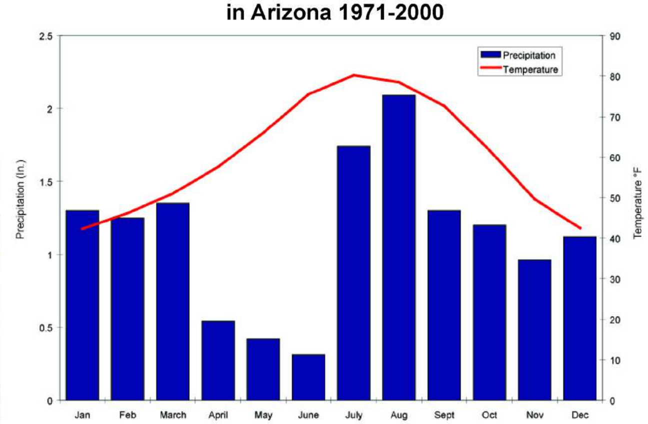
Precipitation in Arizona is characterized by two distinct precipitation seasons: the summer "monsoon" season, generally from July to mid-September and a winter season from November through mid-April (Figure 1-15). Winter precipitation is more hydrologically effective than summer precipitation because it is more widespread, is generally of low intensity and long duration, coincides with cooler temperatures and lower evaporation rates and, when stored as

Figure 1-14
Arizona Meteorologic Stations and Average Precipitation and Temperature



Precipition Data Source: Oregon State University, 1998

Average Monthly Temperatures and Precipitation in Arizona 1971-2000



Data Source: National Climatic Data Center, 2001

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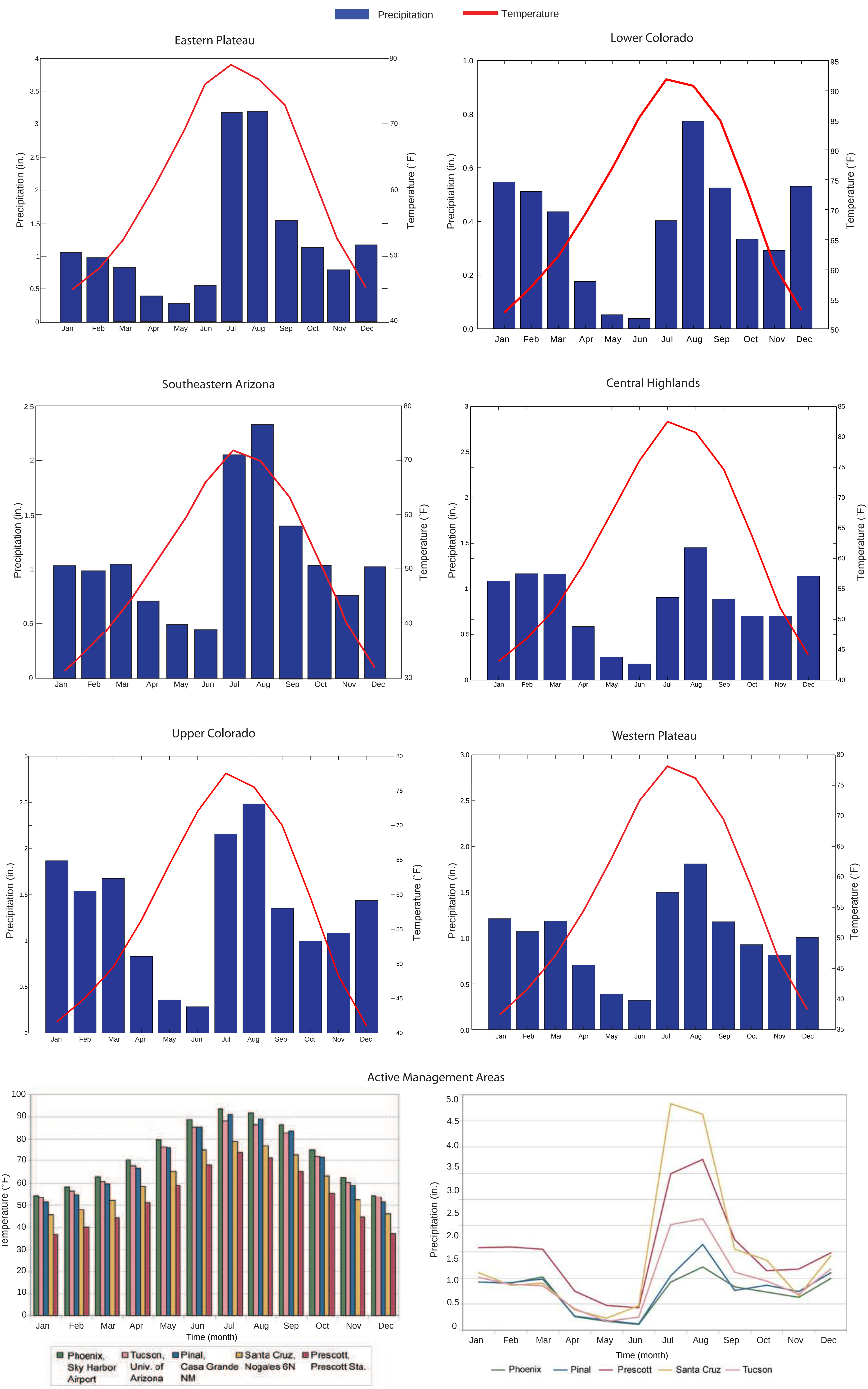
Figure 1-15 Average Monthly Precipitation and Temperature by Planning Area, 1971-2000



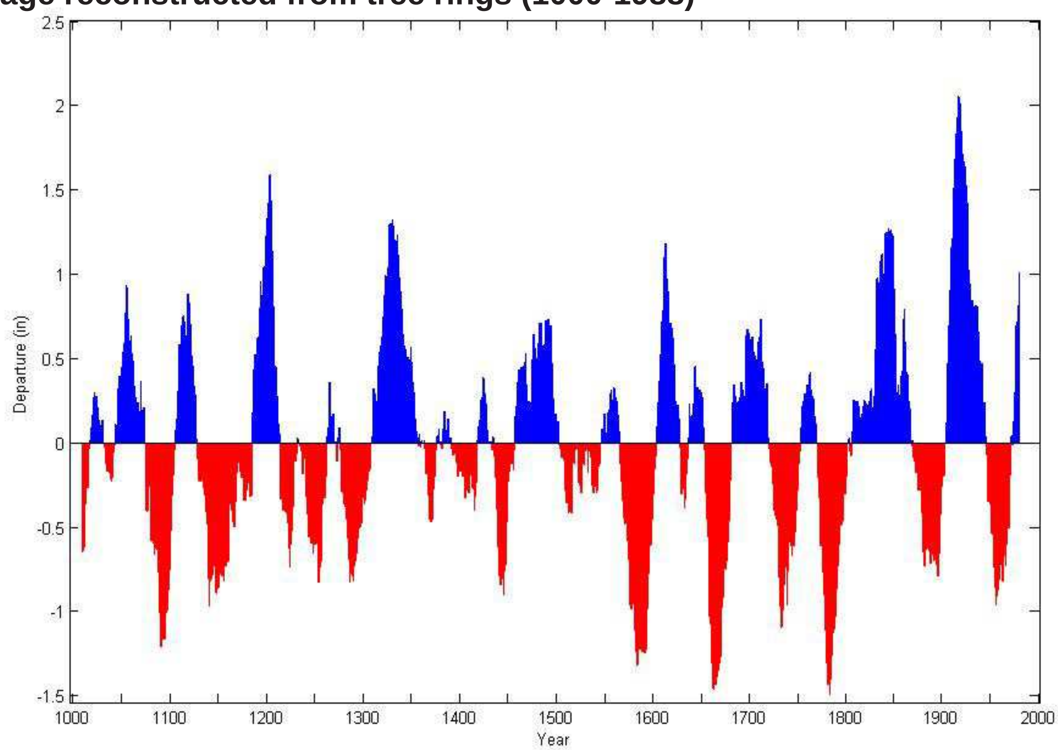
Source: WRCC 2008
Non-AMA figures by CLIMAS

snow, is released gradually, resulting in greater infiltration. Summer rainfall is more localized, of higher intensity and short duration and subject to high evaporation rates.

Arizona's precipitation is also characterized by a high degree of year-to-year variation. The strongest influence on interannual climate and weather variations in Arizona is the El Niño-Southern Oscillation (ENSO), a multi-season to multi-year variation in equatorial Pacific Ocean temperatures and associated atmospheric circulation. Decadal-scale Pacific Ocean circulation persistence can result in long-term drought, which can significantly reduce water supplies as demonstrated in the extremely dry conditions between 1999 and 2005 and during the 1950s. When these sustained circulation patterns are characterized by warm tropical Pacific Ocean temperatures, the result can be above average precipitation such as the post-1976 wet period which lasted until approximately 1998. Precipitation reconstructed from tree-ring records show dry episodes longer and more severe than any that have occurred during the last 100 years. Notable multi-year droughts occurred in almost every century over the last 1,000 years (Figure 1-16).

Temperature and associated evapotranspiration rates also vary widely across Arizona. Average daily temperatures range from the mid 90's (˚F) below 500 feet elevation to the high 50's at elevations above 8,000 feet. A significant feature of Arizona temperature records since 1930 is the trend toward increasing temperatures during the last 30-40 years (Figure 1-17). In some regions, increased temperatures are due primarily to the urban heat island effect from heat-retaining paved areas and buildings replacing desert landscapes in major urban areas. Temperatures in rural communities have also increased, though not at the same rate and not in every town. High temperatures typically result in higher cultural

Figure 1-16 Arizona winter (November-April) precipitation departures from average reconstructed from tree rings (1000-1988)

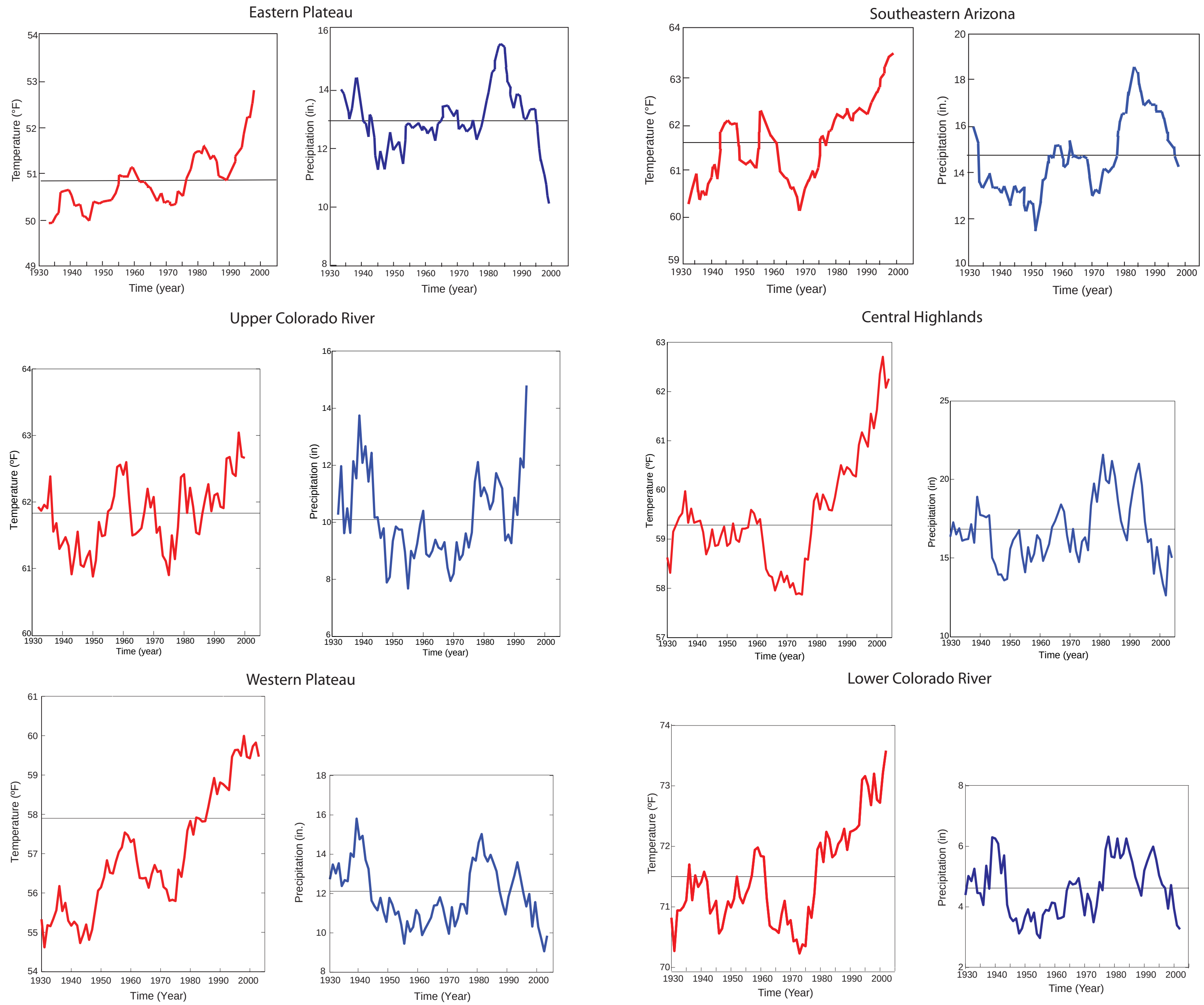


Data are presented as a 20-year moving average (e.g. the value for 1951 is the average of 1942-1961) to show variability on decadal time scales. Average precipitation for the period is 5.8 in. annually. Source: University of Arizona Laboratory of Tree-Ring Research and CLIMAS.

Figure 1-17 Average Water-Year Temperature and Total Precipitation by Planning Area, 1930-2002 (excludes the AMAs)

Temperature
- 1930-2002 average
- 5-year running average

Precipitation
- 1930-2002 average
- 5-year running average



Source: WRCC 2008
Modified from CLIMAS figures

water demands and increased evaporation and evapotranspiration rates.

1.4.4 Environmental Conditions

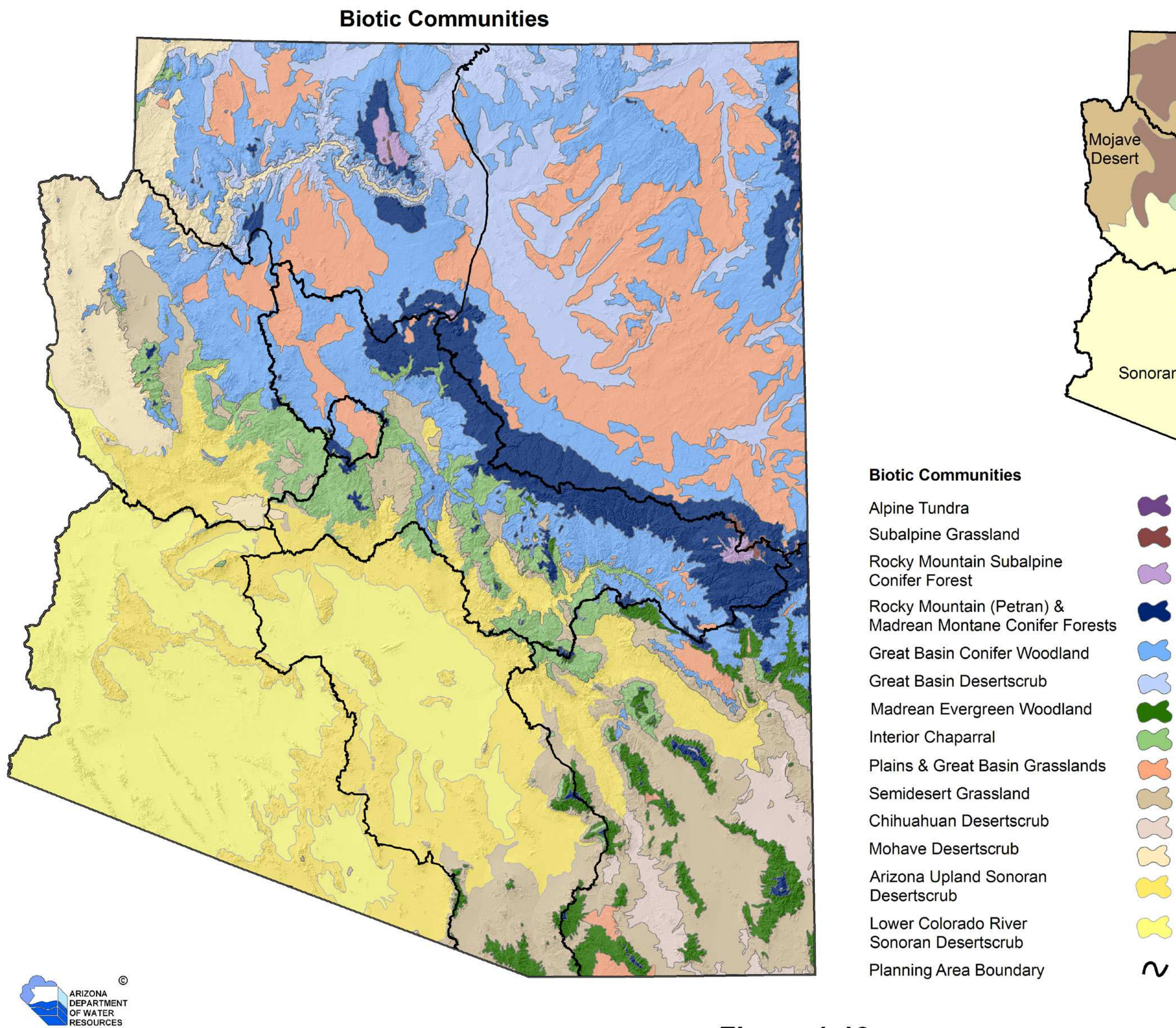
Environmental conditions reflect the geography, climate and cultural activities in an area and may be a critical consideration in water resource planning, management and development. Among conditions that should be considered are biotic communities (Figure 1-18), riparian habitat and restoration activities, instream flow claims, threatened and endangered species, protected areas such as parks, monuments and wilderness areas, and unique and managed waters. Maps, tables and a discussion of environmental conditions specific to each planning area are included in Volumes 2-8.

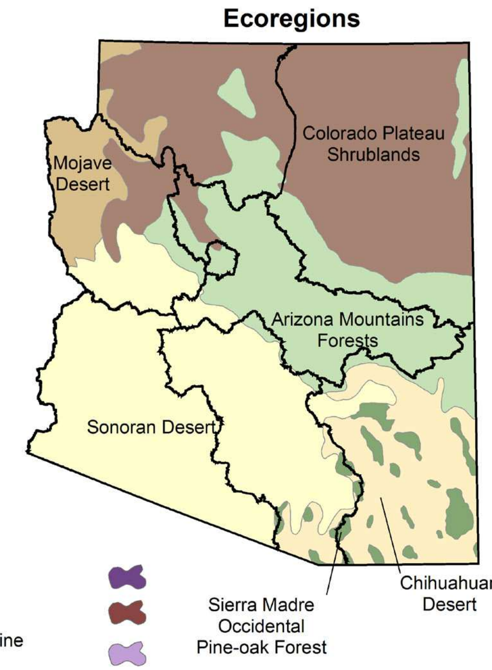
Vegetation type reflects climate and geography and has varying sensitivity to drought, disease and wildfire as well as water demand via evapotranspiration. A number of areas of the state experienced high pinon and ponderosa pine tree mortality in the early 2000s due to a combination of severe drought, high tree densities and a subsequent bark beetle infestation. Wildfire risk increases with the number of dead trees, which provide fuel. Several major wildfires occurred during the severe drought years between 2002 and 2005, including Arizona's largest fire in recorded history, the Rodeo-Chediski that consumed about 462,000 acres in the Central Highlands and Eastern Plateau planning areas. In areas severely burned, peak stream flows after the fire were substantially greater than previously measured, in part due to reduction in rainfall infiltration when surface organic matter is burned. Increased peak flows can degrade stream channels, increase sediment production and cause flood damage (Neary and others, 2003).

A vegetation type of considerable concern in Arizona is riparian vegetation. The Arizona Water Protection Fund (AWPF) program provides funds for protection and restoration of Arizona's rivers and streams and associated riparian habitat. The general location of riparian vegetation adjacent to perennial streams and AWPF grants is shown on Figure 1-19. As of fiscal year 2008, 164 AWPF grants had been issued. A complete list of the grants keyed to a map is presented in Appendix F. Also shown on Figure 1-19 are instream flow water right claims. An instream flow right is a non-diversionary appropriation of surface water for recreation and wildlife use. As of 2008, 69 applications were pending, and 37 certificates and one permit had been issued.

AWPF site in the Eastern Plateau Planning Area

The presence of a listed threatened and endangered species pursuant to the Endangered Species Act (ESA) may be an important consideration in water resource management in a particular area. For example, the Roosevelt Habitat Conservation Plan was developed to minimize and mitigate the impacts from operating Roosevelt Dam and Lake on several endangered species including the southwestern willow flycatcher. The plan includes acquisition and protection of riparian habitat along the San Pedro, Verde and Gila rivers, and other river systems, and other conservation measures to protect habitat. In the Upper San Pedro Basin, Fort Huachuca's Biological Opinion regarding protection of several endangered species makes Fort Huachuca responsible for both direct and indirect effects of its actions, including water





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

Figure 1-13
Arizona Biotic Communities and Ecoregions

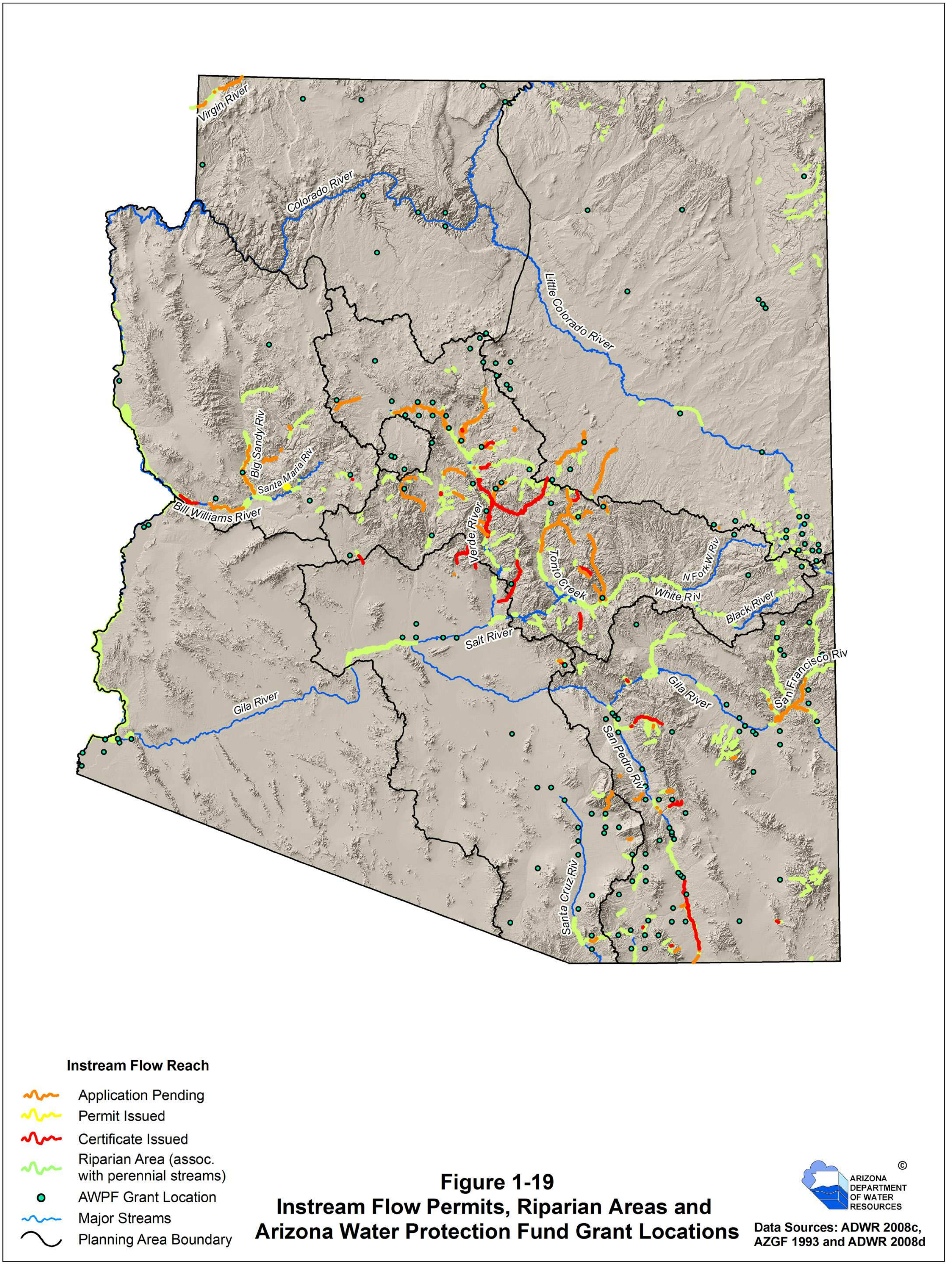


Figure 1-19
Instream Flow Permits, Riparian Areas and Arizona Water Protection Fund Grant Locations

LCR MSCP mitigation site in the Lower Colorado River Planning Area

use in the community related to the Fort. The Defense Authorization Act of 2004, Public Law 108-136, Section 321, stipulates how Section 7 of the ESA applies to Fort Huachuca and directs the Secretary of the Interior to prepare reports (through the Upper San Pedro Partnership) to Congress on steps to reduce the overdraft and restore the sustainable yield of groundwater in the Sierra Vista Subwatershed by 2011.

To comply with the requirements of the ESA, state and federal water, power and wildlife interests created the Lower Colorado River Multi-Species Conservation Program (LCR MSCP). The LCR MSCP is a cooperative, habitat conservation program that identifies specific measures to address the needs of 26 threatened, endangered and other species that rely on habitat associated with the lower Colorado River (US-DOI, 2004). The Pima County MSCP is another example of a large scale plan to comply with the "take" provisions of the ESA and is part of a larger planning effort known as the Sonoran Desert Conservation Plan, which covers 5.9 million acres in Pima County.[2] The plan directs growth to areas with the least natural, historic, and cultural resource values as well as sets aside sensitive habitat through land acquisitions. (Pima County, 2006)

Protected areas such as national parks, monuments, wilderness areas, preserves and wildlife refuges exclude large scale water development within their boundaries. These areas are identified in each planning area volume and may represent a substantial amount of land within a basin or planning area (See Table 1-2).

The Arizona Department of Environmental Quality (ADEQ) has designated nineteen "unique waters" in the state that have exceptional recreational or ecological significance and/or provide habitat for threatened or endangered species. These include portions of Aravaipa and Bonita creeks in the Southeastern Arizona Planning Area, Oak Creek in the Verde River Basin and a number of streams in the White Mountains. No degradation of a unique water is allowed under the ADEQ Surface Water Quality Standards rules.

Other "managed" waters in Arizona include Fossil Creek and a portion of the Verde River in the Central Highlands Planning Area designated as Wild and Scenic Rivers. Flows of Arizona's major rivers (the Colorado, Salt, Verde and Gila rivers) are impounded behind dams and managed for electrical generation purposes and to store water to meet downstream flow obligations pursuant to decrees, settlements and interstate compacts. These actions have fundamentally altered flow regimes and ecosystems along these river systems.

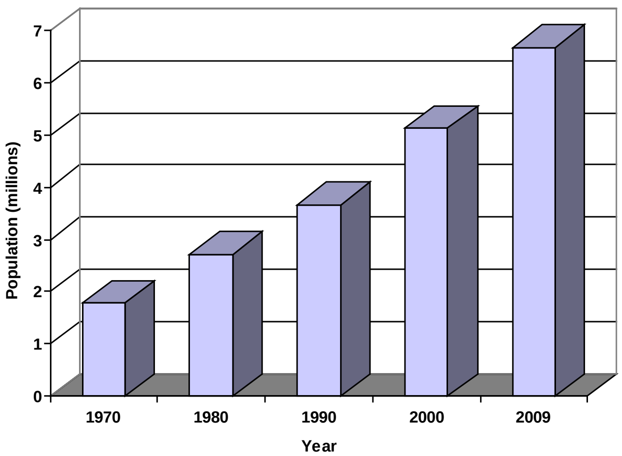
Aravaipa Creek, Southeastern Arizona Planning Area.

[2] As defined in the ESA, to take means to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in other conduct." 16 U.S.C. section 1531 [18].

1.4.5 Population

Arizona is the nation's second fastest growing state, growing at a rate of about 3% per year. Growth from 1970 to 2009 is shown in Figure 1-20. Arizona grew by about 1 million residents per decade between 1970 and 1990, and then grew from 3.6 million to 5.1 million inhabitants, a 40% increase, in the decade from 1990 to 2000. Although the annual growth rate has recently slowed to about 2%, by July 2009, population had increased by 1.58 million people, a 30.3% increase since the 2000 census (ADOC, 2009).

Figure 1-20 Arizona Population 1970-2009



Between 2000 and 2009, Pinal County grew 98.2%, the most rapid of any county in Arizona. During that time period some rural Arizona counties – Yavapai, Mohave and Yuma, grew at rates comparable to that of Maricopa County, which contains the rapidly growing Phoenix metropolitan area (ADOC, 2009). Table 1-6 lists historic and projected planning area and groundwater basin population. While most planning areas show substantial growth, the AMA planning area growth rate continues to outpace the rest of the state with a projected 85% of the state's population in 2030, an increase from 78% in 1980.

Rapid population growth and drought conditions can have significant impacts on water supplies and infrastructure in some areas. Figure 1-21 and Table 1-7 identify Arizona communities with population growth greater than 2% per year between the 2000 Census and the Department of Commerce 2009 estimate.[3] The highest growth rates and greatest concentration of high growth rate communities are located in the AMAs, particularly in smaller communities near larger cities. It should be noted that some high growth rates may be due in part to annexation of unincorporated land with its associated population. This is the case with the town of Marana in the Tucson AMA. Although some incorporated cities, such as Sierra Vista, did not experience more than a 3% annual growth rate, unincorporated areas adjacent to them grew rapidly.

Population Growth and Water Use

The state has limited mechanisms to address the connection between land use, population growth and water supply. The Growing Smarter Plus Act of 2000 (Act) links growth and water management planning by requiring counties with a population greater than 125,000 (2000 Census) to include water resources planning in their comprehensive plans. These counties include Maricopa, Mohave, Pima, Pinal, Yavapai

Main Street Yuma, Lower Colorado River Planning Area. In 2005, the Arizona Legislature passed House Bill 2277, expanding water use reporting and planning statewide.

[3] For some communities the estimates for 2009 show less population than previous estimates for 2006, which are presented in Atlas Volumes 2-8. These declines reflect adjustments to growth rates used to generate estimates, not an actual decline in population.

Table 1-6 Planning area and basin historic and projected population

Basin	1980	1985	1990	1995	2000	2005	2010	2020	2030
Eastern Plateau									
Little Colorado River	175,451	192,452	209,454	229,649	249,545	274,386	299,227	343,049	378,392
Sub-total	**175,451**	**192,452**	**209,454**	**229,649**	**249,545**	**274,386**	**299,227**	**343,049**	**378,392**
Southeastern Arizona									
Aravaipa Canyon	74	101	129	132	135	140	144	151	159
Bonita Creek	5	13	20	21	21	23	24	26	28
Cienega Creek	1,695	2,178	2,662	3,508	4,355	4,880	5,404	6,672	7,820
Donnelly Wash	27	68	109	137	165	185	205	245	285
Douglas	16,600	20,397	24,193	25,207	26,220	28,911	31,609	37,790	41,800
Dripping Springs Wash	329	273	217	196	175	186	197	220	288
Duncan	3,225	3,151	3,077	3,417	3,757	3,683	3,609	3,610	3,655
Lower San Pedro	19,300	17,599	15,898	15,707	15,515	18,710	21,905	29,180	34,736
Morenci	8,620	6,940	5,260	5,200	5,141	5,066	4,990	5,021	5,113
Safford	27,638	29,293	30,948	36,614	42,281	45,110	47,938	52,282	56,570
San Bernardino Valley	20	51	83	74	66	74	82	95	105
San Rafael	143	140	137	142	147	158	169	177	182
Upper San Pedro	50,999	57,079	63,159	70,586	78,013	87,671	97,329	113,044	125,700
Willcox	9,064	9,418	9,773	11,063	12,354	13,862	15,369	16,973	18,237
Sub-total	**137,739**	**146,701**	**155,665**	**172,004**	**188,345**	**208,659**	**228,974**	**265,486**	**294,678**
Upper Colorado River									
Big Sandy	434	490	546	844	1,142	1,423	1,704	2,166	2,541
Bill Williams	5,532	4,835	4,138	4,414	4,691	5,482	6,272	7,068	7,700
Detrital	757	853	949	1,161	1,373	2,142	2,910	3,628	4,212
Hualapai Valley	11,361	15,660	19,960	28,752	37,544	40,539	43,533	55,261	64,789
Lake Havasu	17,487	21,932	26,377	35,484	44,591	56,192	67,792	89,215	106,614
Lake Mohave	13,653	22,152	30,651	41,100	51,549	58,404	65,259	79,878	91,747
Meadview	104	278	453	637	823	1,000	1,176	1,495	1,755
Peach Springs	1,804	1,384	965	1,372	1,780	2,228	2,676	3,391	3,969
Sacramento Valley	7,245	8,910	10,575	14,075	17,575	22,192	26,808	34,099	40,020
Sub-total	**58,377**	**76,494**	**94,614**	**127,839**	**161,068**	**189,599**	**218,130**	**276,201**	**323,347**
Central Highlands									
Agua Fria	2,839	4,076	5,313	6,762	8,210	10,389	12,568	16,104	19,135
Salt River Valley	27,318	27,995	28,671	28,864	29,057	30,299	31,541	33,978	36,094
Tonto Creek	1,934	3,275	4,615	6,295	7,975	9,032	10,088	12,641	14,538
Upper Hassayampa	6,050	7,056	8,062	9,270	10,479	11,414	12,348	15,072	18,362
Verde River	36,049	46,269	56,489	72,899	89,309	101,898	114,487	138,296	155,456
Sub-total	**74,190**	**88,671**	**103,150**	**124,090**	**145,030**	**163,032**	**181,032**	**216,091**	**243,585**
Western Plateau									
Coconino Plateau	6,977	7,349	7,722	8,443	9,164	11,525	13,886	16,081	17,500
Grand Wash	10	11	12	14	15	15	15	15	15
Kanab Plateau	2,815	3,664	4,513	5,222	6,233	8,077	9,921	12,552	14,688
Paria	237	362	487	521	528	547	566	637	695
Shivwits Plateau	4	6	8	10	12	12	12	12	12
Virgin River	99	150	200	866	1,532	1,860	2,188	2,783	3,267
Sub-total	**10,142**	**11,542**	**12,942**	**15,076**	**17,485**	**22,036**	**26,588**	**32,080**	**36,177**
Lower Colorado River									
Butler Valley	5	8	10	13	15	15	15	15	16
Gila Bend	3,437	3,262	3,087	3,672	4,256	6,415	8,573	10,268	15,392
Harquahala	359	590	821	715	608	780	951	1,697	2,443
Lower Gila	9,873	9,571	9,270	10,283	11,297	12,594	13,890	17,192	20,967
McMullen Valley	280	853	1,427	2,426	3,426	3,991	4,555	5,696	6,945
Parker	11,339	11,634	11,928	14,042	16,155	17,137	18,119	20,037	21,775
Ranegras Plain	1,024	802	581	743	905	978	1,050	1,128	1,198
San Simon Wash	4,852	5,488	6,124	5,980	5,837	7,119	8,400	10,622	13,646
Tiger Wash	<10	<10	<10	<10	<10	<10	<10	<10	<10
Western Mexican Drain	10	15	20	27	33	38	42	51	59
Yuma	73,319	87,337	101,355	127,141	152,928	181,600	210,272	261,091	305,904
Sub-total	**104,498**	**119,560**	**134,622**	**165,042**	**195,460**	**230,664**	**265,867**	**327,797**	**388,345**
Active Management Areas									
Phoenix AMA	1,471,074	1,855,960	2,150,726	2,571,732	3,118,049	3,650,464	4,341,229	5,561,461	6,763,848
Pinal AMA	40,956	52,997	62,423	74,494	99,143	136,130	212,699	464,909	624,128
Prescott AMA	35,641	44,112	54,917	68,634	90,061	112,359	137,244	176,560	217,862
Santa Cruz AMA	18,728	20,911	27,747	31,950	37,049	47,201	49,101	60,706	70,343
Tucson AMA	510,609	573,864	654,576	766,720	835,504	952,670	1,059,194	1,285,487	1,488,999
Sub-total	**2,077,008**	**2,547,844**	**2,950,389**	**3,513,530**	**4,179,806**	**4,898,824**	**5,799,467**	**7,549,123**	**9,165,180**
Total	**2,637,405**	**3,183,264**	**3,660,836**	**4,347,230**	**5,136,738**	**5,987,200**	**7,019,285**	**9,009,827**	**10,829,704**

Source: ADWR, 2009

Table 1-7 High growth communities in Arizona[1]`

Map Key & Rank	City/Town	2009 Estimated Population	2000 Census Population	Percent Change 2000-2009	Average Annual Percent Change
1	Maricopa City	39,429	1,482	2561%	285%
2	Sahuarita	24,968	3,242	670%	74%
3	Buckeye	52,764	8,497	521%	58%
4	Queen Creek	25,429	4,316	489%	54%
5	El Mirage	33,610	7,609	342%	38%
6	Surprise	109,482	30,848	255%	28%
7	Goodyear	61,916	18,911	227%	25%
8	Marana	34,191	13,556	152%	17%
9	Youngtown	6,513	3,010	116%	13%
10	Avondale	76,900	35,883	114%	13%
11	Gilbert	217,521	109,697	98%	11%
12	Eloy	19,005	10,375	83%	9%
13	Casa Grande	45,993	25,224	82%	9%
14	San Luis	27,629	15,322	80%	9%
15	Florence	25,794	14,466	78%	9%
16	Chino Valley	13,080	7,835	67%	7%
17	Prescott Valley	38,958	23,535	66%	7%
18	Somerton	11,713	7,266	61%	7%
19	Show Low	12,368	7,695	61%	7%
20	Coolidge	12,159	7,786	56%	6%
21	Dewey-Humboldt[2]	4,499	3,613	25%	6%
22	Oro Valley	43,521	29,700	47%	5%
23	Peoria	158,712	108,364	46%	5%
24	Kingman	29,189	20,069	45%	5%
25	Thatcher	5,819	4,022	45%	5%
26	Taylor	4,526	3,176	43%	5%
27	Star Valley[3]	2,169	1,536	41%	5%
28	Cave Creek	5,208	3,728	40%	4%
29	Tolleson	6,923	4,974	39%	4%
30	Chandler	245,087	176,581	39%	4%
31	Carefree	3,958	2,927	35%	4%
32	Litchfield Park	5,122	3,810	34%	4%
33	Pinetop-Lakeside	4,758	3,582	33%	4%
34	Lake Havasu City	55,502	41,938	32%	4%
35	Wellton	2,363	1,829	29%	3%
36	Fountain Hills	26,107	20,235	29%	3%
37	Saint Johns	4,208	3,269	29%	3%
38	Prescott	43,573	33,938	28%	3%
39	Wickenburg	6,451	5,082	27%	3%
40	Payson	17,242	13,620	27%	3%
41	Douglas	17,758	14,312	24%	3%
42	Snowflake	5,528	4,460	24%	3%
43	Flagstaff	65,522	52,894	24%	3%
44	Sierra Vista	46,597	37,775	23%	3%
45	Bullhead City	41,609	33,769	23%	3%
46	Pima	2,442	1,989	23%	3%
47	Camp Verde	11,603	9,451	23%	3%
48	Cottonwood	11,190	9,179	22%	2%
49	Yuma	94,361	77,515	22%	2%
50	Colorado City	4,033	3,334	21%	2%
51	Scottsdale	243,501	202,705	20%	2%
52	Eagar	4,814	4,033	19%	2%
53	Phoenix	1,575,423	1,321,045	19%	2%
54	Apache Junction	37,864	31,814	19%	2%

Source: ADOC, 2009
[1] High growth = community with greater than 2% average annual population increase between 2000-2009. Average annual percent increase for Arizona during 2000-2009 was 3%.
[2] Dewey-Humboldt was incorporated in 2004; population shown is 2005 estimated census population and percent change is between 2005-2009.
[3] Star Valley was incorporated in 2005; 2000 census data is for the Star Valley (Sun Valley) Census Designated Place.

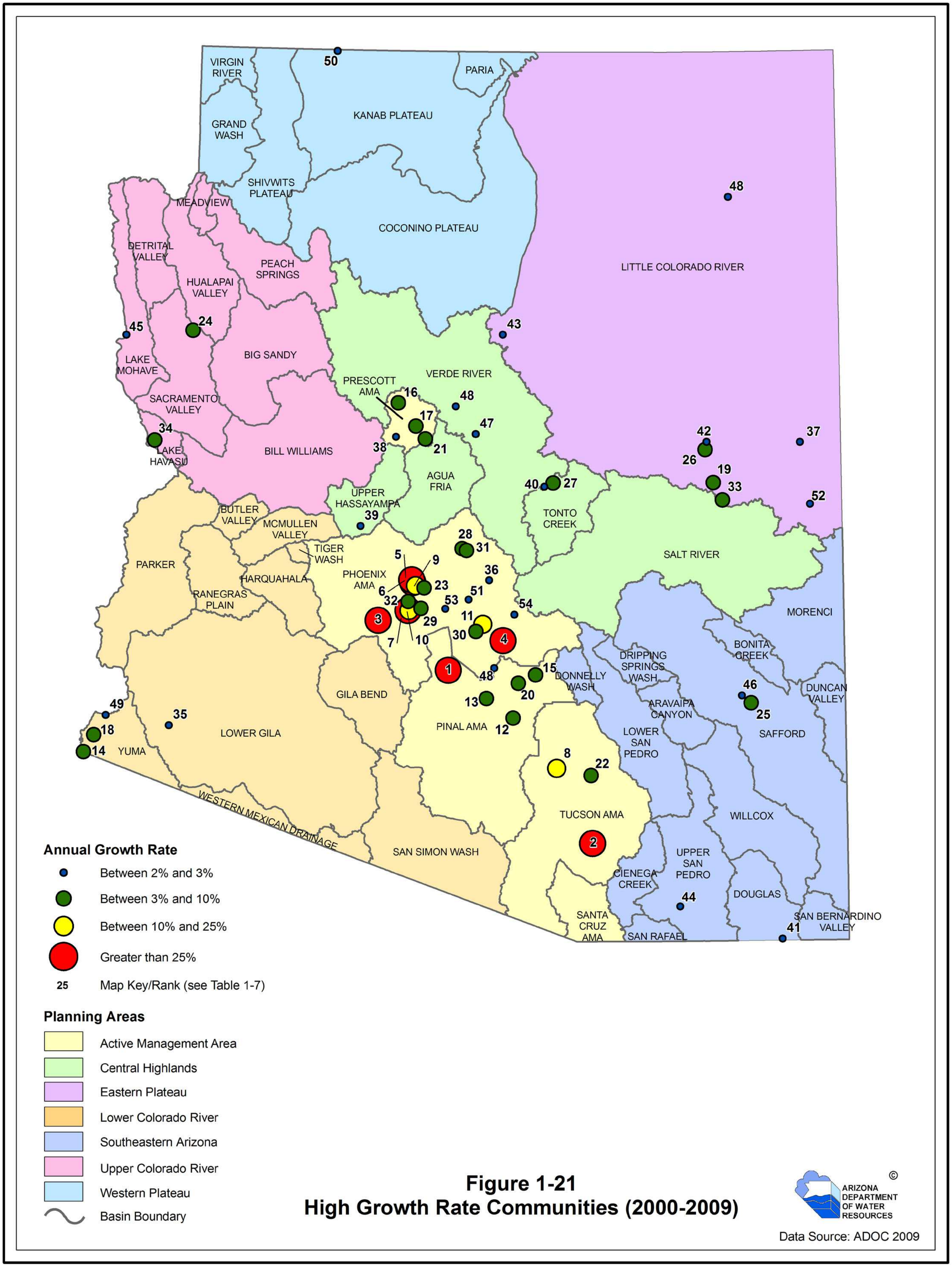


Figure 1-21
High Growth Rate Communities (2000-2009)

and Yuma. The Act also required that 53 communities include a water resources element in their general plans. Brief discussion and references to completed plans are listed in Volumes 2-8 of the Atlas.

In 2005, the Arizona Legislature passed House Bill 2277, (A.R.S. 45 § 331-343), which expanded water use reporting and planning statewide and now requires all community water systems[4] to submit a Water System Plan that includes a Water Supply Plan, a Drought Preparedness Plan and a Water Conservation Plan. It also requires all community water systems to submit an annual report of water withdrawals, diversions and deliveries. 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. Annual water report information and a list of water plans are found in Appendices of Volumes 2-8 of the Atlas.

The Assured and Adequate Water Supply programs relate growth to water supply and demand to some extent but do not control growth or the location of growth if the demonstration criteria are met. These programs are discussed in Section 1.2, in Appendix C and in each of the planning area volumes which contain maps and tables of all assured and adequate water supply determinations at the basin and planning area level. Table 1-8 summarizes water adequacy determinations, which apply outside of the AMAs. As mentioned previously, in most non-AMA areas of the state, lots may be sold without an adequacy determination, but there must be disclosure to the initial buyer if the subdivision water supply is inadequate. Many applicants request an inadequate determination because the law does not prohibit development, it simply re-

Table 1-8 Adequacy determinations outside of the AMAs

Planning Area	Subdivisions		Lots with Inadequate Determinations	
	Total	Number of Lots[1]	Number	Approx. Percent
Eastern Plateau	304	18,790	8,687	46%
Southeastern Arizona	293	>32,258	>8,881	28%
Upper Colorado River	409	>68,823	>23,454	34%
Central Highlands	552	>40,617	>12,983	32%
Western Plateau	86	5,409	2,235	41%
Lower Colorado River	348	>36,942	>3,218	9%
Total	**1,992**	**>202,839**	**>59,458**	**29%**

Percent of Lots with Inadequacy Determinations by Reason [2]

Planning Area	Physical/Continuous				Physical/Continuous plus			Legal[7]	Water Quality	Legal & Water Quality	Unable to locate records
	Insufficient Data[3]	Insufficient Supply[4]	Insufficient Infrastructure[5]	Multiple[6]	Legal	Water Quality	Legal & Water Quality				
Eastern Plateau	74.2%	5.3%	0.7%	7.9%		0.7%		0.7%	4.0%		6.0%
Southeastern Arizona	42.9%	1.0%			2.0%	6.1%		36.7%	5.1%		5.1%
Upper Colorado River	51.4%	4.7%		35.5%			1.9%	1.9%	0.9%		3.7%
Central Highlands	54.9%	6.1%		24.4%	1.4%	4.2%		0.9%	5.6%	0.5%	1.9%
Western Plateau	62.3%	3.3%	8.2%	18.0%	1.6%				1.6%		4.9%
Lower Colorado River	61.8%	1.8%				5.5%		5.5%	18.2%		7.3%

Source: ADWR 2008e
[1] Data on number of lots are missing for some subdivisions; actual number is larger.
[2] Each determination of the adequacy of water supplies available to a subdivision is based on the information available to ADWR and the standards of review and policies in effect at the time the determination was made. In some cases, ADWR might make a different determination if a similar application were submitted today, based on the hydrologic data and other information currently available, as well as current rules and policies.
[3] Applicant chose not to submit necessary information, and/or available hydrologic data was insufficient to make determination.
[4] Existing water supply unreliable or physically unavailable; for groundwater, depth-to-water exceeds criteria.
[5] Distribution system is insufficient to meet demands or applicant proposed water hauling.
[6] Multiple Physical/Continuous reasons cited.
[7] Applicant failed to demonstrate a legal right to use the water or failed to demonstrate the provider's legal authority to serve the subdivision.

[4] Community water system is defined as a public water system that serves at least 15 service connections used by year-round residents or that regularly serves at least 25 year-round residents. A.R.S. § 45-341

Table 1-9 Assured water supply applications in the AMAs

	Assured Water Supply			Water Adequacy Reports (# of Subdivisions)
	Certificates (# of Subdivisions)	Analyses	Designations	
Phoenix AMA	1,118	61	15	208
Pinal AMA	214	19	5	16
Prescott AMA	104	2	1	8
Santa Cruz AMA	34	6	2	32
Tucson AMA	230	16	9	90
Total	**1,700**	**104**	**32**	**354**

Source: ADWR 2008e

quires disclosure. The reason for an inadequacy determination may range from an actual deficiencies in one of the criteria or failure of the developer to submit required information. To distinguish between an actual inadequacy and a failure to comply, Table 1-8 includes the number of different types of inadequacy determinations. Insufficient data was the primary reason for an inadequate determination in all planning areas.

Table 1-9 lists the number of different applications approved under the assured water supply program. Certificates of AWS are issued for subdivisions that meet the AWS criteria. An Analysis of AWS is generally used to prove that water will be physically available for master planned communities but may be used to demonstrate other criteria required for a Certificate of AWS. "Designated" water providers have demonstrated an AWS for their entire service area. Because the Adequate Water Supply program was in effect in the planning area prior to 1980, some Water Adequacy Reports issued for older developments in the AMAs exist. Figure 1-22 shows the location of` assured and adequate water supply determinations across the State. Table 1-10 lists all designated water providers keyed to Figure 1-22.

Table 1-10 Designated water providers in Arizona as of May 2010

Map Key	Water Provider Name	Planning Area	Groundwater Basin	County	Designation		
					Number	Type	Issue Date
1	American Ranch DWID	Central Highlands	Verde River	Yavapai	40-400437.0000	Adequate	3/14/2002
2	Apache Junction Water Utilities Communities Facilities District	AMA	Phoenix	Pinal	26-400989.0000	Assured	2/1/2005
3	Arizona Water Co - Pinetop/ Lakeside	Eastern Plateau	Little Colorado River Plateau	Navajo	40-900000.0000	Adequate	10/25/1973
4	Baca Float Water Company	AMA	Santa Cruz	Santa Cruz	26-400800.0000	Assured	11/17/2004
5	Bachmann Springs Utility Company	Southeastern Arizona	Upper San Pedro	Cochise	40-401893.0000	Adequate	7/5/2006
6	Beaver Dam Water Company	Western Plateau	Virgin River	Mohave	40-700494.0000	Adequate	11/10/2009
7	Big Park Water Company	Central Highlands	Verde River	Yavapai	41-400325.0001	Adequate	5/7/2009
8	Camp Verde Water System, Inc	Central Highlands	Verde River	Yavapai	40-700446.0000	Adequate	4/15/2008
9	Cerbat Water Company	Upper Colorado	Hualapai Valley	Mohave	40-300106.0000	Adequate	7/14/1998
10	Chaparral City Water Company	AMA	Phoenix	Maricopa	26-401242.0000	Assured	2/11/2004
11	City of Avondale	AMA	Phoenix	Maricopa	86-002003.0001	Assured	2/4/2008
12	City of Benson	Southeastern Arizona	Upper San Pedro	Cochise	41-401803.0001	Adequate	7/14/2008
13	City of Bullhead City	Upper Colorado	Lake Mohave	Mohave	41-400649.0001	Adequate	2/11/2008
14	City of Chandler	AMA	Phoenix	Maricopa	86-002009.0001	Assured	6/4/2009
15	City of Cottonwood	Central Highlands	Verde River	Yavapai	40-700578.0000	Adequate	4/27/2009
16	City of Douglas	Southeastern Arizona	Douglas	Cochise	40-900001.0000	Adequate	5/17/1973

Table 1-10 Designated water providers in Arizona as of May 2010 (cont)

Map Key	Water Provider Name	Planning Area	Groundwater Basin	County	Designation		
					Number	Type	Issue Date
17	City of El Mirage	AMA	Phoenix	Maricopa	26-400054.0000	Assured	11/2/1999
18	City of Eloy	AMA	Pinal	Pinal	26-402148.0000	Assured	2/20/2007
19	City of Flagstaff	Eastern Plateau	Little Colorado River Plateau	Coconino	40-900002.0000	Adequate	5/17/1973
20	City of Glendale	AMA	Phoenix	Maricopa	26-002018.0000	Assured	9/25/1997
21	City of Globe	Central Highlands	Salt River	Gila	40-900003.0000	Adequate	5/15/1973
22	City of Goodyear	AMA	Phoenix	Maricopa	26-402090.0000	Assured	1/27/2008
23	City of Holbrook	Eastern Plateau	Little Colorado River Plateau	Navajo	40-900005.0000	Adequate	5/17/1973
24	City of Kingman	Upper Colorado	Hualapai Valley	Mohave	40-900007.0000	Adequate	5/17/1973
25	City of Lake Havasu City	Upper Colorado	Lake Havasu	Mohave	40-900008.0000	Adequate	6/18/1973
26	City of Mesa	AMA	Phoenix	Maricopa	26-002023.0000	Assured	9/19/1997
27	City of Nogales	AMA	Santa Cruz	Santa Cruz	26-401358.0000	Assured	4/19/2005
28	City of Page	Eastern Plateau	Little Colorado River Plateau	Coconino	40-900009.0000	Adequate	6/15/1973
29	City of Peoria	AMA	Phoenix	Maricopa	26-400679.0000	Assured	10/17/2002
30	City of Phoenix	AMA	Phoenix	Maricopa	26-002030.0000	Assured	12/31/1997
31	City of Prescott	AMA	Prescott	Yavapai	86-401501.0001	Assured	12/30/2009
32	City of Safford	Southeastern Arizona	Safford	Graham	40-900011.0000	Adequate	5/17/1973
33	City of Scottsdale	AMA	Phoenix	Maricopa	26-400619.0000	Assured	4/25/2002
34	City of Show Low	Eastern Plateau	Little Colorado River Plateau	Navajo	40-300412.0000	Adequate	4/15/1999
35	City of St. Johns	Eastern Plateau	Little Colorado River Plateau	Apache	40-900012.0000	Adequate	5/16/1973
36	City of Surprise	AMA	Phoenix	Maricopa	26-300431.0000	Assured	9/7/1999
37	City of Tempe	AMA	Phoenix	Maricopa	26-002043.0000	Assured	12/31/1997
38	City of Tucson	AMA	Tucson	Pima	26-400957.0000	Assured	6/12/2007
39	City of Willcox	Southeastern Arizona	Willcox	Cochise	40-900017.0000	Adequate	5/17/1973
40	City of Winslow	Eastern Plateau	Little Colorado River Plateau	Navajo	40-900018.0000	Adequate	5/17/1973
41	City of Yuma	Lower Colorado	Yuma	Yuma	40-900019.0000	Adequate	5/17/1973
42	Copper Mountain Communities Facilities District (City of Casa Grande)	AMA	Pinal	Pinal	26-400728.0000	Assured	7/21/2003
43	Empirita Water Company, LLC	Southeastern Arizona	Cienega Creek	Cochise	41-401435.0001	Adequate	12/10/2008
44	Flowing Wells Irrigation District	AMA	Tucson	Pima	26-700470.0000	Assured	4/14/2009
45	Golden Valley Water Improvement District	Upper Colorado	Sacramento Valley	Mohave	40-900004.0000	Adequate	7/13/1995
46	Havasu Heights Domestic Water Improvement Distr	Upper Colorado	Sacramento Valley	Mohave	40-700420.0000	Adequate	5/8/2008
47	Johnson Utilities L.L.C. - Phoenix	AMA	Phoenix	Pinal	86-400665.0001	Assured	1/2/2009
48	Johnson Utilities L.L.C. - Pinal	AMA	Pinal	Pinal	86-401382.0001	Assured	12/1/2008
49	Joshua Valley Utility Company	Upper Colorado	Sacramento Valley	Mohave	40-900006.0000	Adequate	7/26/1985
50	Little Park Water Company	Central Highlands	Verde Valley	Yavapai	41-400324.0001	Adequate	5/7/2009

Table 1-10 Designated water providers in Arizona as of May 2010 (cont)

Map Key	Water Provider Name	Planning Area	Groundwater Basin	County	Designation		
					Number	Type	Issue Date
51	Livco Water Company	Eastern Plateau	Little Colorado River Plateau	Apache	40-700641.0000	Adequate	4/8/2010
52	Metro Water District - West	AMA	Tucson	Pima	26-401922.0000	Assured	9/25/2006
53	Metropolitan Domestic Water	AMA	Tucson	Pima	26-401062.0000	Assured	7/31/2006
54	Park Valley Water Company, Inc and Fools Hollow	Eastern Plateau	Little Colorado River Plateau	Navajo	40-402065.0000	Adequate	10/16/2007
55	Pineview Water Company, Inc.	Eastern Plateau	Little Colorado River Plateau	Navajo	40-402066.0000	Adequate	9/20/2007
56	Sahuarita Water Company LLC	AMA	Tucson	Pima	86-401203.0001	Assured	1/27/2009
57	Santa Cruz Water Company	AMA	Pinal	Pinal	26-402008.0000	Assured	12/27/2007
58	Snowflake Municipal Water Company	Eastern Plateau	Little Colorado River Plateau	Navajo	40-401841.0000	Adequate	1/17/2006
59	Sopori Domestic Water Improvement District	AMA	Santa Cruz	Santa Cruz	26-700558.0000	Assured	3/30/2010
60	Spanish Trail Water Company	AMA	Tucson	Pima	86-700205.0000	Assured	1/5/2009
61	Town of Florence	AMA	Pinal	Pinal	26-401284.0000	Assured	1/25/2005
62	Town of Gilbert	AMA	Phoenix	Maricopa	26-402208.0000	Assured	10/30/2007
63	Town of Marana	AMA	Tucson	Pima	26-402254.0000	Assured	5/7/2007
64	Town of Oro Valley	AMA	Tucson	Pima	26-400765.0000	Assured	6/26/2003
65	Town of Parker	Lower Colorado	Parker	La Paz	40-900010.0000	Adequate	5/17/1973
66	Town of Quartzsite	Lower Colorado	Parker	La Paz	40-500041.0000	Adequate	3/14/2008
67	Town of Springerville	Eastern Plateau	Little Colorado River Plateau	Apache	40-900013.0000	Adequate	5/17/1973
68	Town of Taylor	Eastern Plateau	Little Colorado River Plateau	Navajo	40-900014.0000	Adequate	12/21/1982
69	Town of Wickenburg	Central Highlands	Upper Hassayampa	Maricopa	40-900016.0000	Adequate	5/17/1973
70	Tubac Water Company, Inc	AMA	Santa Cruz	Santa Cruz	26-700409.0000	Assured	12/10/2008
71	Vail Water Company	AMA	Tucson	Pima	26-401752.0000	Assured	11/10/2005
72	Valley Pioneers Water Company	Upper Colorado	Sacramento Valley	Mohave	40-900015.0000	Adequate	2/1/1995
73	Voyager at White Mountain Lakes Water Company	Eastern Plateau	Little Colorado River Plateau	Navajo	40-700359.0000	Adequate	2/19/2008
74	Walnut Creek Water Company	Upper Colorado	Sacramento Valley	Mohave	40-401425.0000	Adequate	6/27/2005
75	Wickenburg Ranch Water Co., LLC	Central Highlands	Upper Hassayampa	Yavapai	40-700417.0000	Adequate	2/11/2008
76	Willow Springs Utilities, LLC	AMA	Tucson	Pinal	26-402225.0000	Assured	4/15/2008

Source: ADWR 2010

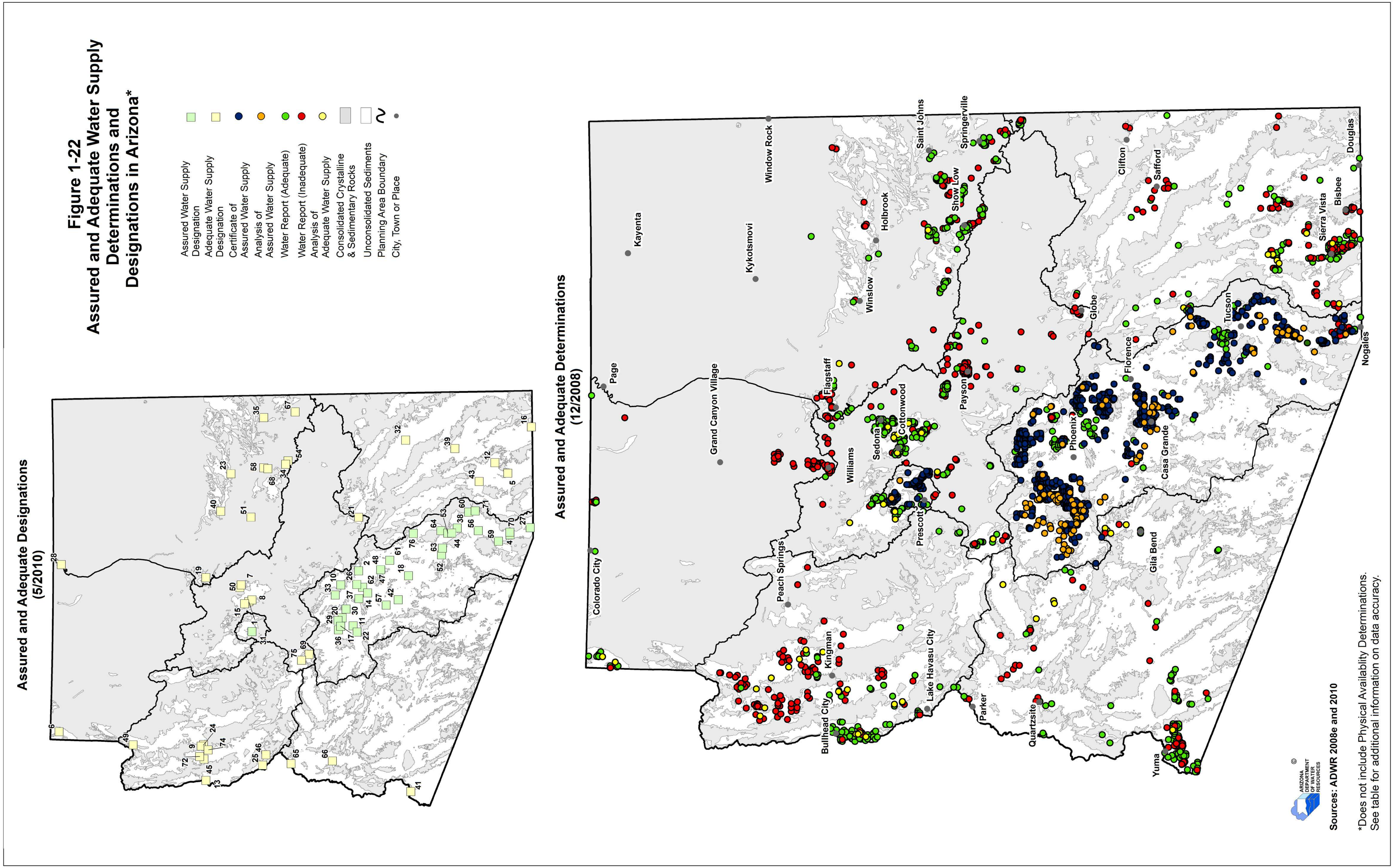
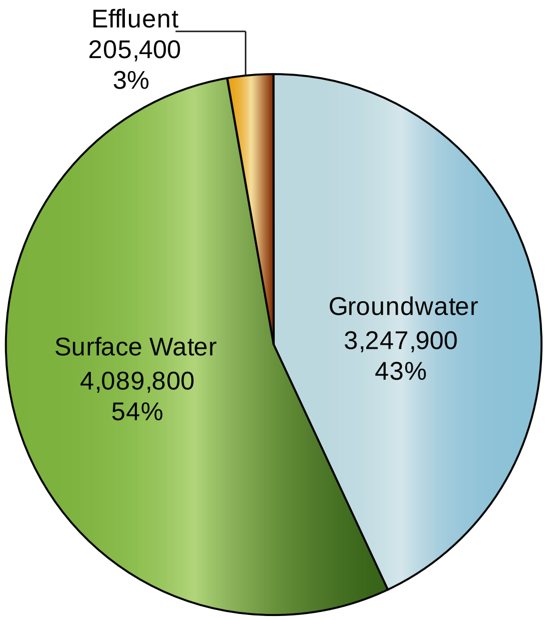


Figure 1-22
Assured and Adequate Water Supply Determinations and Designations in Arizona*

1.4.6 Water Supplies

Arizona's water supplies include water from the Colorado River (including Central Arizona Project water), instate surface water, groundwater and reclaimed water or effluent. Water supply availability and use varies substantially throughout the State's planning areas as shown in Figure 1-30. The average annual percentage and volume of surface water (Colorado River and instate surface water), groundwater, and effluent utilized from 2001-2005 is shown in Figure 1-23. Statewide, water diverted from streams has been the largest supply used, however groundwater is the dominant supply in most planning areas. While groundwater levels in wells may vary over time, groundwater is generally a reliable water supply in most parts of the state while in-state surface water supplies may fluctuate widely from year to year due to precipitation variability. Effluent reuse is increasing and although it represented just 3% of the total water supply in Arizona, it was an important supply in some planning areas. In some areas, water quality conditions, including designated sites of environmental contamination, affect the use of certain water supplies.

Figure 1-23 Average Annual Water Supplies Utilized in Arizona, 2001-2005 (in AF and % of total)



Colorado River Water and the Central Arizona Project

Colorado River water supplies derive primarily from snow in the Rocky Mountains of Wyoming, Colorado, and Utah. Arizona has an annual allotment of 2.8 maf of Colorado River water for consumptive use. Consumptive use (CU) is defined here as diversions from the mainstream of the Colorado River minus returns. The right or authorization to beneficially use Colorado River water is defined as an entitlement. Entitlements are created by decree, through a contract with the Secretary of the Interior (Secretary) or by Secretarial reservation (See Appendices C and D). Of the state's total Colorado River allotment, over 1.3 maf is available for use by municipal, industrial and agricultural users along the Colorado River in the Upper and Lower Colorado River planning areas. A summary of Arizona v. California decree accounting and entitlements are listed in Table 1-11 for basins in these planning areas. In addition, the Navajo Generating Station and the community of Page in the Eastern Plateau Planning Area divert water from Lake Powell for municipal and industrial use pursuant to Arizona's 50,000 AFA Upper Basin allocation. (BOR, 2007) The remaining amount of Colorado River water may be diverted annually via the CAP delivery system to users in the Phoenix, Tucson and Casa Grande areas (shown on Figure 1-1). CAP water is diverted from the Colorado River at Lake Havasu into

CAP Canal, Phoenix AMA

Table 1-11 Arizona v. California Decree accounting of the consumptive use of Colorado River water in Arizona (in acre-feet/year)

Basin/Year [1]	1971-75	1976-80	1981-85	1986-90	1991-95	1996-00	2001-05 [2]	Current Entitlement[3]
Bill Williams								
Agricultural	None							0
Industrial	None							0
Municipal	0	0	0	0	20	18	24	84
Environmental	None							0
Detrital Valley								
Agricultural	None							0
Industrial	None							0
Municipal	0	0	0	0	116	146	104	Unspecified
Environmental	None							0
Lake Havasu								
Agricultural	None							0
Industrial	None							0
Municipal	5,554	8,075	8,872	11,604	13,376	15,053	13,013	29,254
Environmental [4]	14,300	14,064	7,828	15,456	15,927	12,561	5,306	16,317
Lake Mohave								
Agricultural	20,209	47,172	73,885	83,109	96,123	107,700	72,326	144,535
Industrial	216	220	158	103	80	0	0	175
Municipal	295	298	581	6,062	7,857	9,669	8,851	44,192
Environmental [4]	14,300	14,064	7,828	15,456	15,927	12,561	5,306	16,317
Lower Gila								
Agricultural [6]	309,367	209,015	258,612	312,237	241,267	278,826	260,818	272,980
Industrial	0	0	0	0	0	0	0	0
Municipal	2	5	6	7	19	62	80	265
Environmental [5]	40	59	22	743	1,800	1,773	665	6,262
Parker								
Agricultural	334,058	354,197	338,033	407,512	425,204	429,193	389,668	693,486
Industrial	0	0	0	0	0	0	0	0
Municipal	829	1,070	1,770	1,815	1,891	2,339	1,876	8,004
Environmental [4]	148	13,128	8,768	11,822	19,719	18,368	11,785	56,238
Sacramento Valley								
Agricultural	None							0
Industrial	None							0
Municipal	None							0
Environmental [4]	8,066	7,934	4,416	8,719	8,984	7,086	2,993	9,205
Yuma								
Agricultural [6]	676,165	631,711	564,313	571,245	543,251	560,581	457,679	582,257
Industrial	1,046	1,021	839	610	469	2,250	674	1,772
Municipal	13,272	10,146	12,174	13,137	15,255	21,625	21,296	54,945
Environmental	0	0	0	0	0	0	0	0
TOTAL	1,397,867	1,312,178	1,288,105	1,459,633	1,407,284	1,479,812	1,252,464	1,405,907
Central Arizona Project [7]	0	0	33,502	499,917	717,514	1,330,109	1,555,215	Unspecified

Source: USBOR 2003-2009

Notes:

[1] Where the reported consumptive use for individual users does not cover an entire 5-year period, the average is based on the years of record.

[2] In 2003, the United States Bureau of Reclamation began deducting unmeasured return flows from the diversions by individual diverters. Prior to this time, Reclamation only deducted the total amount of unmeasured return flow from the total Lower Basin diversions.

[3] Entitlement amounts do not include 72,000 AFA for the Ak-Chin (50,000 AFA) and Salt River-Pima Maricopa Indian (22,000 AFA) water rights settlements, which are delivered by the CAP to reservations.

[4] The Havasu National Wildlife Refuge spans an area that is located in the Lake Mohave, Lake Havasu, and Sacamento Valley basins; Consumptive use has been prorated based on the percentage of the refuge land in each basin.

[5] The Imperial National Wildlife Refuge spans the Parker and Lower Gila basins; consumptive use has been prorated based on the percentage of refuge land in each basin.

[6] The Wellton-Mohawk Irrigation and Drainage District (IDD) spans the Lower Gila and Yuma basins. Consumptive use has been prorated based on the percentage of IDD land area in each basin.

[7] The CAP diverts water out of Lake Havasu at the Mark Wilmer Pumping Plant located in the Bill Williams Basin. The water has multiple uses in Maricopa, Pinal, and Pima counties.

a 336-mile aqueduct system that lifts the water more than 2,900 vertical feet through a series of pumping plants to users in central Arizona. The Central Arizona Water Conservation District (CAWCD) operates and maintains the CAP.

When Colorado River water allocations were identified in the Colorado River Compact in 1922, the river data showed an average annual "natural" flow of approximately 16.4 maf at Lees Ferry below Lake Powell (See Appendix D). Natural flow is the flow without cultural depletions. A tree-ring based assessment completed in 2005 found that for the period 1521-1964, the mean annual flow at Lees Ferry was about 14.2 maf (Hirschboeck and Meko, 2005). The Bureau of Reclamation's current estimate of natural flow for the period 1906 through 2007 is about 15 maf and their natural flow data show a low of approximately 5.6 maf in 1977 and a high of 25.2 maf in 1984. This situation highlights the importance of the Colorado River dams and reservoirs to store water for use during dry periods. Currently, the Lower Basin (Arizona, California and Nevada) is fully utilizing its 7.5 maf annual allocation. Upper Basin (Colorado, New Mexico, Utah and Wyoming) annual demand is approximately 4.2 maf and Mexico is utilizing its full 1.5 maf annual apportionment.

There is a priority system associated with Colorado River contracts in the event of shortages of supply. Contract priority is an important consideration in water resource planning (see Volumes 4 and 7). The first water to be shorted within Arizona is the CAP and water users of similar priority along the mainstream of the Colorado River. The Arizona Water Banking Authority (AWBA) was established in 1996 to store unused Colorado River water to meet future needs. The AWBA enabled Arizona to use its full allocation earlier than expected and stores water to be used in times of shortage to firm water supplies for Arizona. The primary functions of the AWBA are discussed in Appendix C.

Salt River, Phoenix AMA. The Salt, Verde and Gila rivers are essential supplies for water users in central Arizona.

Surface Water

Arizona surface water supplies derive chiefly from snow along the Mogollon Rim and high elevation mountains of east central Arizona and western New Mexico. The Salt, Verde and Gila rivers are essential supplies for water users in central Arizona. The Salt River Project (SRP), through the Salt River Valley Water Users' Association, annually delivers a total of almost 1 maf of surface water from the Salt and Verde rivers and groundwater to its service area in the Phoenix AMA. SRP manages several dams on the Salt and Verde rivers that produce hydroelectricity and has substantial surface water right claims in the Salt and Verde watersheds. Water supplies utilized by the towns of Cottonwood, Clarkdale, Camp Verde, Payson and others are derived from the watersheds of the Salt and Verde rivers. The water supplies of the upper Gila River communities of Safford, Thatcher and others are impacted by senior surface water rightholders downstream of their communities; the Globe-Equity Decree and by Indian water rights settlements (see Appendices C and G).

Other surface water supplies utilized in Arizona include diversions from the Little Colorado River, San Pedro River, Bonita Creek and other smaller streams, runoff stored in local reservoirs and springs. These supplies may be more drought sensitive than the larger regional systems. Communities that utilize local surface water supplies include Eagar, Flagstaff, Jerome, Tombstone and Williams. The Morenci Mine in the Morenci Basin uses surface water transported from the adjacent Salt River Basin in the Central Highlands Planning Area. Surface water is used for agricultural irrigation in every planning area, either from a local or regional source or from the Colorado River.

The legal availability of a surface water supply is an important consideration. As described in detail in Appendix H, the legal framework and process under which surface water right applications and claims are administered and determined is complex. Each type of surface water right filing has been assigned a unique number as explained in Appendix H and listed in Table 1-12 by planning area. The act of filing a statement of claim of right to use public waters (36) does not in itself create a water right. 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 (LCR). Figure 1-24 shows the location of surface water diversion points listed in the Department's surface water rights registry. Locations of registered wells, many of which are referenced as the basis of claim in adjudication Statement of Claimants (SOCs) are also shown in Figure 1-24.

Groundwater

With the exception of the Lower Colorado River and AMA planning areas, groundwater is the primary water supply utilized for cultural uses, accounting for approximately 43% of the state's total water supply annually during 2001-2005. While a number of hydrologic studies and groundwater models have been completed in the AMAs, there is often less known about the groundwater conditions outside AMAs where fewer comprehensive studies have been done.

The Department conducts water level and water quality measurements periodically statewide

Table 1-12 Count of surface water right and adjudication filings by planning area[1]

PLANNING AREA	TYPE OF FILING							TOTAL
	BB[2]	3R[3]	4A[3]	33[3]	36[4]	38[5]	39[6]	
Eastern Plateau	134	163	196	373	3,289	3,275	12,099	**19,529**
Southeastern Arizona	483	395	716	898	8,288	6,415	19,288	**36,483**
Upper Colorado River	0	224	329	469	2,858	2,084	0	**5,964**
Central Highlands	1	287	625	897	8,517	3,928	25,443	**39,698**
Western Plateau	0	415	207	554	1,177	1,270	324	**3,947**
Lower Colorado River	0	26	48	86	355	304	2,323	**3,142**
Active Management Areas	1	269	341	687	4,072	2,913	27,134	**35,417**
Total	**619**	**1,779**	**2,462**	**3,964**	**28,556**	**20,189**	**86,611**	**144,180**

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) to be mapped within the planning area. If a file lists more than one POD in a given planning area, it is only counted once in the table for that planning area. Several surface water right and adjudication filings are not counted here due to insufficient locational information. However, multiple filings for the same POD 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 claim 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.

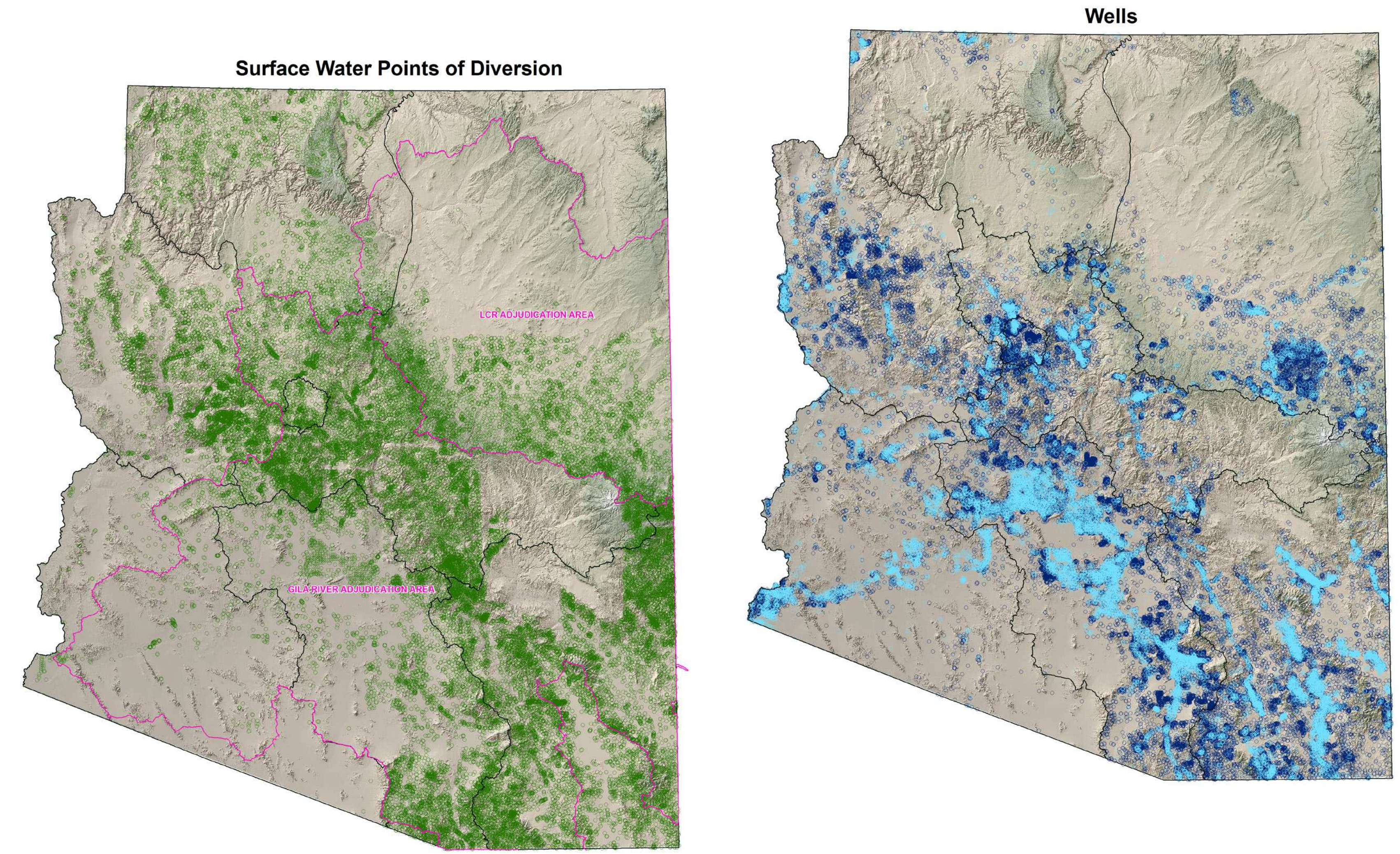


Figure 1-24
Registered Wells and Surface Water Diversion Points in Arizona

Data Sources: ADWR Surface Water Rights Registry and ADWR Wells 55 and maintains a repository for statewide groundwater well data, the Groundwater Site Inventory (GWSI) database, available on the Department's website (www.azwater.gov). The database includes well log data and historic groundwater level records. Approximately 1,700 wells are designated as Index Wells statewide out of over 43,700 GWSI sites and are typically measured once each year by the Department (Figure 1-25). The Department also operates a network of about 120 automated groundwater monitoring sites throughout the state. Hydrographs for Index Wells and Automated Groundwater Monitoring Sites are also available on the Department's website.

As discussed in Section 1.4.2, some areas of the state have relatively deep basin-fill aquifers with substantial amounts of groundwater in storage. This is generally true for the southern part of Arizona including much of the Pinal, Phoenix and Tucson AMAs. In other areas however, hydrologic conditions are less favorable. Aquifers may be alluvial or unproductive, particularly in mountainous areas, or depth to groundwater may be very great. This is the case in the Payson area and in much of the Santa Cruz AMA, where thin alluvial or fractured rock aquifers make them sensitive to precipitation events and susceptible to drought. Poor water quality can also be an issue. For example, some of the regional aquifers of the Eastern Plateau are characterized by high levels of total dissolved solids, and may be unsuitable for use without treatment.

Automated well in the Prescott AMA

Effluent recharge in the Phoenix AMA.

As drought and growth stress the availability of surface water supplies, communities that historically have relied on surface water are exploring groundwater resource options including drilling additional wells and acquiring land for wellfield development.

Effluent

Access to renewable water supplies, especially outside of the AMAs, may be physically or legally limited. An exception is reclaimed water or effluent, which increases with population growth served by a sewer system. Effluent has met up to 8% of the municipal demand and 27% of the agricultural demand in the Eastern Plateau Planning Area and 28% of the industrial demand in the AMA Planning Area. Table 1-13 summarizes recent effluent use by planning area. While the percentage of reporting treatment facilities is low in some planning areas, data are available for the largest facilities. Of the 53% of total facilities for which treatment volumes and reuse data are available, 53% of that effluent has been reused primarily for turf irrigation, groundwater recharge, agricultural irrigation and for cooling purposes at the Palo Verde Nuclear Generating Station in the Phoenix AMA. The highest per-

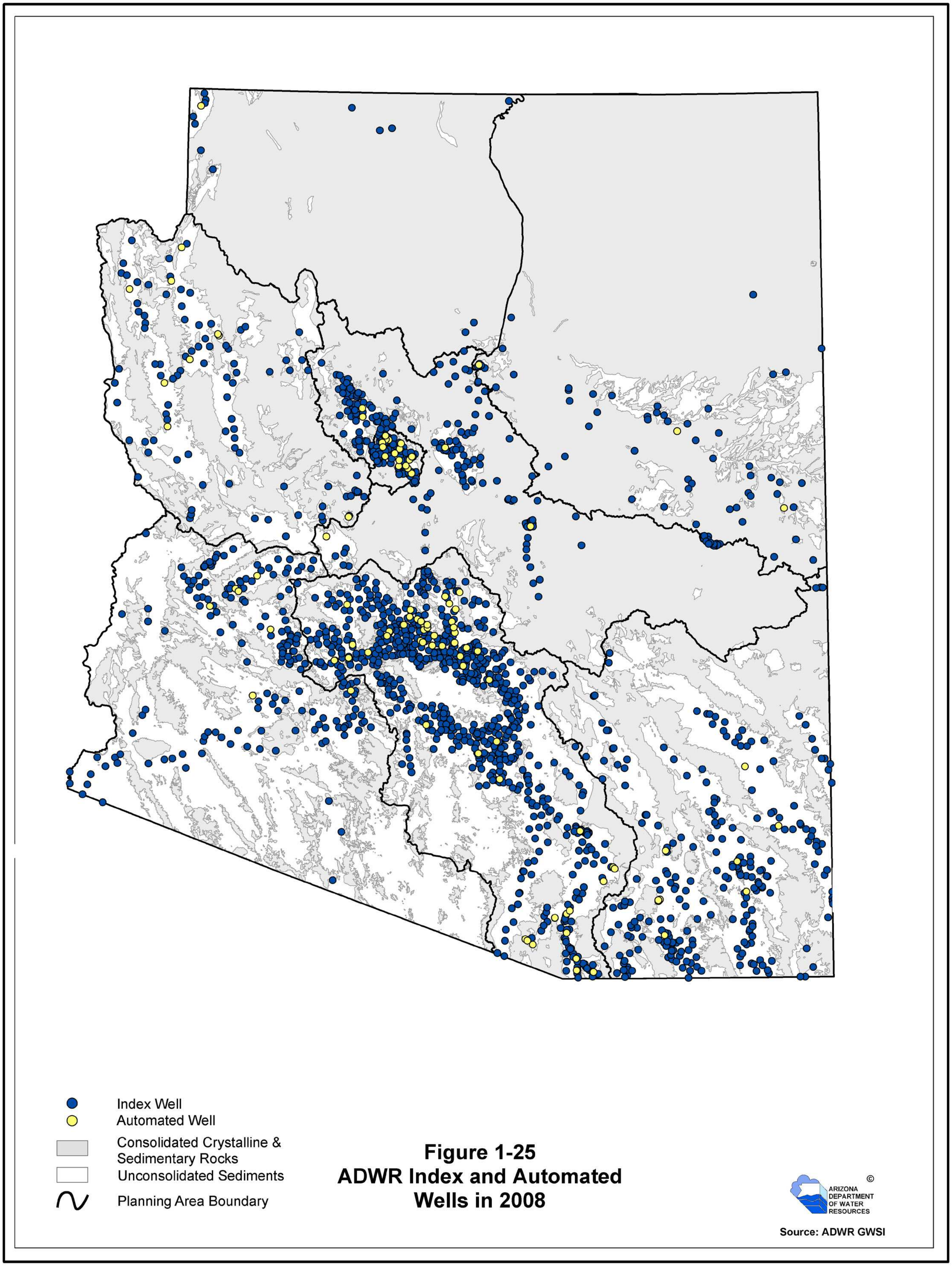


Figure 1-25
ADWR Index and Automated Wells in 2008

Table 1-13 Annual effluent generation and use by planning area (c. 2006)

Planning Area	Percent of Reporting Facilities[1]	Volume Generated (acre-feet)	Direct Use[2] (acre-feet)	Permitted Recharge Facility Storage[3] (acre-feet)	Created Wetland Delivery[4] (acre-feet)	Disposal[5] (acre-feet)	% use by reporting facilities
Eastern Plateau Planning Area	83%	36,100	14,900	0	2,700	18,500	49%
Southeastern Arizona Planning Area	86%	10,600	1,670	2,000	0	6,930	35%
Upper Colorado River Planning Area	53%	8,700	3,400	0	0	5,300	39%
Central Highlands Planning Area	48%	9,300	1,200	300	426	7,374	21%
Western Plateau Planning Area	71%	2,200	300	0	0	1,900	14%
Lower Colorado River Planning Area	58%	16,700	1,600	0	0	15,100	10%
Active Management Areas	43%	419,346	200,700	34,000	1,350	183,296	56%
Phoenix AMA	*42%*	*315,000*	*177,200*	*13,100*	*1,350*	*123,350*	*61%*
Pinal AMA	*33%*	*6,900*	*4,800*	*600*	*0*	*1,500*	*78%*
Prescott AMA	*67%*	*6,900*	*2,700*	*3,600*	*0*	*600*	*91%*
Santa Cruz AMA	*50%*	*16,311*	*0*	*0*	*0*	*16,311*	*0%*
Tucson AMA	*42%*	*74,235*	*16,000*	*16,700*	*0*	*41,535*	*44%*
Arizona Total	**53%**	**502,946**	**223,770**	**36,300**	**4,476**	**238,400**	**53%**

Various sources, see Arizona Water Atlas Volumes 2-8

[1] Facilities that have reported both volume generated and a disposal method.

[2] Includes effluent used for irrigation, golf courses, and industrial use. The Upper Colorado River Planning Area includes an estimated 200 af of use at the Bagdad Mine. According to the GRIC annual report, 10,686 af of effluent (through exchange) was used for irrigation in the Phoenix AMA by the GRIC during 2008. This additional use is not included here.

[3] Quantities delivered to constructed and managed facilities, minus annual recovery, evaporation and cut to the aquifer. The Fort Huachuca recharge facility in the Southeastern Arizona Planning Area and the Green Valley Park Lakes recharge facility in the Central Highlands Planning Area are not permitted, but the estimated volume recharged is listed..

[4] Created wetland accessible to the public that is not permitted as a recharge facility.

[5] Includes the following disposal methods: watercourse, evaporation pond, discharge to another facility and non-permitted infiltration basins.

centage of reuse is in the Prescott AMA where 91% of the treated effluent is either recharged or used directly for golf course irrigation. A constraint on more reuse is that potential users, such as parks and golf courses, are often distant from treatment facilities and communities lack financing to construct the necessary delivery infrastructure.

Contamination Sites

Sites of environmental contamination and exceedences of drinking water standards (DWS) may impact the use of some water supplies. An inventory of primary DWS exceedences and Department of Defense (DOD), Leaking Underground Storage Tank (LUST), Resource Conservation and Recovery Act (RCRA), Superfund, Uranium Mill Tailings Remedial Action (UMTRA), Voluntary Remediation Program (VRP) and Water Quality Assurance Revolving Fund (WQARF), sites was conducted for each planning area. More information on water quality programs is found in Appendices C and D. Water quality and contamination site information is compiled in maps and tables in both the overview and basin sections of Atlas Volumes 2-8. The most commonly exceeded DWS constituents in Arizona are arsenic, fluoride and nitrate as shown on Figure 1-26. While there is no primary DWS for total dissolved solids (TDS), locations of concentrations in excess of 3,000 milligrams per liter (mg/L), which requires special well construction, are also shown on Figure 1-26. TDS levels in Arizona waters are typically elevated due to natural hydrogeologic factors or have resulted from irrigation practices. The location of contamination sites and impaired waters (a lake or stream not meeting one or more surface water quality standards as established in A.R.S. § 49-231) are shown on Figure 1-27.

1.4.7 Cultural Water Demand

Cultural water demand refers to the quantity

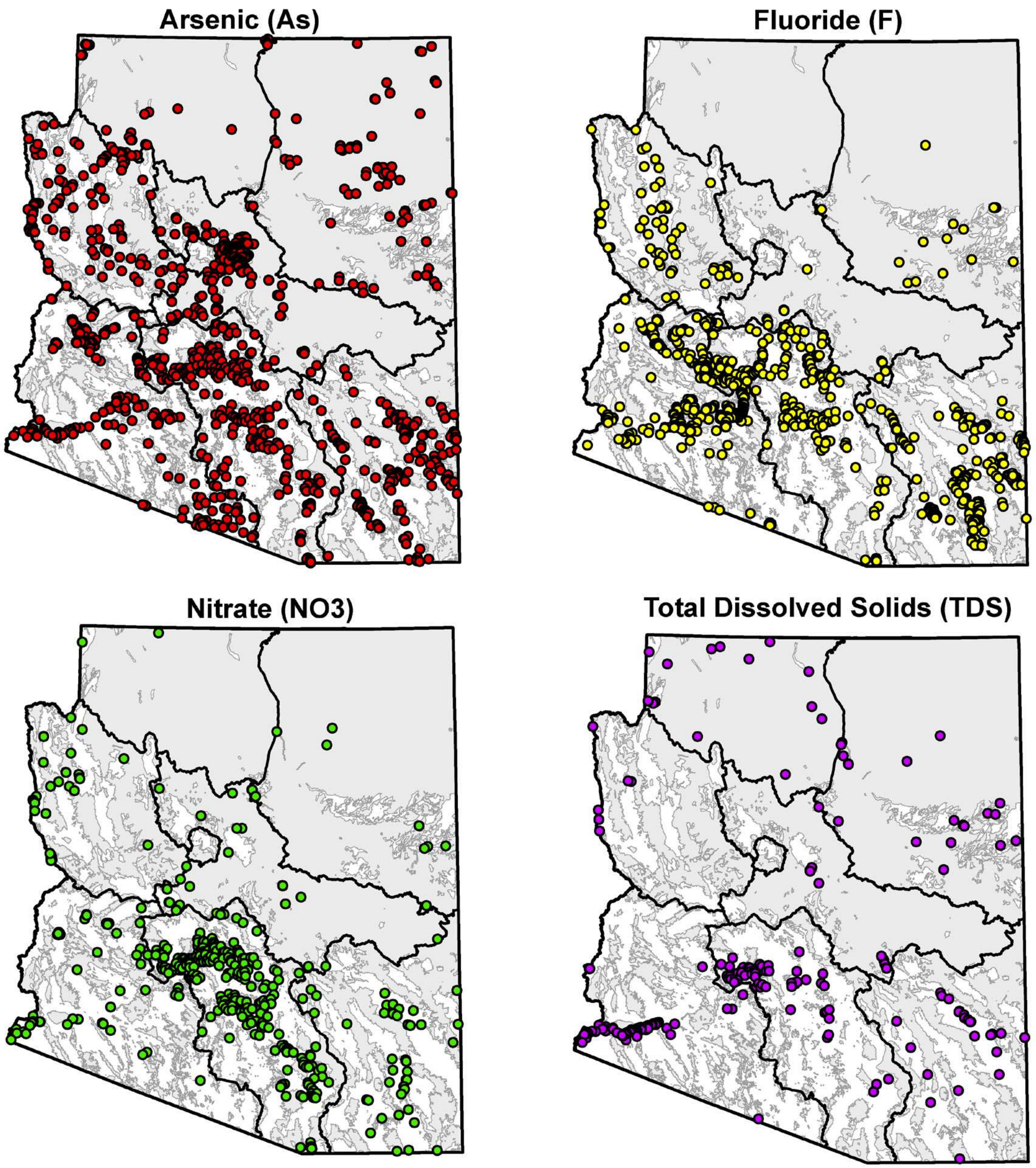


Figure 1-26
Common Groundwater Quality Exceedances[1, 2]

Sampling Location

- As
- F
- NO3
- TDS[3]
- Consolidated Crystalline & Sedimentary Rocks
- Unconsolidated Sediments
- Planning Area Boundary

Notes:

1. Parameter concentrations equaled or exceeded drinking water quality standards. The information presented in this map may not indicate the quality of water supplied by public water systems which must comply with Federal and State water quality regulations.
2. A more comprehensive list of sampling data, obtained from a variety of sources, has been compiled and presented in Volumes 2 through 8 of the Water Atlas. Most samples were collected from groundwater wells, but includes some springs and mines.
3. Samples contained over 3,000 milligrams per liter (mg/L) of TDS and would require special well construction per Arizona Administrative Code (A.A.C.) R12-15-812(B). There is not a Primary Drinking Water Standard for TDS; however, the Secondary Drinking Water Standard is 500 mg/L.

Source: Compilation of data from ADWR and others.

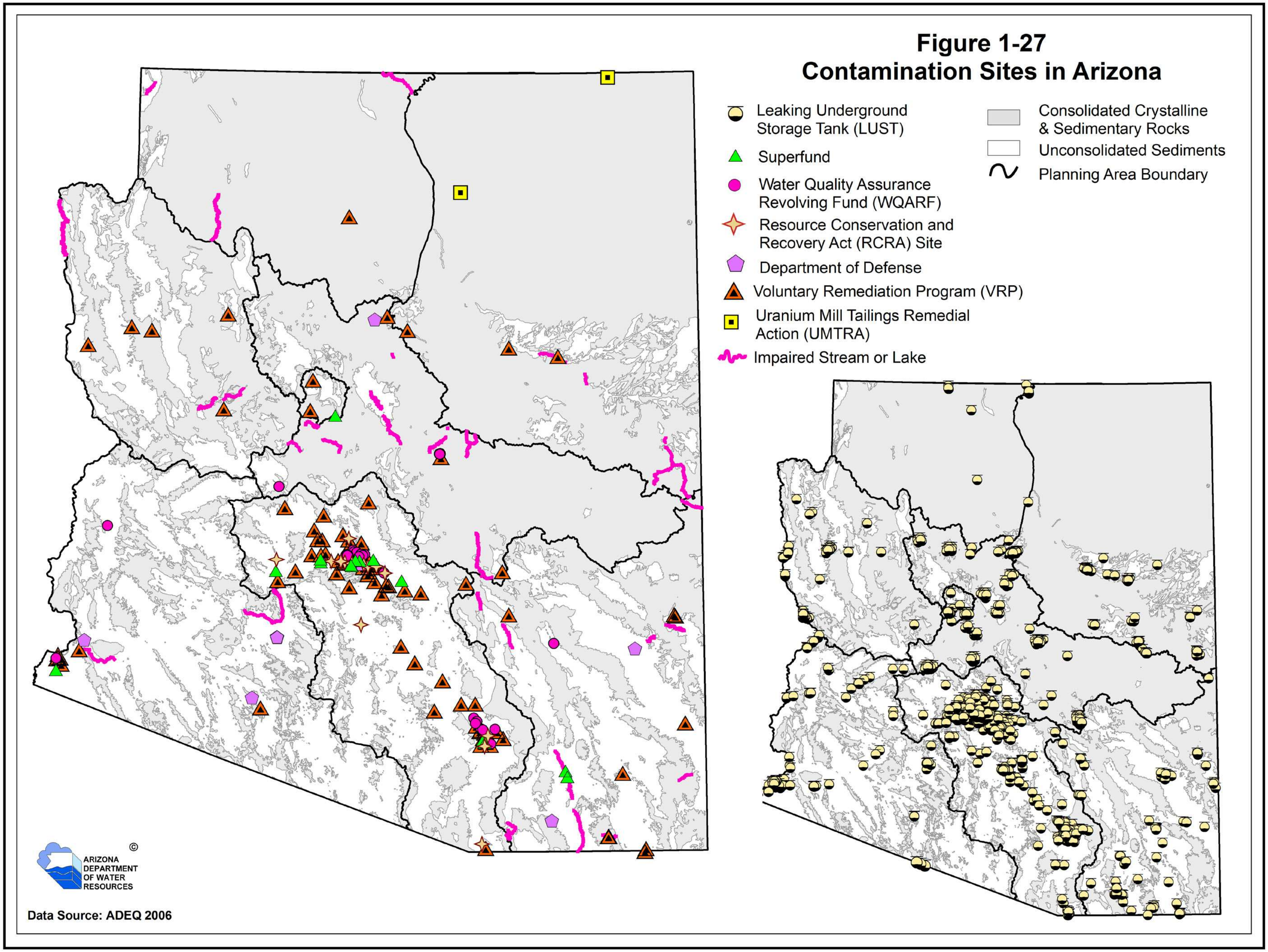


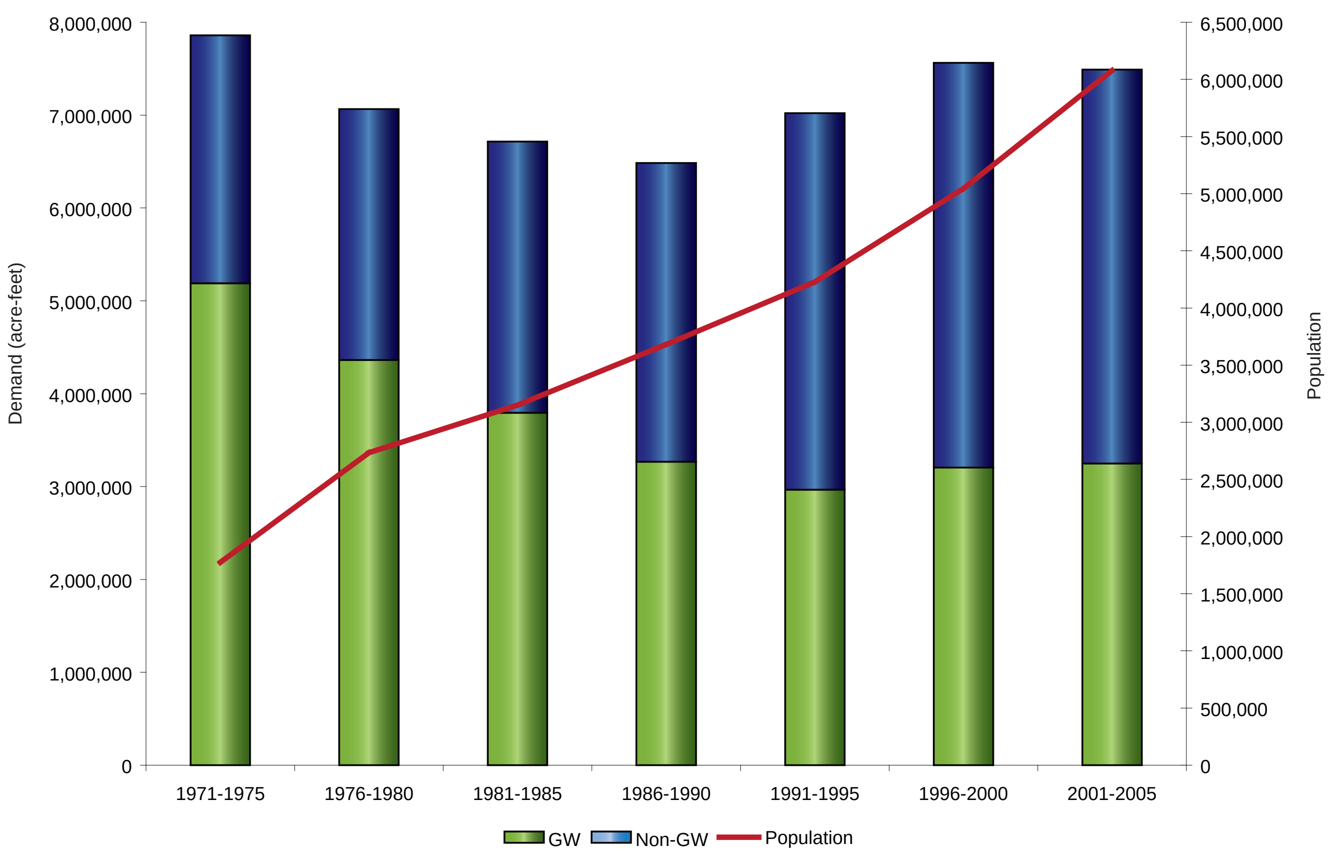
Figure 1-27
Contamination Sites in Arizona
Leaking Underground Storage Tank (LUST)
Superfund
Water Quality Assurance Revolving Fund (WQARF)
Resource Conservation and Recovery Act (RCRA) Site
Department of Defense
Voluntary Remediation Program (VRP)
Uranium Mill Tailings Remedial Action (UMTRA)
Impaired Stream or Lake
Consolidated Crystalline & Sedimentary Rocks
Unconsolidated Sediments
Planning Area Boundary
ARIZONA DEPARTMENT OF WATER RESOURCES
©
Data Source: ADEQ 2006

of water diverted from streams, reservoirs and springs; pumped from wells; or treated wastewater delivered for municipal, industrial and agricultural purposes (see also Section 1.3). Data presented here provide a general assessment of water demands in Arizona by municipal, agricultural and industrial users. These demand sectors are defined according to AMA regulatory definitions (see Definitions section). A general description of water demand data sources and methods is found in Appendix B and fully documented in each volume.

As shown graphically in Figure 1-28, while the population of Arizona has increased significantly, water demand statewide has declined or remained stable due to retirement of agricultural lands, increased water use efficiency and effluent reuse. In addition, use of non-groundwater supplies (CAP, effluent, and surface water) has increased substantially compared to pre-1990 levels, primarily due to importation of CAP water to central Arizona. Figure 1-29 shows the demand and water supply use trends in each planning area. Recent (2001-2005) AMA water demand is comparable to that in the early 1980s despite a doubling of population between the 1980 and 2000 census and use of non-groundwater supplies has increased by 52%. By contrast, demand in the Lower Colorado River, Upper Colorado River and Southeastern Arizona planning areas has increased from the early 1980s.

Average annual planning area water demand and the water supply used by each demand sector during 2001-2005 is shown in Figure 1-30 and summarized to the basin level in Table 1-14. These demands include water pumped from wells (including from the Colorado River

Figure 1-28 Comparison of Arizona's Average Annual Water Demand to Its Population, 1971-2005

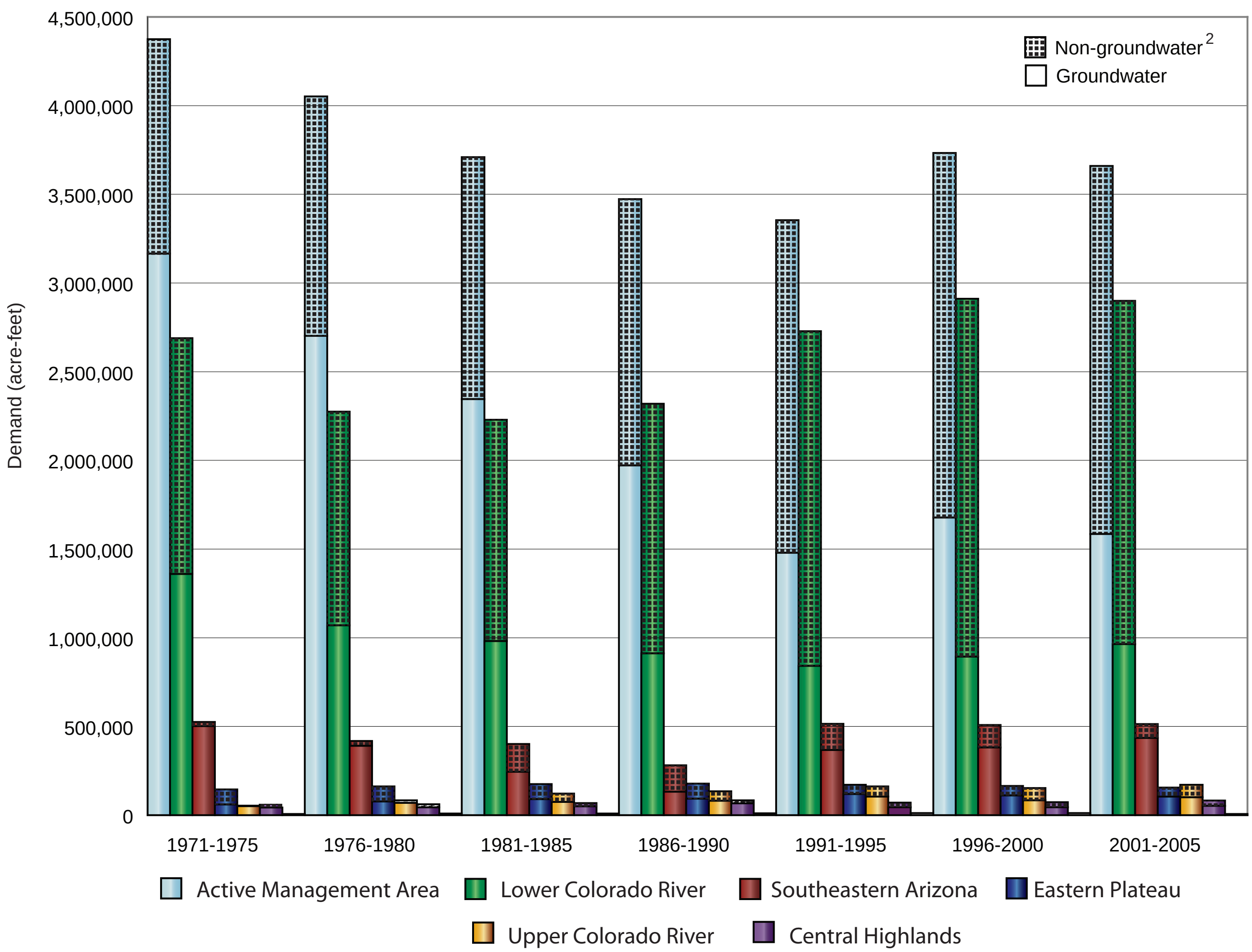


Various data sources, see Arizona Water Atlas Volumes 2-8 accounting surface), diverted from streams, and reused effluent. Water that returns to the Colorado River (return flow) for Colorado River contract accounting purposes (approximately 0.85 maf/year) in the Upper and Lower Colorado River planning areas (Table 1-11) is not subtracted from the total. The annual volume of water pumped and diverted during 2001-2005 was approximately 7.65 maf.

Water demand in the planning areas varies significantly by volume, water source and demand sector. Approximately half of the state's water demand occurs in the AMAs where non-groundwater supplies such as CAP and in-state surface water account for most of the municipal and agricultural water supply. CAP water use includes both direct use and CAP water used "in-lieu" of groundwater pumping by the agricultural sector and recovery of CAP recharge credits by municipal users.[5] A Groundwater Savings (GSF) Permit allows the permit holder to deliver the in-lieu water to the recipient who agrees to replace groundwater pumping with in-lieu water, creating a groundwater savings.

Municipal water demand centers, active agricultural lands and the general location of major industrial water users are shown on Figure 1-31. Average total water use in Arizona by demand sector for 2001-2005 is shown on Figure 1-32.

Figure 1-29 Change in Average Annual Water Demand in Arizona Planning Areas[1]



Various data sources, see Arizona Water Atlas Volumes 2-8
1 Water demand in the Western Plateau Planning Area is relatively small (<11,000 acre-feet) and not shown here due to scale.
2 Non-groundwater may include surface water, effluent, Central Arizona Project water and tailwater. In most basins outside of the AMAs, non-groundwater is surface water.

[5] In AMA water budgets,"in-lieu" CAP water is accounted for as a debit to the groundwater supply because credits are accrued by the storer that may be recovered in the future through groundwater pumping.

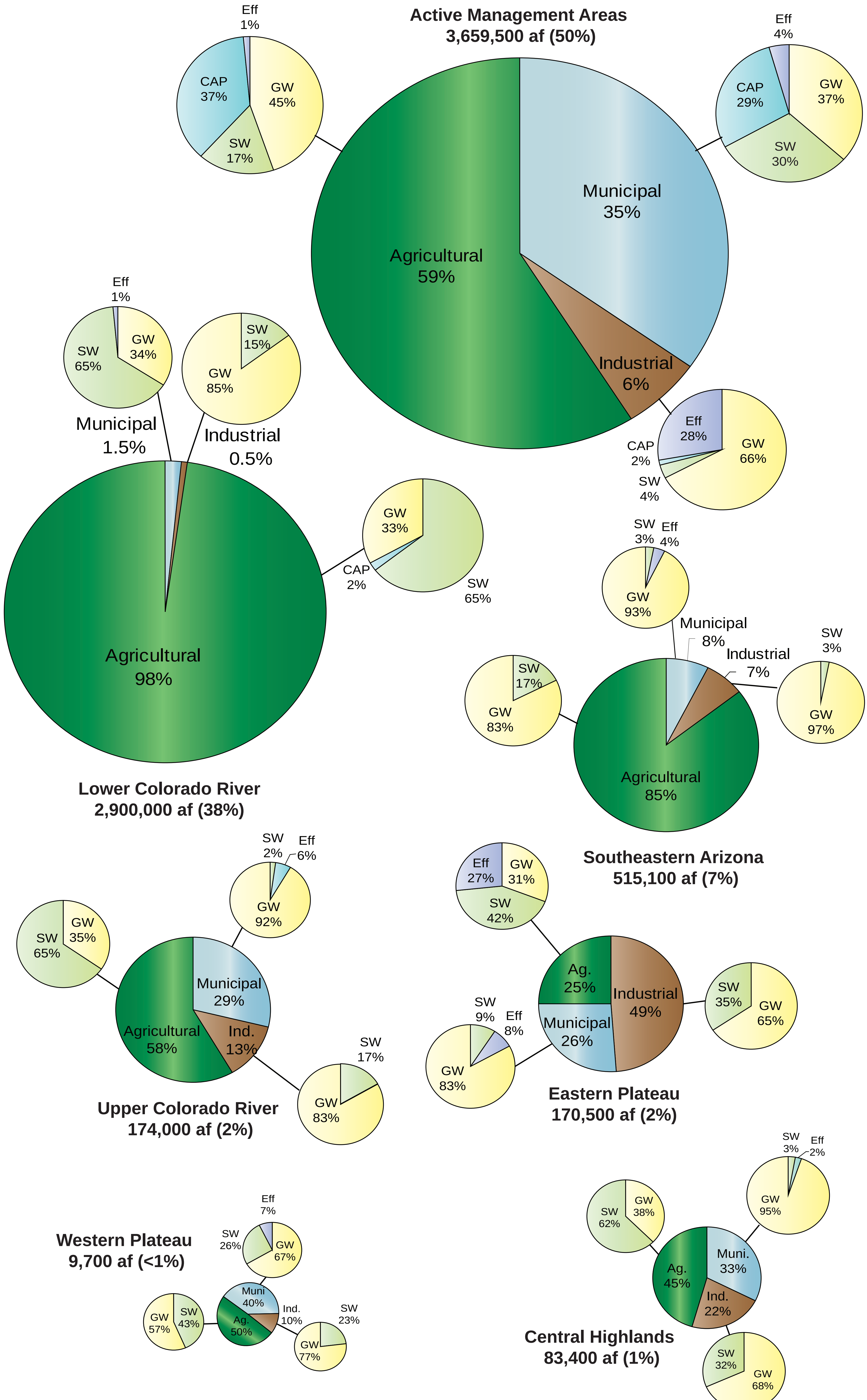


Figure 1-30
Average Annual Planning Area Water Demand by Sector and Water Source During 2001-2005

Source: ADWR 2008c

Table 1-14 Average annual cultural water demand (2001-2005)[1]

Basin	Total Number of Registered Water Supply Wells Drilled through 2005		Average Annual Demand (in acre-feet)								
			Well Pumpage			Surface Water Diversions[2]			Effluent		
	Q ≤ 35 gpm	Q > 35 gpm	Municipal	Industrial	Agricultural	Municipal	Industrial	Agricultural	Municipal	Industrial	Agricultural
Eastern Plateau											
Little Colorado River	7,990	1,657	37,300	54,407	13,100	4,100	28,707	18,000	3,600	NR	11,300
Sub-total	**7,990**	**1,657**	**37,300**	**54,407**	**13,100**	**4,100**	**28,707**	**18,000**	**3,600**	**NR**	**11,300**
Southeastern Arizona											
Aravaipa Canyon	192	50	<300	NR	<1,000	NR	NR	<1,000	NR	NR	NR
Bonita Creek	12	15	3,200	NR	NR	NR	NR	NR	NR	NR	NR
Cienega Creek	1,874	169	600	<300	500	NR	NR	NR	NR	NR	NR
Donnelly Wash	140	6	<300	NR	NR	NR	NR	NR	NR	NR	NR
Douglas	1,666	899	5,500	NR	47,300	NR	NR	NR	NR	NR	NR
Dripping Springs	119	40	<300	NR	NR	NR	NR	NR	NR	NR	NR
Duncan Valley	866	325	600	300	10,000	NR	NR	9,900	NR	NR	NR
Lower San Pedro	1,630	398	2,300	15,900	7,500	300	NR	<1,000	145	NR	NR
Morenci	505	145	1,400	8,200	NR	600	1,100	NR	NR	NR	NR
Safford	2,698	2,278	3,300	800	120,400	NR	NR	61,300	500	NR	NR
San Bernardino	164	12	<300	NR	NR	NR	NR	NR	NR	NR	NR
San Rafael	224	26	<300	NR	NR	NR	NR	NR	NR	NR	NR
Upper San Pedro	5,021	1,106	17,300	1,900	9,900	<300	NR	4,300	830	NR	NR
Willcox	3,150	1,873	2,700	6,200	167,400	<300	NR	NR	211	NR	NR
Sub-total	**18,261**	**7,342**	**37,650**	**33,450**	**363,500**	**1,200**	**1,100**	**76,500**	**1,686**	**NR**	**NR**
Upper Colorado											
Big Sandy	1,240	212	<300	15,600	<300	NR	NR	NR	NR	NR	NR
Bill Williams	1,627	445	900	<300	4,100	500	NR	NR	NR	NR	NR
Detrital Valley	168	51	<300	NR	NR	<300	NR	NR	NR	NR	NR
Hualapai Valley	918	90	8,900	<300	NR	NR	NR	NR	NR	NR	NR
Lake Havasu	99	45	16,500	<300	NR	<300	<300	NR	2,433	NR	NR
Lake Mohave	1,887	353	18,800	600	30,400	400	3,700	64,900	715	NR	NR
Meadview	21	15	<300	NR	NR	NR	NR	NR	NR	NR	NR
Peach Springs	36	18	350	<300	NR	NR	NR	NR	NR	NR	NR
Sacramento Valley	1,010	151	2,100	1,600	NR	NR	NR	NR	NR	NR	NR
Sub-total	**7,006**	**1,380**	**48,000**	**18,400**	**34,500**	**1,200**	**3,850**	**64,900**	**3,148**	**NR**	**NR**
Central Highlands											
Agua Fria	1,776	310	1,800	NR	1,500	NR	NR	NR	NR	NR	NR
Salt River	1,593	412	4,000	8,100	<1,000	<300	4,900	6,400	NR	NR	NR
Tonto Creek	1,948	280	2,400	<300	<1,000	NR	NR	1,000	200	NR	NR
Upper Hassayampa	1,890	312	2,600	800	<1,000	NR	NR	NR	NR	NR	NR
Verde River	11,093	1,659	15,200	3,200	11,100	600	800	16,000	980	NR	NR
Sub-total	**18,300**	**2,973**	**26,000**	**12,250**	**14,100**	**750**	**5,700**	**23,400**	**1,180**	**NR**	**NR**
Western Plateau											
Coconino Plateau	172	38	500	NR	NR	300	NR	NR	273	NR	NR
Grand Wash	11	1	<300	NR	NR	NR	NR	NR	NR	NR	NR
Kanab Plateau	220	119	1,600	NR	<1,000	1,000	NR	<1,000	NR	NR	NR
Paria	12	4	<300	NR	NR	NR	NR	NR	NR	NR	NR
Shivwits Plateau	17	2	<300	NR	NR	NR	NR	NR	NR	NR	NR
Virgin River	268	136	<300	700	2,100	NR	<300	1,500	NR	NR	NR
Sub-total	**700**	**300**	**2,700**	**700**	**2,600**	**1,300**	**150**	**2,000**	**273**	**NR**	**NR**
Lower Colorado[3]											
Butler Valley	18	21	<300	NR	9,700	NR	NR	NR	NR	NR	NR
Gila Bend	146	391	1,000	4,700	289,000	NR	NR	54,000	NR	NR	NR
Haraquahala	157	212	950	500	36,500	NR	300	69,600	NR	NR	NR
Lower Gila	718	850	2,000	3,600	246,000	500	NR	383,200	NR	NR	NR
McMullen Valley	338	240	500	<300	89,100	NR	NR	NR	NR	NR	NR
Parker	1,749	191	3,800	<300	<1,000	500	NR	630,600	220	NR	896
Ranegras Plain	522	138	400	NR	28,800	NR	NR	NR	NR	NR	NR
San Simon Wash	7	1	1,000	NR	3,900	NR	NR	NR	NR	NR	NR
Tiger Wash	7	1	<300	NR	NR	NR	NR	NR	NR	NR	NR
tern Mexican Drainage	20	5	<300	NR	NR	NR	NR	NR	NR	NR	NR
Yuma	2,689	693	8,300	500	232,200	32,000	2,000	762,000	460	NR	NR
Sub-total	**6,371**	**2,743**	**18,400**	**9,600**	**935,700**	**33,000**	**2,300**	**1,899,400**	**680**	**NR**	**896**
Active Management Areas											
Phoenix	13,535	10,683	295,600	88,800	429,900	701,300	10,300	594,500	41,600	65,900	55,100
Pinal	2,077	3,256	24,700	13,200	439,600	3,700	900	533,200	500	2,200	1,700
Prescott	10,651	724	14,600	1,400	3,500	800	80	400	1,900	NR	1,400
Santa Cruz	1,246	593	7,800	1,500	13,000	NR	NR	NR	NR	NR	NR
Tucson	7,145	4,848	124,100	51,400	76,400	44,400	600	32,100	12,200	100	NR
Sub-total	**34,654**	**20,104**	**466,800**	**156,300**	**962,400**	**750,200**	**11,880**	**1,160,200**	**56,200**	**68,200**	**58,200**
Total	**75,021**	**29,157**	**636,850**	**285,107**	**2,325,900**	**791,750**	**53,687**	**3,244,400**	**66,767**	**68,200**	**70,396**

Various data sources see Arizona Water Atlas Volumes 2-8

Notes:

NR = Not Reported

[1] Amount shown is water pumped from wells (including from the Colorado River accounting surface) or diverted from streams and includes Colorado River return flow (0.85 MAF). Evaporation losses from stockponds and reservoirs, long-term storage credits (CAP and effluent), intentionally created surplus and system losses (approx. 0.3 MAF) are not included. To calculate totals, half of the less than (<) values were assumed.

[2] Surface water supplies may include streamflow, spring discharge, spill/tail water and Central Arizona Project water.

[3] Groundwater demand for agriculture in the Lower Gila and Yuma Basins includes water pumped from drainage wells.

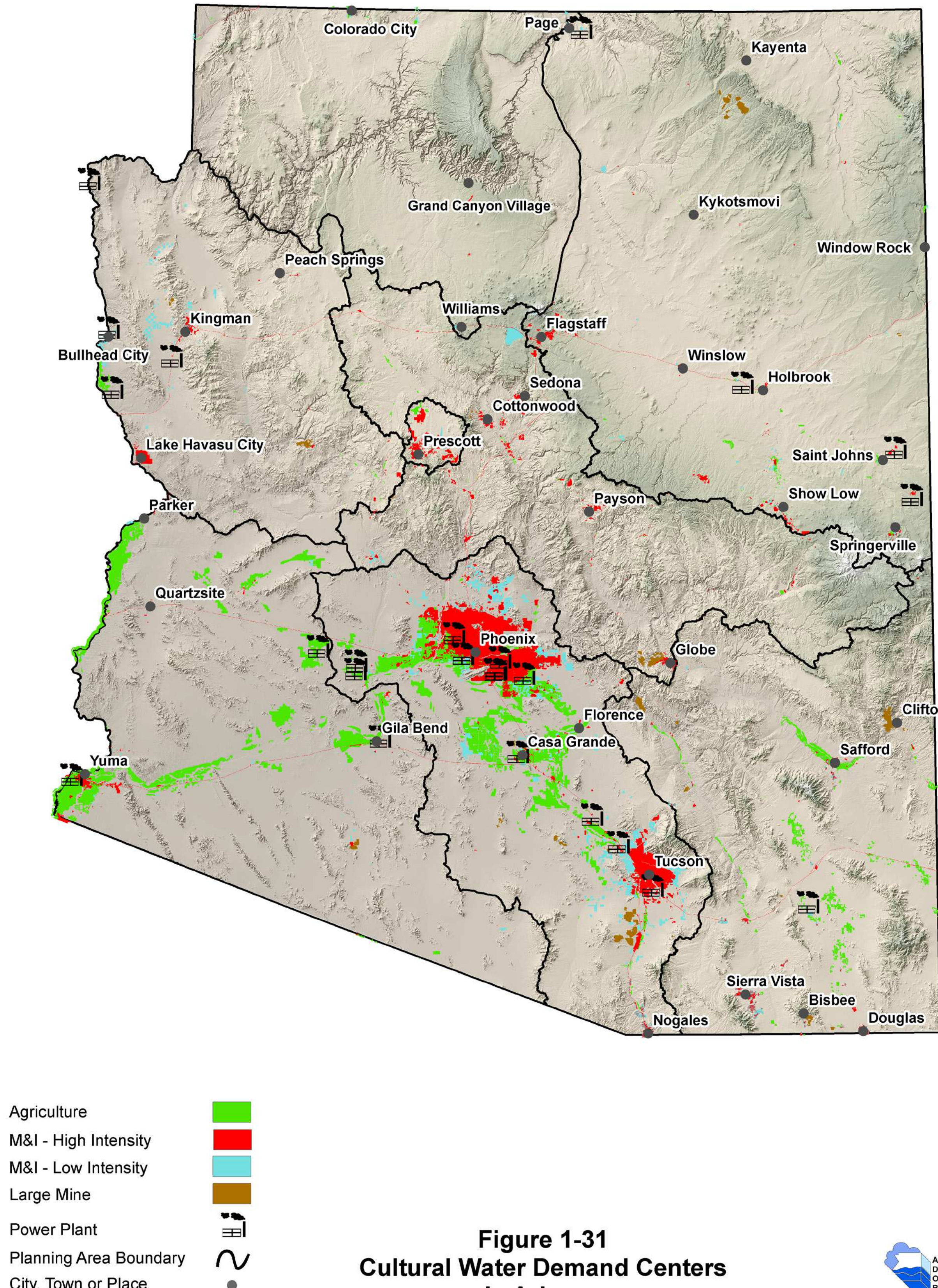


Figure 1-31
Cultural Water Demand Centers
in Arizona

ARIZONA DEPARTMENT OF WATER RESOURCES

Primary Data Source: USGS National Gap Analysis Program, 2004

Agricultural Demand

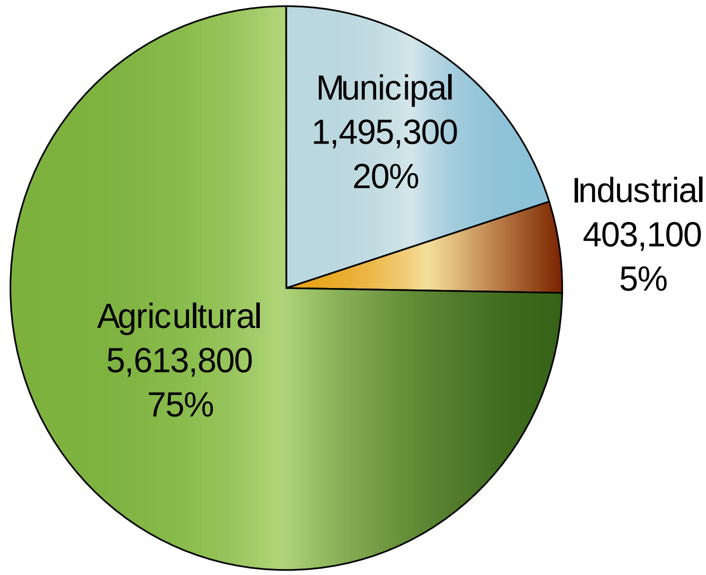
Agriculture continues to be the largest water demand sector in the state, accounting for 75% of water demand (not counting return flow) from 2001-2005 (Figure 1-32). Agricultural demand accounts for all but 2% of the total demand in the Lower Colorado River Planning Area, met primarily by Colorado River water. Agriculture is the largest demand sector in every planning area except the Eastern Plateau (Figure 1-30).

While current agricultural demand has declined in most planning areas from 1970-1980 levels, since 1990 agricultural demand has increased in the AMA, Lower Colorado River and Southeastern Arizona planning areas (Figure 1-33). Increasing agricultural use in the AMAs is due to a combination of new agricultural tribal lands, changes in cropping practices and cultivation of alfalfa rather than historic, lower water demand crops.

Agricultural use in the AMAs and INAs must be reported to the Department annually and holders of Colorado River water entitlements must report use annually to the Bureau of Reclamation. Elsewhere, basin demand has been estimated based on acreage, crops grown and irrigation method (see Appendix B).
Surface water meets most agricultural demand in the Upper Colorado River, Lower Colorado River, Eastern Plateau and Central Highlands

Agriculture in the AMA Planning Area. Agriculture continues to be the largest water demand sector in the state, accounting for 75% of water demand (not counting return flow) from 2001-2005 .

Figure 1-32 Average Annual Water Demand in Arizona by Sector, 2001-2005 (in AF and percentage of total)



planning areas. In the AMAs a mix of water supplies are utilized including groundwater, CAP water, in-state surface water and effluent (Figure 1-30). In the Eastern Plateau Planning Area, wastewater discharged from the Catalyst Paper Mill is applied to pasture and accounts for 27% of the agricultural water supply. Information on agricultural water demand by basin is found in Volumes 2-8.

Municipal Demand

Municipal demand is composed of water delivered by a public or private water system and pumped from domestic wells to serve individual homes or several homes. During 2001-2005, municipal demand accounted for about 20% of the statewide demand. Municipal water use data are reported annually in AMAs and in INAs (by users withdrawing more than ten acre-feet a year). In addition, beginning with the 2006 reporting year, community water systems statewide report annual water use to the Department. Domestic wells are generally not metered and because there are no reporting requirements anywhere in the state, domestic well demand must be estimated.

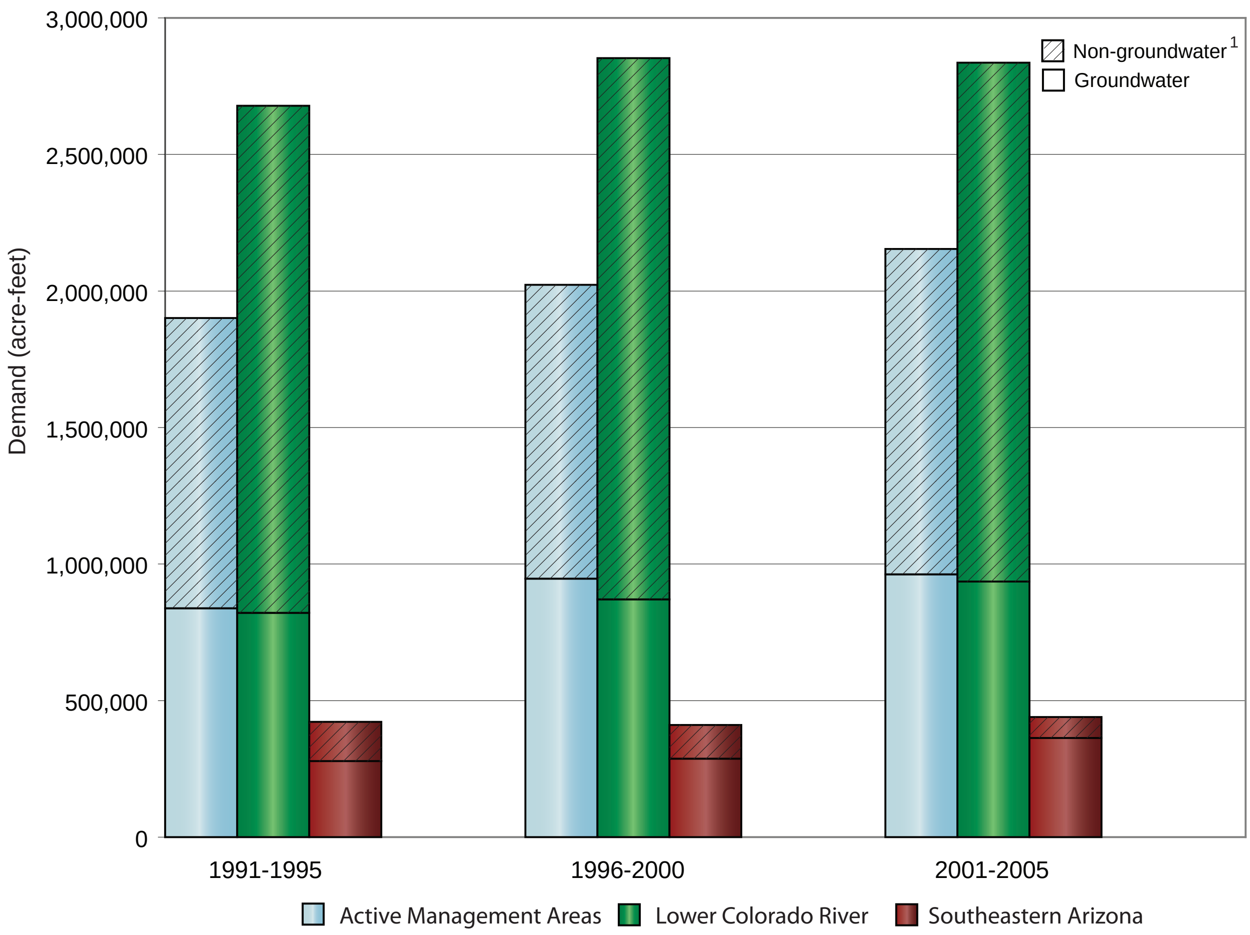
The percentage of municipal demand ranges from 1.5% in the Lower Colorado River Planning Area to 40% in the Western Plateau Planning Area. Municipal demand represents just 35% of the demand in the AMA Planning Area although most of the State's population resides in AMAs. Principal municipal supplies are groundwater with the exception of the AMA planning area where a mixture of CAP, in-state surface water, effluent and groundwater are used (Figure 1-30). Information on municipal basin and individual water system demand is found in Volumes 2-8.

Industrial Demand

Industrial demand, generally consisting of mining, electrical generation, dairies, feedlots and turf irrigation accounted for about 5% of the state total from 2001-2005. Industrial demand is defined as water used by an industrial facility that is not served by a municipal water system.

Industrial demand data are reported annually to the Department in the AMAs and INAs (by users withdrawing more than ten acre-feet a year) and collected for some types of industrial users by the USGS (USGS, 2007). Industrial demand is a significant demand sector in the

Figure 1-33 Average Annual Agricultural Water Demand for Selected Planning Areas



1 Non-groundwater may include surface water, effluent, CAP water and tailwater. In most basins outside of the AMAs, non-groundwater is surface water.

Source: ADWR, 2008f,g

Eastern Plateau Planning Area accounting for 49% of the demand and in the Central Highlands Planning Area at 22%. Elsewhere, industrial sector demand ranges from 0.5% to 13% of the planning area total (Figure 1-30).

Planning area industrial demand by industrial category is listed in Table 1-15. The primary industrial user in the Eastern Plateau and Lower Colorado River planning areas is power plants. Mining is the predominant industrial user in the Central Highlands, Southeastern Arizona and Upper Colorado River planning areas. Golf courses are the largest industrial use in the AMA and Western Plateau planning areas. Groundwater meets most of the industrial demand in every planning area, although 28% of the industrial demand in the AMA Planning Area is met with effluent delivered to the Palo Verde Nuclear Generating Station. Information on industrial basin and industrial category demand is found in Volumes 2-8.

Tribal Demand

Tribal water demand is included in the totals described above and varies significantly throughout the state although it is a relatively small component of planning area demands. As listed in Table 1-16, most tribal water demand is for agricultural irrigation. As Indian water right claims have been settled, several tribes including the Gila River Indian Community (Phoenix

Table 1-15 Average annual planning area industrial demand by category

	1991-1995	1996-2000	2001-2005
Type/*Planning Area*	**Water Use (acre-feet)**		
Power Plant			
Eastern Plateau	52,918	56,943	63,279
Southeastern Arizona	6,000	5,200	5,700
Upper Colorado River	0	0	4,900
Lower Colorado River	285	700	7,670
Active Management Areas	52,200	61,700	69,410
Turf[1]			
Eastern Plateau	1,266	1,326	1,596
Southeastern Arizona	1,596	1,806	2,316
Upper Colorado River	0	440	530
Central Highlands	2,910	3,010	3,334
Western Plateau	920	920	920
Lower Colorado River	440	440	440
Active Management Areas	53,300	70,100	77,800
Dairy/Feedlot			
Eastern Plateau	472	524	546
Southeastern Arizona	262	272	502
Upper Colorado River	0	0	80
Central Highlands	790	790	790
Western Plateau	30	30	30
Lower Colorado River	3,400	3,500	3,700
Active Management Areas	10,370	13,600	19,200
Mining[2]			
Eastern Plateau	11,144	11,445	6,241
Southeastern Arizona	48,195	47,085	25,831
Upper Colorado River	16,740	17,800	16,610
Central Highlands	17,900	14,100	14,160
Lower Colorado River	350	380	550
Active Management Areas	54,900	53,700	45,800
Other[3]			
Eastern Plateau	17,092	15,530	11,452
Southeastern Arizona	290	290	290
Lower Colorado River	2,600	2,900	1,200
Active Management Areas	16,900	18,000	21,620

Source: ADEQ 2005, ADWR 2008 f,g, and USGS 2007

[1] In the AMA Planning Area turf-related facilities include golf courses, schools, parks, cemeteries and common areas of subdivisions. Water use outside of the AMAs is predominately by golf courses.

[2] Mining uses include both hard rock mines and sand and gravel operations.

[3] Other category includes large cooling facilities, new large landscape, paper mills and other industrial users.

AMA) and Tohono O'odham Nation (Pinal and Tucson AMAs) have expanded their irrigated agricultural acreage with a commensurate increase in water demand. Information on tribal water demand is found in Volumes 2-8.

1.4.8 Water Resource Issues

A number of issues face communities and regions in Arizona including population growth and associated concerns about sustainable water supplies, lack of sufficient data to make informed water management decisions, drought, legal questions related to surface water availability, aging water delivery infrastructure, insufficient financial resources, water level declines, environmental protection, and Endangered Species Act (ESA) implications. These concerns have resulted in groundwater studies, regional planning, legislation, establishment of conservation easements and other activities. Issues vary from area to area and are discussed

Table 1-16 Average annual water demand on Arizona Indian Reservations (2001-2005)

<table>
<tr><th rowspan="2">Planning Area/Reservation</th><th rowspan="2">Population (2000 Census)</th><th colspan="3">Groundwater/Surface Water (acre-feet)</th></tr>
<tr><th>Agricultural</th><th>Municipal</th><th>Industrial</th></tr>
<tr><td>Eastern Plateau</td><td>111,800</td><td rowspan="5">0/1,550[1]</td><td rowspan="5">11,040/160</td><td rowspan="5">0[2]</td></tr>
<tr><td>Navajo</td><td>104,600</td></tr>
<tr><td>Hopi</td><td>6,900</td></tr>
<tr><td>San Juan Southern Paiute</td><td>300</td></tr>
<tr><td>Zuni</td><td>NA</td></tr>
<tr><td>Southeastern Arizona</td><td>8,300</td><td rowspan="2" colspan="2">~5,300</td><td rowspan="2">0</td></tr>
<tr><td>San Carlos Apache</td><td>8,300</td></tr>
<tr><td>Upper Colorado River</td><td>2,200</td><td rowspan="3">NA</td><td rowspan="3">~300</td><td rowspan="3">0/4,000</td></tr>
<tr><td>Fort Mojave</td><td>800</td></tr>
<tr><td>Hualapai</td><td>1,400</td></tr>
<tr><td>Central Highlands</td><td>21,200</td><td rowspan="5">200/3,750</td><td rowspan="5">700/60</td><td rowspan="5">0</td></tr>
<tr><td>Fort Apache</td><td>20,400</td></tr>
<tr><td>Tonto Apache</td><td>100</td></tr>
<tr><td>San Carlos Apache</td><td>NA</td></tr>
<tr><td>Yavapai-Apache</td><td>700</td></tr>
<tr><td>Western Plateau</td><td>3,950</td><td rowspan="4">46</td><td rowspan="4">310</td><td rowspan="4">0</td></tr>
<tr><td>Havasupai</td><td>650</td></tr>
<tr><td>Kaibab-Paiute</td><td>200</td></tr>
<tr><td>Navajo</td><td>3,100</td></tr>
<tr><td>Lower Colorado River</td><td>10,850</td><td rowspan="6" colspan="2">658,000</td><td rowspan="6">0</td></tr>
<tr><td>Cocopah</td><td>1,000</td></tr>
<tr><td>Colorado River Indian Tribes</td><td>3,400</td></tr>
<tr><td>Gila Bend</td><td>600</td></tr>
<tr><td>Fort Yuma (Quechan)</td><td>50</td></tr>
<tr><td>Tohono O'odham</td><td>5,800</td></tr>
<tr><td>Active Management Areas</td><td>34,730</td><td rowspan="8">135,600/131,600[3]</td><td rowspan="8">8,900/200</td><td rowspan="8">1,300/0</td></tr>
<tr><td>Ak-Chin</td><td>750</td></tr>
<tr><td>Fort McDowell Yavapai</td><td>900</td></tr>
<tr><td>Gila River</td><td>14,000</td></tr>
<tr><td>Pascua Yaqui</td><td>7,700</td></tr>
<tr><td>Salt River Pima-Maricopa</td><td>6,200</td></tr>
<tr><td>Tohono O'odham</td><td>5,000</td></tr>
<tr><td>Yavapai-Prescott</td><td>180</td></tr>
</table>

Sources: ACC (2005); ADWR (1992, 2007, 2008f,g,h,i); BIA (1998); BOR(2006), CAP (2008); ITCA (2008); Truini and others (2005); USGS (2007, 2008b)
NA = Not Available
[1] Navajo irrigated acreage estimated based on 2005 aerial imagery. Does not include dryland farming by the Hopi Tribe and Navajo Nation.
[2] Does not include water withdrawn from tribal lands leased by Peabody Energy for use at the Black Mesa Mines
[3] Includes CAP water

for each planning area in Volumes 2-8. Appendix I lists issues identified by watershed groups in Arizona organized by planning area.

Water resource issues have been identified by community groups, through the distribution of surveys and from other sources. While not a complete list, some of the key issues identified in each planning area are listed below.

Eastern Plateau

- Accessibility of groundwater supplies in some areas due to hydrologic conditions and water quality problems
- Infrastructure deficiencies that influence access to water supplies
- Lack of financial resources for infrastructure development or repair
- Drought impacts on surface water supplies
- Ability to meet future water demands for many communities
- Widespread water hauling on the Navajo Reservation and other locations
- Resolution of Indian water rights settlements
- Impact of mine pumping on tribal water supplies

Southeastern Arizona

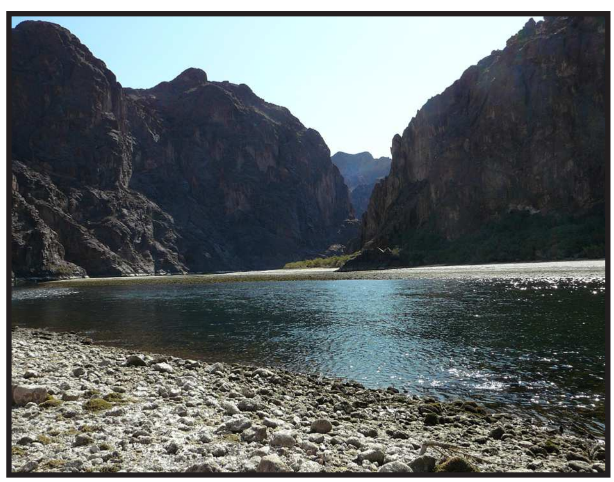
- Population growth and associated concerns about sustainable water supplies
- Water level declines and land subsidence in some areas
- Increasing agricultural demand in some areas
- Insufficient data to make informed water management decisions
- Legal issues related to surface water availability and the legal nature of water supplies
- ESA implications and environmental protection
- Aging infrastructure and the lack of financial resources to make capital improvements

Upper Colorado River

- Large master-planned communities proposed in Detrital Valley, Hualapai Valley and Sacramento Valley basins
- Potential for extensive solar power development and associated water demand
- Unregulated lot splits and large number of domestic wells with associated lack of regulation
- Limited groundwater data in many areas and limited funding for studies, planning, projects and infrastructure
- Limited groundwater and Colorado River water supplies
- Colorado River accounting surface rulemaking and impacts on water users

Central Highlands

- Unregulated lot splits and large number of existing and projected private domestic wells
- Significant projected growth
- Limited and deep (costly) groundwater supplies available to meet current and projected demands
- Drought-sensitive groundwater and surface water supplies
- Seasonal demand/peaking problems in Payson/Pine/Strawberry area
- Lack of access to water development on public lands



Colorado River, Upper Colorado River Planning Area.

Roosevelt Lake, Central Highlands Planning Area.

- Inter basin water transfer conflicts (Big Chino, Payson)
- Subflow/adjudication decisions and potential impact on legal access to water
- Limited funding for planning, projects, infrastructure, augmentation and studies
- ESA issues involving critical habitat and pumping impacts on perennial streams
- Environmental issues pertaining to Fossil Creek and the Verde River

Western Plateau
- Limited and deep (costly) groundwater supplies; physical accessibility issues in areas
- Drought sensitive and inadequate surface water supplies in some areas
- Need to develop water supply alternatives to meet current and future demands
- Lack of sufficient financial resources for planning, projects, water supply development and studies; limited groundwater data
- Concerns regarding resource development and environmental needs e.g. potential for groundwater development to impact springs in the Grand Canyon and on tribal lands
- Interstate stream issues involving the Virgin River
- Numerous water haulers with few hauling stations sometimes cut-off during drought

Lower Colorado River
- Equitable Colorado River shortage sharing
- Issues related to transfers of Colorado River entitlements
- Colorado River accounting surface rulemaking and impacts on water users
- Consequences related to compliance with the International Treaty with Mexico
- Salinity control and water quality
- Groundwater transportation issues; groundwater may be withdrawn and transported outside the planning area from three designated basins
- Environmental protection and restoration
- Local management of water resources to meet the needs of growing communities while maintaining the agricultural economy

Active Management Area
- Allowable groundwater pumping conflicts with meeting AMA goal
- Feasibility of meeting AMA management goals by 2025
- Drought sensitivity of CAP supplies
- Physical and legal access to limited renewable water supplies
- Need to construct infrastructure and secure necessary funding to allow full use of renewable water supplies
- Concerns about the spatial disconnect between water storage (recharge) and pumping location
- Statutory differences between groundwater and non-groundwater and conjunctive use
- Desire for environmental protection and restoration in some areas with associated allocation of water resources
- Mechanism needed to address water management problems in specific geographic areas
- Long term roles of the Central Arizona Groundwater Replenishment District (CAGRD) and the Arizona Water Banking Authority to ensure long-term availability of

renewable supplies

• Increasing salinity in groundwater and soil from use of CAP, surface water and effluent

In March 2003, the Department sent a questionnaire to over 600 rural water providers, cities and towns, counties and tribal governments in order to gather information on drought impacts in support of preparation of the Arizona Drought Preparedness Plan. It was also hoped that information could be gathered about water supply and demand issues in rural Arizona to support other projects. Results from the survey were published in October 2004 (ADWR, 2004).

Four priority issues were mentioned consistently: the need for additional water supplies for future needs, lowering water tables, aging infrastructure, and inadequate sources of capital to pay for infrastructure improvements. Interestingly, while many respondents reported that domestic wells were a significant source of water for households in their area, few mentioned that they caused any water supply problems.

To support this initial information gathering effort and to collect additional information for the Atlas, the Department conducted a second, brief, direct-contact survey in 2004, focused on 360 rural water providers. Because of the direct contact effort, response was received from 246 water providers, a 65% response rate. The 2004 survey lacked the drought and growth impact focus of the 2003 survey but included questions about water demand and supply, water-level trends, metering and water quality.

Results of the issues ranking portion of the 2004 survey, with 212 total responses, are summarized in Table 1-17. Shown is the percentage of respondents reporting that the listed issue was a moderate or major concern, with the highest three percentages in each planning area highlighted in bold. As shown, the lack of capital for infrastructure repair was most often identified as an issue of moderate or major concern in every planning area. Although results vary between planning areas, other common priority issues were infrastructure in need of repair, inadequate storage capacity to meet peak demand and drought. A summary of survey results for each planning area are found in Volumes 2-7.

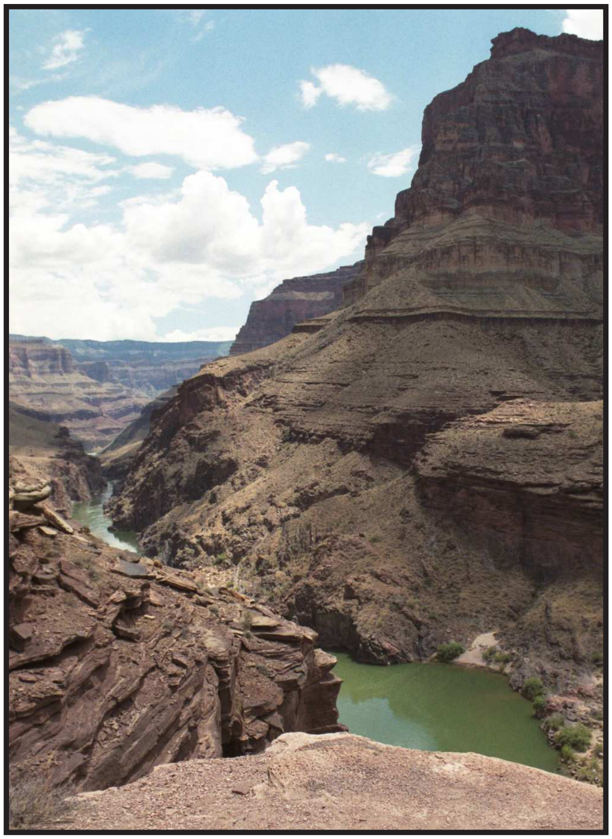
Current and Future Developments in State Water Planning

Several current statewide initiatives focus on assessing future water needs and promoting

Table 1-17 Percent of 2004 survey respondents reporting issue was a moderate or major concern

Issue	Planning Area					
	Eastern Plateau (39 respondents)	Southeastern Arizona (44 respondents)	Upper Colorado River (23 respondents)	Central Highlands (66 respondents)	Western Plateau (10 respondents)	Lower Colorado River (30 respondents)
Inadequate storage capacity to meet peak demand	**31%**	34%	30%	13%	**43%**	**26%**
Inadequate well capacity to meet peak demand	28	25	26	18	14	10
Inadequate water supplies to meet current demand	13	20	13	15	**43**	6
Inadequate water supplies to meet future demand	**31**	32	35	32	**43**	23
Infrastructure in need of replacement	**49**	**41**	**39**	**36**	29	**45**
Inadequate capital to pay for infrastructure improvements	**56**	**61**	**44**	**38**	**71**	**58**
Drought related water supply problems	26	**39**	**39**	**38**	29	6

Source: ADWR, 2005



Colorado River, Western Plateau Planning Area

water sustainability. These efforts include the Blue Ribbon Panel on Water Sustainability, the Water Resource Development Commission, the Colorado River Basin Water Supply and Demand Study, Bureau of Reclamation appraisal and feasibility level studies, and Volume 9 of the Arizona Water Atlas. These efforts are discussed briefly below and represent a comprehensive approach to evaluating Arizona's future water needs.

Governor Brewer established the Blue Ribbon Panel on Water Sustainability in August 2009 with a final report due November, 2010. Its purpose is to *"advance water sustainability statewide by increasing reuse, recycling, and conservation to protect Arizona's water supplies and natural environment while supporting continued economic development and to do so in an effective, efficient and equitable manner"*. The Panel's goal is to provide recommendations on statute, rule, and policy changes that, by the year 2020 will significantly:

1. Increase the volume of reclaimed water reused for beneficial purposes in place of raw or potable water;
2. Advance water conservation, increase the efficiency of water use by existing users, and increase the use of recycled water for beneficial purposes in place of raw or potable water;
3. Reduce the amount of energy needed to produce, deliver, treat, and reclaim and recycle water by the municipal, industrial, and agricultural sectors;
4. Reduce the amount of water required to produce and provide energy by Arizona power generators; and
5. Increase public awareness and acceptance of reclaimed and recycled water uses and the need to work toward water sustainability.

The Water Resource Development Commission was legislatively established in 2010 (H.B. 2661) to assess current and future water needs in Arizona including identification of future supplies and financing mechanisms for water supply acquisition and infrastructure. The Commission must prepare a report including recommendations and suggested legislation by October 2011. The Commission is expected to integrate the findings from studies mentioned in this sub-section in its analysis.

The Colorado River Basin Water Supply and Demand Study is a comprehensive regional study involving the Bureau of Reclamation and representatives of the seven Colorado River Basin States. Beginning in January 2010, the study will define current and future imbalances in water supply and demand in the Colorado River Basin and adjacent areas of the Basin States that receive Colorado River water for approximately the next 50 years. The study, to be completed by January 2012, will also develop and analyze adaptation and mitigation strategies to resolve those imbalances (BOR, 2010b). In Arizona the initial phase of the study included generation of population, water supply and demand projections through 2060 for those areas of the state that use, or plan to use, Colorado River water (including CAP water).

At a more local level, several appraisal studies have been completed in rural Arizona under the Bureau of Reclamation's Rural Water Program (RWP) including North Central Arizona, the Mogollon Highlands and the Sierra Vista Subwatershed. An appraisal study is also underway for the Central Yavapai Highlands. Under the RWP, an appraisal level study is conducted to evaluate water supply and demand conditions and prepare a preliminary assessment of alternatives to determine if there is a viable alternative to warrant a more detailed investigation at the feasibility level. Investigations have progressed to the feasibility level in the Sierra Vista Subwatershed, North Central Arizona and Mogollon Highlands study areas. A feasibility study is a detailed investigation that identifies a preferred alternative to meet future needs. (BOR, 2010c)

Volume 9 of this Atlas (Water Sustainability Assessment) will evaluate water resource vulnerability and sustainability conditions across Arizona to support and improve water planning and management decisions at the state, regional and local level. "Sustainability" will be defined differently in different parts of the state depending on local management goals. This assessment will compile and incorporate information from Atlas Volumes 2-8, other water supply and demand studies and previously conducted evaluations and public processes including those mentioned above.

As Arizona continues to grow and water demands increase, local development of water resources will increasingly be influenced by statewide and regional conditions. Water management and planning will need to extend beyond local boundaries as interrelationships often exist across the state, both rural and urban. The recent efforts summarized above should provide additional information and strategies to address Arizona's water needs now and in the future and hopefully resolve the most pressing issues identified within planning areas.

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ACRONYMS AND ABBREVIATIONS

A.A.C.	Arizona Administrative Code
A.R.S.	Arizona Revised Statutes
AACD	Arizona Association of Conservation Districts
ACC	Arizona Corporation Commission
ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
AF	Acre-feet
ALERT	Automated Local Evaluation in Real Time
ALRIS	Arizona Land Resource Information System
AMA	Active Management Area
APP	Aquifer Protection Permit
ARS	Agricultural Research Service
AWBA	Arizona Water Banking Authority
AWPF	Arizona Water Protection Fund
AWS	Assured Water Supply
AZGF	Arizona Game and Fish
AZMET	Arizona Meteorological Network
BIA	Bureau of Indian Affairs (U.S.)
BLM	Bureau of Land Management (U.S.)
BOR	Bureau of Reclamation (U.S.)
CAGRD	Central Arizona Groundwater Replenishment District
CAP	Central Arizona Project
CAWCD	Central Arizona Water Conservation District
CCN	Certificate of Convenience and Necessity
CDP	Census Designated Place
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act - 42 U.S.C. Section 9601 *et seq.*
cfs	Cubic feet per second
CLIMAS	Climate Assessment for the Southwest
CODE	Arizona Groundwater Management Act - A.R.S. § 45-401 *et seq.*
COE	Corps of Engineers (U.S.)
CRWUA	Colorado River Water Users Association
CU	Consumptive use
CWA	Clean Water Act - 33 U.S.C. Section 1251 *et seq.*
CWN	Clean Water Needs
Department	Arizona Department of Water Resources
DES	Arizona Department of Economic Security
DLG	Digital Line Graph
DOD	Department of Defense (U.S.)
DOE	Department of Energy (U.S.)
DOI	Department of Interior (U.S.)
DWID	Domestic Water Improvement District
EA	Environmental Assessment
EIS	Environmental Impact Statement
ENSO	El Nino/Southern Oscillation
EPA	Environmental Protection Agency (U.S.)
ESA	Endangered Species Act - 7 U.S.C. 136; 16 U.S.C. 460 *et seq.*

FMIC	Fort McDowell Indian Community
ft bls	Feet below land surface
GIS	Geographic Information System
GNIS	Geographic names information system
GPCD	Gallons Per Capita Per Day
GPHUD	Gallons Per Housing Unit Per Day
gpm	Gallons per minute
GPS	Global Positioning Station
GRIC	Gila River Indian Community
GSF	Groundwater Savings Facility
GWSI	Groundwater Site Inventory
HCN	Historic Climate Network (U.S.)
HMS	Hydrologic Map Series
HOA	Home Owners Association
HUC	Hydrologic Unit Code
HSR	Hydrographic Survey Report
IBWC	International Boundary Water Commission
ID	Irrigation District
IHS	Indian Health Service
INA	Irrigation Non-expansion Area
ISPE	Institute for the Study of Planet Earth (University of Arizona)
LAIAG	Local Area Impact Assessment Group
LCR	Little Colorado River
LCRWCC	Little Colorado River Watershed Coordinating Council
LUST	Leaking Underground Storage Tank
maf	Million acre-feet
MCL	Maximum Containment Level
mg/l	Milligrams per liter
mgd	Million gallons per day
MSCP	Multi-Species Conservation Plan
NEPA	National Environmental Policy Act - 42 U.S.C. § 4321-4347
NAU	Northern Arizona University
NDEQ	Navajo Department of Environmental Quality
NDWR	Navajo Department of Water Resources
NHA	Navajo Housing Authority
NHD	National Hydrography Data Set
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent to Drill a Well
NPDES	National Pollution Discharge Elimination System
NPL	National Priorities List
NPS	National Park Service (U.S.)
NRA	National Recreation Area
NRCD	Natural Resources Conservation District
NRCS	Natural Resources Conservation Service
NTUA	Navajo Tribal Utility Authority
NWIS	National Water Information System
NWS	National Weather Service
Pan ET	Pan evaporation

PCE	Tetrachloroethylene
P.L.	Public Law
POD	Point of diversion
POU	Point of use
ppb	Parts per billion
ppm	Parts per million
PRISM	Parameter elevation Regression on Independent Slopes Model
PWC	Private Water Company
RCD	Resource Conservation District
RCRA	Resource Conservation and Recovery Act – 42 U.S.C. § 6901 *et seq*.
RRA	Reclamation Reform Act - 43 U.S.C. § 390aa *et seq.*
RVID	Round Valley Irrigation District
RWCD	Roosevelt Water Conservation District
SAWRSA	Southern Arizona Water Rights Settlement Act- P.L. 108-451 (2004)
SCAS	Spatial Climate Analysis Service
SDW	Safe Drinking Water Act- 43 U.S.C. § 300f *et seq.*
Secretary	U.S. Secretary of the Interior
SLD	Arizona State Land Department
SNOTEL	SNOwpack TELemetry
SOC	Statement of Claimant
SPRNCA	San Pedro Riparian National Conservation Area
SRIM	Statewide riparian inventory and mapping
SRP	Salt River Project
TDS	Total dissolved solids
TEPCO	Tucson Electric Power Company
TCE	Trichloroethylene
TMDL	Total maximum daily load
TMP	Third management plan
TNC	The Nature Conservancy
UMTRA	Uranium Mill Tailings Remedial Action
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
USF	Underground Storage Facility
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	Underground Storage Tank
VOC	Volatile organic compound
VRP	Voluntary Remediation Program
WAPA	Western Area Power Administration
WID	Water improvement district
WIFA	Water Infrastructure Funding Authority
WMAT	White Mountain Apache Tribe
WQARF	Water Quality Assurance Revolving Fund
WRCC	Western Regional Climate Center
WWTP	Wastewater treatment plant

DEFINITIONS

Acre-feet (AF): The amount of water it takes to cover one acre of land to the depth of one foot, approximately 325,851 gallons.

Active management area (AMA): A geographic area that has been designated pursuant to A.R.S.§ 45-411 as requiring active management of groundwater or, in the case of the Santa Cruz AMA, active management of any water, other than stored water, withdrawn from a well. Subsequent active management areas may be designated through local initiative or by the Director of ADWR.

Advanced primary treatment: The enhanced removal of suspended solids and organic matter in the wastewater treatment process through the use of chemicals and/or filtration.

Advanced treatment I: A wastewater treatment level that is more stringent than secondary treatment and reduces the organic and inorganic substances from the treated wastewater through the use of chemical and physical techniques. It is often referred to as tertiary treatment.

Advanced treatment II: Highest level of wastewater treatment with a BOD < 10 mg/l and/or the removal of nutrients.

Agricultural water use: Water applied to two or more acres of land to produce plants or parts of plants for sale for human consumption or for use as feed for livestock, range livestock or poultry.

Aquifer: A geologic formation that contains sufficient saturated materials to be capable of storing water and transmitting water in useable quantities to a well.

Aquifer recharge: Water added to the aquifer through seepage and infiltration.

Aquifer storage: Water stored underground for future use. Also, water stored pursuant to a permit issued under A.R.S. § 45-831.01, the Underground Water Storage, Savings and Replenishment Program.

Artificial recharge: Water recharged to the aquifer through recharge projects, which may be recovered in the future based on accrued recharge credits.

Baseflow: The part of a stream discharge that is not attributable to direct runoff from precipitation or melting snow. It is sustained by groundwater discharge and may be considered as normal day-to-day flow during most of the year.

Baseline: A surveyed line that serves as a reference to which surveys are coordinated and correlated.

Basin fill: Unconsolidated material such as sand, gravel and silt, eroded from surrounding mountains and deposited in a valley.

Basin sweep: A technique used to collect information on groundwater level conditions by measuring selected wells throughout a basin. Specific and randomly selected wells are measured to provide the best aerial and vertical coverage in the basin.

Calendar year: The 12-month period from January 1 to December 31.

Census blocks: A geographic area bounded by visible and/or invisible features shown on a map prepared by the U.S. Census Bureau. A block is the smallest geographic entity for which the Census Bureau tabulates decennial census data.

Census designated place: A geographic entity that serves as the statistical counterpart of an incorporated place for the purpose of presenting census data for an area with a concentration of population, housing, and commercial structures that is identifiable by name, but is not within an incorporated place.

Consumptive use: The part of the water demand that becomes unavailable for future use because it is evaporated or consumed by the use. Consumptive use also refers to diversions from the mainstream of the Colorado River minus the returns.

Contamination site: A geographic area where the quality of the water and/or soil quality is naturally hazardous to animals or humans or has been impaired by sewage, industrial wastes, or other materials and where remediation is either ongoing, scheduled for the future or not practicable.

Continuous flow gage: Mechanical device placed in a stream that measures the volume of water flowing at that specific location over an extended period of time.

Community Water System: A public water system, as defined in A.R.S. § 49-352(B), that serves at least fifteen service connections used by year-round residents of the area served by the system or that regularly serves at least twenty-five year-round residents of the area served by the system. A person is a year-round resident of the area served by a system if the person’s primary residence is served water by that system.

Cultural water demand: The quantity of water diverted from streams and reservoirs and pumped from wells for municipal, industrial and agricultural purposes. It should not be confused with “consumptive use”, which refers to the amount of cultural water demand that is lost from the hydrologic system.

Deficit irrigation: The practice of reducing the number of irrigation applications to lower crop production costs while achieving acceptable yields.

Drinking water standards: Criteria developed by the Arizona Department of Environmental Quality and other state and local agencies, the US Public Health Service, and the US Environmental Protection Agency to assure safe water for human consumption.

Drought: A sustained natural reduction in precipitation that results in negative impacts to the environment and human activity.

Dry lake: A basin that formally contained a lake.

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

Effluent dependent water: Surface waters that would generally be ephemeral, except for the discharge of treated effluent.

Ephemeral stream: A stream or part of a stream that flows only in direct response to precipitation; it receives little or no water from springs, melting snow or other sources; its channel is at all times above the water table.

Evaporation pan: An open tank used to measure the amount of evaporation. The US Department of Commerce Weather Station Class A pan is 4 feet in diameter and 10 inches deep set so the top rim is 16 inches above ground.

Evapotranspiration: Loss of water from the land through transpiration of plants and evaporation from the soil and surface water bodies.

Exempt well: Within an AMA, a well having a pump with a maximum pumping capacity of 35 gallons per minute or less, which is used to withdraw groundwater for non-irrigation purposes. This term is also used to describe any well outside an AMA having a pump with a maximum pumping capacity of 35 gallons per minute or less.

Groundwater: Generally, water below the earth's surface but commonly applied to water in fully saturated soils and geologic formations.

Groundwater flow model: A digital computer model that calculates a hydraulic head field for the modeling domain using numerical methods to arrive at an approximate solution to the differential equation of groundwater flow.

Groundwater savings facility: A facility that meets the requirements of section 45-812.01 in an active management area or an irrigation non-expansion area at which groundwater withdrawals are eliminated or reduced by recipients who use in lieu water on a gallon-for-gallon substitute basis for groundwater that otherwise would have been pumped from within that active management area or irrigation non-expansion area.

Hydrograph: A graphic representation of the changes in the flow of water or the elevation of water levels over time.

Igneous rock: A rock formed by the crystallization of magma or lava.

Impaired: A lake or stream that is not meeting one or more surface water quality standards as established in A.R.S. § 49-231

Incidental recharge: The percolation of water to the water table after the water has been used. Components of incidental recharge include recharge that occurs from septic tanks, turf watering and effluent discharge.

Index well: A well that is measured during specific periods or continuously monitored by automatic recorders. These wells allow a lower density of representative monitoring to occur in the years between "sweeps".

Industrial demand: Water used by an industrial facility, such as a golf-course, dairy, feedlot, power plant, mine or paper mill, and that is served by the industrial facility's well.

Inflow: All water that enters a hydrologic system. Examples include mountain front and stream channel recharge, artificial and incidental recharge and baseflow and underflow into a system.

In-lieu water: Water that is delivered to a groundwater savings facility in an AMA or INA and that is used at the facility by the recipient on a gallon for gallon substitute basis for groundwater that otherwise would have been pumped from within the AMA or INA.

Irrigation non-expansion area (INA): A geographic area that has been designated pursuant to A.R.S. §§ 45-431 or 45-432 as having insufficient groundwater to provide a reasonably safe supply for the irrigation of cultivated lands at the current rate of withdrawal.

Instream flow right: A non-diversionary surface water right for recreation and wildlife purposes, including fish.

Intermittent lake: A lake that normally contains water for only a portion of the year or one that is only seasonally dry.

Intermittent stream: A stream or part of a stream that flows only at certain times of the year when it receives water from springs, snowmelt, surface run-off or other sources.

Jurisdictional dam: Any artificial barrier, including appurtenant works, for the impounding or diversion of water, 25 feet or more in height or with storage capacity more than 50 acre-feet, except:
(a) Any barrier that is or will be less than six feet in height, regardless of storage capacity;
(b) Any barrier that has or will have a storage capacity of fifteen acre-feet or less, regardless of height;
(c) Any barrier for the purpose of controlling liquid-borne material;
(d) Any barrier that is a release-contained barrier; or
(e) Any barrier that is owned, controlled, operated, maintained or managed by the United States government or its agents or instrumentalities if a safety program that is at least as stringent as the state safety program applies and is enforced against the agent or instrumentality.

Maximum storage capacity: Total storage space in a reservoir below the maximum attainable water surface elevation, including any surcharge storage.

Meridian: A surveyed line that serves as a reference to which surveys are coordinated and correlated.

Metamorphic rock: A rock that is the product of heat, pressure, and chemical activity so that some or all of its minerals are re-crystallized and may show preferred orientation.

Municipal demand: All non-agricultural uses of water supplied by a city, town, private water company, irrigation district, domestic water improvement district, water cooperative or private domestic well.

Non-exempt well: Within an AMA, a well having a pump with a maximum pumping capacity of more than 35 gallons per minute and used for non-irrigation purposes or any well used for irrigation purposes. This term is also frequently used to describe any well outside an AMA having a pump with a maximum pumping capacity greater than 35 gallons per minute.

Non-jurisdictional dam: An artificial barrier for impounding water that does not qualify as a jurisdictional dam.

Normal storage capacity: the total volume, in acre-feet, at the normal retention level, including dead and inactive storage and excluding flood control and surcharge storage.

Outflow: All water that leaves a hydrologic system. Examples include cultural water demand, phreatophyte use and underflow and baseflow out of the system.

Pan evaporation: Evaporation in inches from a standard Weather Bureau Class A pan.

Peak flow gage: A mechanical device that measures the maximum instantaneous discharge of a stream or river at a given location. Peak flow usually occurs at the time of maximum stage.

Perennial stream: A stream or part of a stream with surface flow throughout the year, drying only during periods of drought.

Period of record: The length of time represented in the data.

Phreatophyte: A deep-rooted plant that obtains it water from a permanent groundwater supply.

Primary treatment: The first stage in wastewater treatment where some solids and organic material are removed by screening and sedimentation. It removes about 35% of the biochemical oxygen demand (BOD) and less than half of the metals or toxic organic substances.

Range: In the U.S. Public Land Survey System, any series of contiguous townships aligned north and south and numbered consecutively east to west from a prime meridian to which it is parallel.

Recent stream alluvium: Unconsolidated clay, sand, silt or gravel that has been recently deposited, from a geological perspective, by a stream or running water along the stream channel, on its flood plain or at the base of a mountain slope.

Reference crop evapotranspiration (Eto): An estimate of the water used by a well-watered, full-cover grass surface, 8-11.5 cm in height (the reference crop).

Reservoir: An artificially created lake where water is collected and stored for future use.

Return Flow: The amount of water that reaches a groundwater or surface water source after release from the point of use and thus becomes available for further use. In other words, that part of a diverted flow, which is not consumptively used and returns to its original source or another body of water.

Run-off: The portion of precipitation that is not intercepted by vegetation, absorbed by land surfaces or evaporated and that flows overland into a depression, lake, stream or ocean.

Secondary treatment: The second stage in wastewater treatment that involves both chemical and biological processes. The screened wastewater is passed through a series of holding and aeration tanks and ponds further removing organic and inorganic substances. Disinfecting with chlorine may be included.

Secondary treatment with nutrient removal: An additional process in the secondary treatment of wastewater that removes nutrients such as nitrogen and phosphorus.

Section: In the US Public Land Survey System, one of the 36 subdivisions of a township. A section represents 1 square mile or 640 acres.

Sedimentary rock: A rock formed by the accumulation and consolidation of loose sediments in layered deposits.

Snowcourse: A permanent site where measurements of snow depth and snow water equivalent are taken at multiple locations by trained observers. A Snowcourse is generally 1,000 feet long and located in small meadows protected from the wind.

Snow water equivalent (SWE): The amount of water contained in the snowpack that would theoretically appear if the snow were melted all at once; also known as snow water content.

Spring: A place where water emerges naturally from the earth without artificial assistance onto the land surface or into a body of surface water.

Stockpond: An impoundment of any size that stores appropriable water and that is for the sole purpose of watering livestock and wildlife.

Superfund: The federal government's program to clean up the nation's uncontrolled hazardous waste sites, also known as "CERCLA," the Comprehensive Environmental Response, Compensation and Liability Act of 1980, 42 U.S.C. §§ 9601, *et seq*.

Surface water: An open body of water such as a stream, lake, or reservoir.

Surface water standards: Numeric and narrative criteria developed to ensure surface water quality for 6 designated uses; aquatic and wildlife, body contact, fish consumption, domestic water source, and agricultural use for irrigation or livestock watering.

Tertiary treatment: Wastewater treatment beyond the secondary or biological stage that includes the removal of nitrogen and phosphorus and a high percent of suspended solids through chemical and mechanical means such as additional filtration, carbon adsorption, distillation and reverse osmosis.

Township: A unit of survey in the U.S. Public Land Survey System that represents a piece of land that is bounded on the east and west sides by meridians approximately 6 miles apart.

Underflow: The downstream flow of water through permeable deposits underlying a stream.

Underground storage facility: means a constructed underground storage facility or a managed underground storage facility. “Constructed underground storage facility” means a facility that meets the requirements of section 45-811.01 and that is designed and constructed to store water underground pursuant to permits. “Managed underground storage facility” means a facility that meets the requirements of section 45-811.01 and that is designed and managed to utilize the natural channel of a stream to store water underground pursuant to permits through artificial and controlled releases of water other than surface water naturally present in the stream. Surface water flowing in its natural channel is not a managed underground storage facility.

Volcanic rock: A finely crystalline or glassy igneous rock resulting from volcanic action at or near the earth’s surface.

Water Adequacy Program: The program implementing A.R.S. § 45-108, requiring a developer of subdivided land outside an AMA to obtain a determination from the Department regarding the availability of water supplies before the land may be marketed for sale or lease to the public, unless the land will be served by a water provider designated as having an adequate water supply. Under this regulatory program, developers are required to disclose a determination that the water supply is inadequate to potential buyers.

Water duty: The amount of water that is reasonable to apply to irrigated land to produce a crop. The water duty accounts for field location and soil type, and incorporates consumptive use, evaporation and seepage from the farm water delivery system and the water that is returned to the soil via percolation and runoff.

Water year: A 12-month period beginning on October 1 and ending on September 30. The water year is designated by the calendar year in which it ends, e.g. the 2006 water year ends September 30, 2006.

Well yield: The volume of water discharged from a well in gallons per minute or cubic meters per day.

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APPENDIX A: PLANNING AREA VOLUME CONTENT

APPENDIX A
Planning Area Volume Content

The standard basin and AMA maps, figures and tables found in Volumes 2-8 are listed below. Additional maps, figures and tables may be found for some basins such as sub-basin maps and surface water hydrographs.

Basin and AMA Maps and Figures

1. Geographic Features
   Topographic map with principal places
2. Land Ownership
   Landownership categories ≥ 0.1%
3. Precipitation and Meteorological Stations
   Location of NOAA, NWS, AZMET, Pan ET, SNOTEL and Snowcourse stations keyed to climatic data table
4. Surface Water Conditions
   Major rivers and streams, unit runoff contours, location of flood warning gages, USGS stream gages, reservoirs ≥500 acre-feet keyed to stream gage, flood gage and large reservoir tables
5. Perennial/intermittent Streams and Major (>10gpm) Springs
   Location of perennial and intermittent streams and location of major springs keyed to major springs table
6. Groundwater Level Conditions
   Current depth to water, groundwater level changes over an approximately ten-year period in selected wells, general groundwater flow direction, keyed to selected basin hydrographs
7. Selected Basin Hydrographs
8. Well Yields
   Well yields measured by USGS and the Department and reported for >10 inch diameter wells, shown by different yield increments
9. Recharge Sites (Active Management Areas, Volume 8)
   Location of underground storage facilities and groundwater savings facilities
10. Water Quality Conditions
    Location of wells, springs and mine sites with drinking water exceedences, impaired lakes and stream reaches, and effluent dependent reaches, keyed to water quality exceedences table
11. Contamination Sites (Active Management Areas, Volume 8; this is a planning area map in Volumes 2-7)
    Location of DOD, LUST, RCRA, Superfund, UMTRA, VRP, and WQARF sites
12. Cultural Water Demand
    Location of active agricultural lands, power plants, large mines, small mines/quarries and high density and low density municipal and industrial demand centers.
13. Water Adequacy and Assured Water Supply Determinations
    Outside AMAs, location of water adequacy reports and inadequacy determinations, analysis of water adequacy determinations and water providers designated as having an adequate water supply keyed to table. Inside AMAs, location of pre-Code water adequacy reports and inadequacy determinations, certificates of assured water supply, analysis of assured water supply determinations and water providers designated as having an assured water supply keyed to keyed to table.

Basin and AMA Tables

1. Climate Data
   - NOAA and NWS stations: name, period of record, elevation, minimum and maximum average temperature, average seasonal and average annual rainfall
   - Pan Evaporation stations: name, period of record, elevation, average annual evaporation
   - AZMET stations: name, period of record, elevation, average annual reference ET
   - SNOTEL/Snowcourse stations: name, period of record, elevation, monthly snow water equivalent
2. Streamflow Data
   - gage name, drainage area, period of record, total years of record, mean basin elevation, average seasonal flow, minimum, median, mean and maximum annual flow
3. Flood ALERT Equipment
   - Flood/ALERT gages: name, identification number, station type, installation date, operator
4. Reservoirs and Stockponds
   - Large reservoirs (>500 acre-feet or 50 acres or greater surface area): name of lake/reservoir and dam, owner/operator, maximum storage/surface acres, purpose/use, jurisdiction
   - Small reservoirs, (15 to 500 acre-feet or 5 to <50 acre surface area): total number and maximum storage/surface acres
   - Stockponds (up to 15 acre-feet capacity): total number
5. Springs
   - Major springs (10 gpm or greater): name, location, discharge rate, measurement date
   - Minor springs (1 to 10 gpm discharge): name, location, discharge rate, measurement date
   - Total number of springs in the basin
6. Groundwater Data
   - basin area in square miles
   - major aquifer(s)
   - well yields; range and median yields
   - estimated natural recharge
   - groundwater in storage
   - number of index wells, date of last well sweep
7. Recharge Sites (Active Management Areas, Volume 8)
   - Facility name, number, permittee name, facility type, permitted acre-feet/year, water source
8. Water Quality Exceedences
   - Wells, springs and mines: site type, location, water quality standard, parameter(s) exceeded
   - Lakes and streams: site type, name, length of impaired stream reach/area of impaired lake, water quality standard, parameter(s) exceeded
9. Contamination Sites
   - Contamination site name and media affected and contaminant
10. Effluent Generation
    - facility name/ownership, city/location served, volume treated, disposal method, treatment level, population served/not served, year of record
11. Cultural Water Demand
    - historic, current and projected population
    - historic and current number of wells < 35gpm and >35gpm
    - historic and current agricultural, municipal and industrial surface water diversions (or non-groundwater supply) and groundwater pumpage
12. Assured (AMA) and Adequate (outside AMA) Water Supply Determinations
    - For AMAs: Certificates of Assured Water Supply (AWS), water adequacy reports (pre-1980), and Analyses of AWS including name, county, location, number of lots, ADWR file number, date of determination, water provider.

- For AMAs: Designation of AWS including name, ADWR file number, date issued, projected or annual estimated demand and year of projected or annual demand
- Outside AMAs: Water Adequacy Reports including name, county, location, number of lots, ADWR file number, date of determination, water provider, adequacy determination and the reason for the inadequacy determination.
- Outside AMAs: Analyses of Adequate Water Supply including name, county, location, number of lots, ADWR file number, date of determination, water provider.
- Outside AMAs: Designation of Water Adequacy including name, ADWR file number, date issued, projected or annual estimated demand and year of projected or annual demand

APPENDIX B: DATA SOURCES AND METHODS

APPENDIX B
DATA SOURCES AND METHODS

This appendix describes the sources of data and methods of analysis for tables and maps presented in Volumes 1-8 of the Atlas. These descriptions may not completely explain some details of the data sources and analysis in all cases. More detailed information may be obtained by contacting the Department. Also, the references cited here may differ slightly from those presented in Volumes 2-8 if additional and/or more recent data became available.

B.1 Adequate and Assured Water Supply Determinations

Adequacy Determinations

Information related to the Department's water adequacy determinations is presented on basin-scale maps (*Adequacy Determinations)* and summarized in a table for each basin (*Adequacy Determinations)* in Volumes 2-7. Where water adequacy reports and requests for analysis of adequate water supply have been filed, the tables include subdivision names, number of lots, locational data, Department file numbers, determination dates, reasons for inadequate determinations, and water providers at the time of application. Where water supplies have been designated for water provider service areas, the tables list information on Department file numbers, projected or estimated annual demand, the year the demand is expected, and designation dates. Adequacy determinations are further summarized in this volume by grouping the data into planning areas (Table 1-8) and by plotting on a statewide map (Figure 1-22).

Sources for this information come from the Department and include electronic databases maintained by the Office of Assured and Adequate Water Supply and paper files stored in the Hydrology Division (ADWR, 2010 and 2008e). Database queries were reviewed and some information was excluded from the Atlas based on subdivision location, duplicate applications, etc. Paper files were also reviewed to complete information that had not been entered into the databases such as number of lots and reasons for inadequate determinations.

Each determination of the adequacy of water supplies available to a subdivision is based on the information available to the Department and the standards of review and policies in effect at the time the determination is made.

Assured Water Supply Determinations

Information related to the Department's assured water supply determinations is presented on AMA scale maps (*Assured Water Supply Determinations)* and summarized in a table for each AMA (*Assured Water Supply Determinations)* in Volume 8. Where assured water supply certificates, water adequacy reports (pre-1980) and requests for analysis of adequate water supply have been filed, the tables include subdivision names, number of lots, locational data, Department file numbers, determination dates, and water providers at the time of application. Where water supplies have been designated, the tables list Department file numbers, information on projected or estimated annual demand, the year the demand is expected, and designation dates. Assured water supply determinations are further summarized in this volume by grouping the data by AMA (Table 1-9) and by plotting on a statewide map (Figure 1-22).

Sources for this information come from the Department and include electronic databases maintained by the Office of Assured and Adequate Water Supply and paper files stored in the Hydrology Division (ADWR, 2010 and 2008e). Database queries were reviewed and some information was excluded from the Atlas based on subdivision location, duplicate applications, etc. Lot count totals may over estimate the actual number of platted lots due to database accounting, changes in file numbering methodology and subsequent development plan changes.

Each determination of assured water supply is based on the information available to the Department and the standards of review and policies in effect at the time the determination is made.

B.2 Aquifers

Flow Direction

Groundwater flow directions are presented on basin- and some sub-basin scale maps (*Groundwater Conditions)* in Volumes 2-8. This information was taken from a variety of technical reports prepared by the Department and the USGS. Flow directions are not shown for some basins, either because of insufficient groundwater level data and/or complex subsurface geology. The flow directions that are shown in the Atlas generally reflect long-term, regional aquifer flow in the basin and are not meant to depict temporary or local-scale conditions.

Major Types

Major aquifer types are listed in a table for each basin (*Hydrogeologic Data)* and are generally described in the text for each planning area volume. Information on aquifer types was taken from Volume II of the Department's 1994 *Arizona Water Resources Assessment* (ADWR, 1994b). To ensure consistency and simplify comparison between basins, aquifer descriptions from the 1994 *Assessment* were reviewed and grouped in the Atlas into five basic aquifer types:

- Basin fill;
- Igneous and metamorphic rocks;
- Recent stream alluvium;
- Sedimentary rock; and
- Volcanic rock.

In some basins, two or more of these aquifer types are found. Also, several aquifers in Arizona have been given specific names related to their geologic formation or location. Where known and applicable, this information is included in the Atlas. The aquifers in most basins can be further described by their rock type or sediment grade (e.g. sandstone vs. limestone) and position in the geologic sequence (e.g. upper vs. lower basin fill). This level of detail is not provided in the Atlas, but for reference, can be found in the 1994 *Assessment*. A summary of the major aquifers in Arizona is included in this volume (Table 1-4).

Recharge and Storage

Estimates of aquifer recharge and storage are listed in a table for each basin (*Groundwater Data)* and described in the overviews of Volumes 2-8. The estimates are based on one or more of six primary data sources:

- *Phase I; Arizona State Water Plan* published by the Arizona Water Commission in 1975 (AWC, 1975);

- A 1986 study by the USGS of predevelopment hydrologic conditions in the alluvial basins of Arizona and adjacent states (Freethey and Anderson, 1986);
- A 1990 internal report by the Department summarizing water resources information for the groundwater basins (ADWR, 1990);
- Volume II of the Department's 1994 *Arizona Water Resources Assessment* (ADWR, 1994b);
- A 1995 report by the USGS describing groundwater flow models developed for selected alluvial basins in south-central Arizona and parts of adjacent states (Anderson and Freethey, 1995);
- The Department's 1999 Third Management Plans (TMP);
- A 2009 Department memo summarizing groundwater storage estimates for the AMAs (ADWR, 2009c); and
- Various hydrologic reports and maps prepared by the USGS and the Department for select basins and subbasins across Arizona.

In many cases, these data sources provide information for areas that do not exactly coincide with the Department's groundwater basins. It was often necessary to adjust reported recharge and storage values to account for these differences in basin area as well as the location of the border between basin fill and bedrock and zones of high recharge (i.e. along or near mountain fronts).

Aquifer recharge is a difficult hydrologic parameter to measure and, on a regional level, it is usually determined indirectly either through development of water budgets and/or use of groundwater flow models. The recharge estimates presented in the Atlas generally represent long-term, natural (predevelopment) conditions. Wet and dry periods are averaged and artificial recharge is not considered. Such factors can significantly affect aquifer recharge in a given year. Aquifer storage is also a difficult parameter to measure and the estimates in the Atlas were usually based on a combination of point data from wells and results from large-scale surface geophysical surveys. Where aquifers consist of consolidated rock and storage is controlled by fractures, storage estimates can be highly unreliable. In light of these uncertainties, the Atlas often provides more than one estimate of aquifer recharge and storage for each basin. A summary of the aquifer recharge and storage estimates for Arizona is included in this volume (Table 1-4).

B.3 Climate

Average Annual Precipitation

Average annual precipitation, in inches, is shown on basin-scale maps (*Meteorological Stations and Annual Precipitation*) in Volumes 2-8 and on a statewide map in this volume (Figure 1-14). Contour lines and color-coding are used on the maps to delineate areas of equal and similar precipitation. This precipitation information comes from the Spatial Climatic Analysis Service (SCAS) at Oregon State University. Using an analytical tool called PRISM (Parameter-elevation Regressions on Independent Slopes Model), SCAS analyzed regional precipitation data averaged over the period 1961-1990 and prepared digital precipitation maps for the United States in 1998. The Department downloaded the PRISM map for Arizona from the SCAS website (SCAS, 1998).

Evaporation Stations

Evaporation data collected from AZMET and pan stations are summarized in a table for each basin (*Climatic Data*) and station locations are shown on basin-scale maps (*Meteorological Stations* *and Annual Precipitation*) in Volumes 2-8 and on a statewide map in this volume (Figure 1-14). Arizona Meteorological Network (AZMET) stations are operated in southern and Central Arizona and provide weather-based information to agricultural and horticultural interests. Pan stations refer to Class A evaporation pans that are used to estimate evaporation rates from natural surfaces such as shallow lakes and wet soils. Summary tables in the Atlas list the name and elevation of these stations, their period of record, and average annual evaporation rates in inches. Note that the pan evaporation rates listed are usually adjusted by multiplying by 0.7 or 0.8 before being used to estimate natural conditions. Reference evapotranspiration (Eto) rates are listed for the AZMET stations and refer to the amount of water evaporated and transpired by well-maintained, well-watered turf grass.

Data from the AZMET stations were downloaded from a website maintained by the University of Arizona Cooperative Extension (AZMET, 2007), and data from the pan stations were downloaded from a website maintained by the Western Regional Climate Center (WRCC, 2005). Pan data were presented as monthly averages, which the Department summed for all months and presented as an annual average. Some pan stations did not measure evaporation rates during winter months and others estimated those rates using other meteorological data.

Several factors can affect evaporation rates, including air temperature, humidity, and wind. The data presented in the Atlas represent conditions at the measuring stations and provide a general indication of average evaporation rates in the basin. Care should be taken when using these data for site-specific studies.

Precipitation and Temperature Stations

Precipitation and temperature data from a network of weather stations are summarized in a table for each basin (*Climatic Data*) and station locations are shown on basin-scale maps (*Meteorological Stations and Annual Precipitation*) in Volumes 2-8 and on a statewide map in this volume (Figure 1-14). The summary tables list the name and elevation of these stations, their period of record, and temperature and precipitation data. Temperature data include average minimum and maximum temperatures in degrees Fahrenheit and in which months these extremes occur. Precipitation data include average seasonal precipitation and average annual precipitation in inches. Seasons are defined in the Atlas as follows:

- Winter – January through March;
- Spring – April through June;
- Summer – July through September; and
- Fall – October through December.

The weather stations presented are part of a cooperative network maintained by the National Oceanic and Atmospheric Administration (NOAA) and the National Weather Service (NWS). Data from these stations has been compiled by the WRCC and posted on its website (WRCC, 2008). Statistics presented in the summary tables were downloaded directly from this website. Several factors can affect temperature and precipitation rates, particularly elevation and other geographic features. The data presented in the Atlas represent conditions at the measuring stations and provide a general indication of average temperature and precipitation conditions in the basin. Care should be taken when using these data for site-specific studies.

Snowfall Stations

Snowfall data from Snowcourse and Snowpack Telemetry (SNOTEL) stations are summarized in a table for each basin (*Climatic Data*) and station locations are shown on basin-scale maps (*Meteorological Stations and Annual Precipitation*) in Volumes 2-8 and on a statewide map in this volume (Figure 1-14). The summary tables list the name and elevation of these stations, their period of record, and snowpack measurements. The average snowpack at the beginning of each month is presented as inches of snow water content, also referred to as the snow water equivalent. Only those months when snow surveys are usually conducted (January through June) are included.

Snowcourse and SNOTEL stations are operated by the Natural Resources Conservation Service (NRCS). Data from these stations have been compiled by NRCS and posted on its website. Statistics presented in the summary tables were downloaded directly from this website (NRCS, 2006 and 2005). Many factors can affect snowpack depths such as aspect, elevation and forest cover and NRCS takes great care to locate snow course and SNOTEL stations that provide representative data. Nevertheless, the data presented in the Atlas represents conditions at the measuring stations and only provides a general indication of average snowfall conditions across the highlands of some basins. Care should be taken when using these data for site-specific studies.

Trends in Precipitation and Temperature

Long-term trends in precipitation and temperature are shown by Planning Area in Volumes 2-8 and in Section 1.4.3 and Appendix E of this volume. Trend data are presented graphically with explanatory text. This information was primarily contributed by researchers at the University of Arizona, including the Institute for the Study of Planet Earth, which is responsible for the Climate Assessment for the Southwest (CLIMAS) program (CLIMAS, 2008). WRCC (2008) provided trend data for the AMAs.

B.4 Contamination Sites

Contamination sites are shown on planning area and AMA maps (*Contamination Sites*) in Volumes 2-8 and on a statewide map in this volume (Figure 1-27). Included are the locations of U.S. Department of Defense (DOD), Voluntary Remediation Program (VRP), Superfund (listed on the National Priorities List or NPL), Resource Conservation and Recovery Act (RCRA), Water Quality Assurance Revolving Fund (WQARF) and Uranium Mill Tailings Remedial Action (UMTRA) sites as well as leaking underground storage tanks (LUST).

The data were provided by ADEQ and included locations for all LUST sites in Arizona, regardless of reported contaminant levels or whether remediation had been completed (ADEQ, 2006). For purposes of the atlas, LUST sites are only shown where contamination is either suspected or known to exist and remediation is required to meet soil and water quality standards. LUST sites that meet applicable standards and/or have been remediated and closed-out are not included.

B.5 Cultural Water Demands

Location of Major Water Use

Locations of major water use are shown on basin-scale maps (*Cultural Water Demands*) in Volumes 2-8 and on a statewide map in this volume (Figure 1-31). Included on the maps are agricultural lands, low- and high-intensity developments, mines and power plants. The primary data source for the water use maps was a land cover study of the southwestern United States, completed by the USGS (2004). Land cover types were mapped in this study at a 5- to 12-acre resolution using Landsat satellite imagery collected between 1999 and 2001. The Department supplemented the data with the locations of active power plants and mines (ADMMR, 2005).

Due to its resolution, use of Landsat imagery to map land cover types requires a high degree of interpretation and some areas of water use, particularly agricultural lands, may be misclassified. The Department reviewed the USGS land covers to ensure that they were reasonable and made edits as needed. It should also be noted that the Landsat imagery used by the USGS is now as much as 10 years old, and some land cover types may have changed since the imagery was taken.

Surface Water Diversions

Annual surface water diversions for agriculture, industrial, and municipal uses are listed in a table for each basin (*Cultural Water Demand*) in Volumes 2-8 and on a statewide table in this volume (Table 1-14). For the AMAs, surface water diversions are grouped with other non-groundwater supplies which can include Central Arizona Project (CAP) water, effluent, and spill and tail waters

Surface water demand data for the period 1971-1990 (and through 1985 in the AMAs) were taken from the Department's 1994 *Assessment* (ADWR, 1994a). A variety of sources were utilized to determine more recent surface water demands for the period 1991 through 2005. ADEQ (2005b) furnished a list of municipal water providers who utilize surface water and the ACC (2005b) supplied annual reports for some of these providers indicating how much surface water they were diverting and/or delivering. USGS (2007) provided data on surface water demands for agriculture for those basins where the diversions have been metered. Most other surface water demands had to be determined by the Department through one or more methods including review of existing Department, BOR, county, and consultant reports; analysis of recent aerial photography; Internet and records research; questionnaires and phone interviews; consultation with the USGS; and, limited fieldwork (ADWR, 2008f). The Department's Colorado River Management Section was an important data source and provided records of Colorado River water users, locations and annual diversion volumes (ADWR, 2006). Department Annual Withdrawal and Use Reports provided data on most surface water demands in the AMAs since 1986 (ADWR, 2008g).

In many cases outside of the AMAs, the Department had to estimate the quantity of surface water demand because the records were nonexistent, imprecise or incomplete (ADWR, 2008f and 2005b). For example, to estimate unmetered surface water diversions for agriculture, the Department made assumptions about the number of cropped acres and water duty. For some irrigated areas, diversion amounts were adjusted to account for basin boundaries. Similarly, for most non-AMA golf courses determined to be using surface water, the Department estimated demand based on the number of holes and local irrigation needs for turf (ADWR, 2008j). The surface water demand of municipal water providers was estimated in some cases based on the number of hookups, an assumed per capita use rate and delivery losses.

As previously mentioned, the surface water demand for agricultural, industrial, and municipal use was often unmetered and had to be estimated by the Department. Historic demands were assumed to represent current conditions and vice versa if information was not available. Assumptions were also made where water demands were met by combining surface water diversions and well pumpage, but the precise volume of each was not known. Furthermore, it is likely that several relatively small surface water diversions were simply not identified by the Department and not included in the Atlas. The values presented in the Atlas should, therefore, not be considered precise, but they provide an estimate of these demands and indicate where surface water is an important water source to meet cultural demands. The following conventions were used to round cultural demand values met by surface water:

- 0 to 1,000 acre feet – round to the nearest 50 acre-feet (af);
- 1,000 to 10,000 acre-feet – round to the nearest 100 af;
- 10,000 to 100,000 acre-feet – round to the nearest 500 af; and
- 100,000 to 1,000,000 acre-feet – round to the nearest 1,000 af.

Recent non-groundwater demands in the AMAs were generally rounded to the nearest 100 af.

Finally, it should be noted that surface water stored in reservoirs and stockponds and diverted through fish hatcheries were not included in the cultural demand tables. Practically all of the surface water diverted by fish hatcheries passes through the facilities and is released for use downstream. Surface water stored in reservoirs and stockponds may or may not be released for use downstream and some of this water is lost to evaporation.

Well Pumpage

Annual well pumpage for agricultural, industrial, and municipal uses is listed in a table for each basin (*Cultural Water Demand*) in Volumes 2-8 and on a statewide table in this volume (Table 1-14). Data on well pumpage are also summarized by planning area in the text of the planning area volumes. Well pumpage data for the period 1971 through 1990 (and through 1985 in the AMAs) are from the Department's 1994 *Assessment* (ADWR, 1994a). Outside of the AMAs, the primary data source for well pumpage for the period 1991 through 2005 was the USGS (2007), which describes its methodology, assumptions, and data limitations in the 2005 report *Water Withdrawals for Irrigation, Municipal, Mining, Thermoelectric-Power, and Drainage Uses in Arizona Outside of Active Management Areas, 1991-2000* (Tadayon, 2004). The Department's Annual Withdrawal and Use Reports provided most well pumpage data for the AMAs since 1986 (ADWR, 2008g).

The Department had to adjust the USGS pumpage values for a few basins where mining companies pump from the same wells to supply both industrial and municipal needs and, in other basins where springs have been identified as a water source. The USGS accounted for water use from springs as well pumpage, whereas the Department considers these to be surface water diversions. In addition, the USGS did not evaluate water use by feedlots and golf courses. The Department considers both to be industrial uses and, for the Atlas, estimated well pumpage following methods similar to those used to estimate surface water diversions (ADWR, 2008j and 2008k). To estimate well pumpage for feedlots, the Department identified feedlots by using ADEQ's list of active feedlots in Arizona (ADEQ, 2005a) and, based on the type and number of animal units at each feedlot, applied a consumptive rate.

Outside of the AMAs, the quantity of well pumpage for agricultural, industrial and municipal use was not always metered, requiring estimation in some cases (ADWR, 2008f). Historic pumpage was assumed to represent current conditions, and vice versa, if information was unavailable.

Assumptions were also made where water demands were met by combining well pumpage and surface water diversions, but the precise volume of each was unknown. Lastly, it is likely that several relatively small well withdrawals were simply not identified by the USGS or the Department and are not included in the Atlas. The values presented in the Atlas should, therefore, not be considered precise, but they provide an estimate of pumpage and indicate where well water is an important water source to meet cultural demands. The following conventions were used to round cultural demand values met by well pumpage:

- 0 to 1,000 acre feet – round to the nearest 50 af;
- 1,000 to 10,000 acre-feet – round to the nearest 100 af;
- 10,000 to 100,000 acre-feet – round to the nearest 500 af; and,
- 100,000 to 1,000,000 acre-feet – round to the nearest 1,000 af.

In the AMAs, recent well pumpage was rounded to the nearest 100 af.

Community Water System Annual Reports

Beginning in 2006, all community water systems in the state must submit an annual report of water withdrawals, diversions and deliveries to the Department. Systems in the AMAs have been reporting this information to the Department since 1984 under provisions of the Groundwater Management Act. A community water system is defined as a public water system that serves at least 15 service connections used by year-round residents or that regularly serves at least 25 year-round residents. A.R.S. § 45-341. This information has been compiled by planning area in the Appendices of Volumes 2-7 and data for the largest water providers are included in water demand summary tables in the overview of these volumes.

Planning Area Summaries

The overview of Volumes 2-8 summarize the basin surface water diversion and well pumpage data described above by planning area. Average cultural water demands during the period 2001-2005 are listed in tables and displayed on graphs and pie charts. For comparison, water demands for the periods 1991-1995 and 1996-2001 are also listed in certain tables and tribal water demands are presented separately. These planning area data are further summarized in Section 1.4.7 of this volume.

B.6 Drought

Drought conditions in the planning areas are discussed under the Climate Section of Volumes 2 through 8 and in Appendix E of this volume. This information was provided by the Department's Drought Planning Section, University of Arizona Cooperative Extension, CLIMAS/Institute for the Study of Planet Earth, and the USGS (CLIMA, 2005).

B.7 Effluent

Facility Data

Information on facilities that treat and discharge effluent is summarized in a table for each basin (*Effluent Generation*) in Volumes 2-8 and summarized in a planning area table (Table 1-13) of this volume. For each treatment facility, the tables list the name, owner, city/location served, population served, volume of effluent treated/generated annually, effluent disposal methods, levels of treatment, unserved population, and year of record.

Primary data sources were the Clean Water Needs (CWN) Surveys sponsored by the Water Infrastructure Financing Authority (WIFA), and annual reports provided by the ACC. CWN Surveys are conducted every two to four years and are used to assist treatment facilities in obtaining funding. To capture data for as many treatment facilities as possible, survey results from 1996, 2000, 2004 and 2006 were used for the Atlas (EPA, 2005a, 2005b, 2002, 2000 and 1996). The ACC regulates private treatment plants and requires that operators file annual reports that sometimes included data on effluent production (ACC, 2005). The data were supplemented, when possible, with information from facility operators, from ADEQ (2005c,d,e,f), which issues facility discharge permits), and city, county and Department reports. The latter include Annual Withdrawal and Use Reports (in AMAs) and Community Water System annual reports.

Wastewater treatment is a dynamic industry with frequent changes in plant names, treatment levels and effluent volumes. Although the last CWN survey was conducted in 2006, updated information was not available for all facilities. The Department used the most recent data available, which for some facilities is over 10 years old (WIFA, 2005a and b).

Effluent Dependent Waters

The location of effluent-dependent waters, including lakes and stream reaches, are shown on basin-scale maps (*Water Quality Conditions)* in Volumes 2-8. A GIS cover of effluent- dependent waters in Arizona was provided by ADEQ (2005g). These reaches are also listed and described by ADEQ in their surface water quality rules (A.A.C. R18-11-113).

B.8 Environmental Conditions

Biotic Communities and Ecoregions

Information on biotic communities (Brown and Lowe, 1980) and ecoregions (Olson and others, 2001) are discussed in the overview and shown on planning area-scale maps *(Biotic Communities and Ecoregions)* in Volumes 2-8. A statewide map is presented in Figure 1-18 of this volume.

National Parks, Monuments, Wildlife Refuges and Wilderness Areas

A discussion of National Parks, Monuments, Wildlife Refuges and Wilderness Areas is provided in the overview of Volumes 2-8 and their location is shown on planning area maps *(Protected Areas)* in these volumes (BLM, 2008 and 2006; USFS, 2007). A table of wilderness areas with total acres and brief description of prominent features is also found in the overview of Volumes 2-8.

Riparian Areas

The location of riparian areas (AZGF, 1993) is shown on planning area maps *(Instream Flow Applications)* in Volumes 2-8 and a statewide map is presented in Figure 1-19 of this volume.

Threatened and Endangered Species

A table listing threatened and endangered species (USFWS, 2008) by planning area and their elevation and habitat is found in the overview of Volumes 2-8.

B.9 Geology

Surface Maps
Surface geologic conditions are shown on planning area maps (*Surface Geology)* in the overviews of Volumes 2-8 and on a statewide map (Figure 1-3) in this volume. The maps display nine generalized geologic units based on more detailed mapping by Reynolds (1988).

Cross Sections
The Eastern and Western Plateau planning areas are underlain by a sequence of sedimentary rocks with water-bearing formations most common in sandstones and limestones. The relationship between the formations is shown on cross sections in the overviews of Volumes 2 and 6 and in this volume (Figure 1-5, ADWR 1989). Cross-sections of typical subsurface geologic conditions in other planning areas are shown in Figure 1-6 (ADWR, 1993) and Figure 1-7 (Parker and Flynn, 2000) of this volume.

B.10 Land Ownership

Land ownership information is presented on basin-scale maps (*Land Ownership*) and summarized in the text of Volumes 2-8. Included on the maps are the location of major landowner types (e.g. private, BLM, NPS, etc.) and the percentage that each type comprises of the total basin area. Data on current land ownership was downloaded from the Arizona Land Resource Information System (ALRIS) website maintained by the Arizona State Land Department (SLD) (ALRIS, 2004). A statewide summary table (Table 1-2) is presented in this volume.

B.11 Lands Survey

A number of Atlas maps show township and range lines. Most lands in Arizona have been mapped according to a rectangular coordinate system known as the Public Lands Survey. Under this survey, lands are divided into “townships” and “sections.” A township is a square parcel of land six miles on each side that is subdivided into 36 equal parts called sections. A section covers one square mile or 640 acres. Because of the earth’s curvature, surveying errors and other factors, not all townships are square, not all townships contain 36 sections, and not all sections contain 640 acres.

Townships are located relative to a point that forms at the intersection of an east-west “baseline” and a north-south “meridian.” Locations are referenced as being so many six-mile units, called “Townships”, north or south of the baseline and so many six-mile units, called “Ranges,” east or west of the meridian. Most of Arizona’s townships were surveyed relative to the point of intersection of the Gila and Salt Rivers, referred to as the Gila and Salt River Baseline and Meridian. Approximately 20 townships in Apache County were surveyed from the Navajo Baseline and Meridian established in New Mexico, and a small portion of land near the town of Yuma was surveyed from the San Bernardino Baseline and Meridian established in California (ASLD, 2006).

Townships surveyed from the Gila and Salt River Baseline and Meridian are plotted on all basin-scale maps in the Atlas. This information was digitized from USGS Quads. Townships surveyed from the Navajo and San Bernardino Baselines and Meridians have generally not been plotted, but these are included on the base map that was used to prepare *Geographic Features* maps. Note that in some areas in Arizona no townships have been surveyed. These include a large portion of the Navajo and Hopi Indian Reservations in northeastern Arizona, a small portion of the San Carlos Indian Reservation in east-central Arizona, and several Spanish land grants in southeastern Arizona. To provide general mapping reference, Department staff protracted these unsurveyed areas extending townships based on the Gila and Salt River Baseline and Meridian into these areas. These unofficial townships are included on maps in the Atlas.

B.12 Physiographic Regions

Based on differences in geography, Fenneman and Johnson (1946) divided Arizona into three physiographic regions – the Colorado Plateau, Transition Zone, and Basin and Range. The overview of Volumes 2-8 and Figure 1-3 of this volume show the location of the three regions and associated topographic conditions.

B.13 Population

Population data are listed in a table for each basin (*Cultural Water Demand)* in Volumes 2-8. The tables include yearly estimates of population from 1980-2005 and population projections every 10 years from 2010-2030. Data from the U.S. Bureau of Census (Census, 2006) were used to estimate past populations and Arizona Department of Commerce data were used for population projections (ADOC, 2009). The overviews of Volumes 2-8 also list communities in the planning areas with 2000 Census populations greater than 1,000 and this volume summarizes population data by planning area (Table_1-6) and lists the largest communities and highest growth rates statewide (Table 1-7). Communities with annual growth rates greater than 2% are shown on Figure 1-21 of this volume.

The Census provided spatial data for the years 1980, 1990 and 2000, which were organized into tracts (largest), groups, and blocks (smallest). Using GIS software, the Department divided the Census blocks into their respective basins and, as necessary, proportionally split by area those blocks that covered two or more basins. Populations between Census years were estimated by straight-line interpolation.

ADOC provided projections of how the population in Census places, such as towns and cities, would change in the future. The Department identified the Census places in each basin and applied the projected ADOC population change, as a percentage, to the 2000 Census data. If more than one Census place occurred in the same basin, the projected changes were averaged and applied across the basin. For three basins (Dripping Springs Wash, Paria, and San Simon Wash) there was insufficient data to make population projections and it was assumed that basin populations have been and will remain the same from 2001 through 2030.

B.14 Recharge Facilities

Recharge facilities permitted by ADWR are located in the Phoenix, Pinal, Prescott and Tucson AMAs and include underground storage facilities (USF) and Groundwater Savings Facilities (GSF). The location and permitted capacity of the USF and GSF sites are shown on a map for each AMA (*Recharge Sites)*. A table (*Recharge Sites*) accompanies each map with associated data from ADWR's Office of Assured and Adequate Water Supply and Recharge Permitting. The tables list the facility name, number and type, the permittee and permitted annual quantity of recharge water, and source of water.

B.15 Reservoirs

Location, Capacity and Use

Information on large to small reservoirs is summarized in a table for each basin (*Reservoirs and Stockponds*) and locations of the large reservoirs are shown on basin-scale maps (*Surface Water Conditions*) in Volumes 2-8. A statewide map showing the location of large reservoirs, Figure 1-10, is presented in this volume. Natural water bodies, such as dry and intermittent lakes, as well as man-made reservoirs, are included.

Large reservoirs are defined in the Atlas as water bodies with a maximum storage capacity of 500 acre-feet or greater, or where capacity data were unavailable to the Department, a maximum surface area of 50 acres or greater. Small reservoirs are defined as water bodies with a capacity of greater than 15 but less than 500 acre-feet, or a maximum surface area of between 5 and 50 acres. The tables list the name of each large reservoirs and the name of the dam (if different), the owner/operator, the maximum storage or surface area, its use (recreation, power, water supply, etc.) and jurisdiction (federal, state, tribal or private). The tables also list the total number of small reservoirs in a particular basin and their combined maximum storage capacity and surface area.

Reservoir information was obtained from 5 primary data sources:

- National Inventory of Dams maintained by the U.S. Army Corps of Engineers (USACE, 2004 and 2005);
- The Department's database of jurisdictional and non-jurisdictional dams in Arizona (ADWR, 2005c and 2005d);
- Arizona Game & Fish Department's waterways file and lake classification study (AZGF, 2005 and 1982);
- Digital versions of 1:100,000 scale USGS topographic maps (ALRIS, 2005b); and
- The Department's registry of surface water right and adjudication filings (see further discussion in this section under 'Stockponds').

For consistency, the Atlas lists maximum storage capacities for most large reservoirs. When these values were not available, normal storage capacities are presented and noted or, as described above, maximum surface area is presented. Several reservoirs were identified by more than one data source. To avoid duplication, reservoir locations were compared and the most recent data source was typically used. In most cases, reservoir locations presented in the Atlas represent the center of the reservoir, but in some cases, it marks the middle of the dam.

For the purpose of establishing dam jurisdiction, large reservoirs located on federal lands, such as national forests and national parks, were assumed to be under federal jurisdiction. Similarly, large reservoirs located on tribal lands were assumed to be under tribal jurisdiction. Some reservoirs listed in the data sources probably no longer exist, either because they have filled in with sediment and/or have been breached. Where more recent information indicates that a dam has filled with sediment or has been breached, it was not included in the Atlas.

The location of major (>20,000 acre-feet capacity) reservoirs in Arizona are shown on Figure 1-11 of this volume

Storage Trends

Figure 1-13 of this volume shows recent (1980-2008) trends in reservoir storage along Arizona's four major rivers – the Colorado, Salt, Verde, and Gila. May 1st storage quantities are shown separately for Lakes Mead and Powell on the Colorado River; are combined for Roosevelt, Apache Canyon and Saguaro lakes on the Salt River and Horseshoe and Bartlett reservoirs on the Verde River; and shown for San Carlos Reservoir on the Gila River. ADWR plotted these storage hydrographs using data compiled by the BOR (2010a), SRP (2008) and Gila Commissioner (various dates), respectively. Capacities for the individual lakes and reservoirs along the Salt and Verde Rivers are displayed on a schematic in Volume 8 (Figure 8.0-17) and Volume 5 (Figure 5.0-6) and a graph of changes in the end of month water level elevation for Lake Mead since 1980 is included in Volume 4 (Figure 4.0-13).

B.16 Rural Watershed Initiative Partnerships

Arizona's Rural Watershed Initiative Partnerships are tabulated in Appendix D of Volumes 2-7 along with their activities, accomplishments, and identified issues in 2008 and a statewide summary table and map showing the location of partnerships are found in Appendix I of this volume. The Regional Strategic Planning Office at the Department tracks the status of the partnerships and provided the partnership information presented in the Atlas. Note that the issues identified by partnership participants may not represent all of the water resource issues currently faced in rural Arizona.

B.17 Springs

Major and minor springs are listed in a table for each basin (*Springs*) in Volumes 2-8. A spring was considered 'major' if its discharge was 10 gallons per minute (gpm) or greater and 'minor' if its discharge was between 1 and 10 gpm. The tables include the name of the major and minor springs, their location (latitude/longitude), the most recent discharge measurement, and the measurement date. The tables also include an estimate of the total number of springs, regardless of discharge, that have been mapped in the basin. Locations of the major springs are shown on basin-scale maps (*Perennial/Intermittent Streams and Major (≥10 gpm) Springs)* in Volumes 2-8 and in Figure 1-12 of this volume.

Spring data were obtained from a variety of sources, most notably the USGS (2006a), which maintains a database of spring discharge records. Reports compiled from universities and public land agencies such as the U.S. Forest Service, National Park Service, and BLM were also useful (ADWR, 2008b). To estimate the total number of springs in each basin, the Department downloaded GIS covers from ALRIS (2005c) and the National Hydrography Data Set (NHD) that incorporate spring locations from the USGS Geographic Names Information System (GNIS or Geonames) database and from USGS Digital Line Graphs (DLGs) (USGS, 2006b). ALRIS and NHD do not indicate how or when the USGS located these springs. It is also not known whether a detailed, ground survey would now identify more springs or, in light of recent drought conditions, less spring sites.

Many of the springs with discharge data were listed in more than one data source. To avoid over-counting, the Department compared spring names, locations, discharge rates, and dates of measurement and removed obvious duplicates. Topographic maps were also checked to verify that the springs had been mapped. Those springs not verified on topographic maps were included in the Atlas but noted accordingly. For most springs, the location and point of discharge measurement were, for practical purposes, the same. But in some areas, particularly the Grand Canyon, access was poor and discharge measurements had to be made at a point significantly downstream of the spring orifice.

The Atlas generally presents the most recent discharge measurement identified at a spring site. However, for springs fed by shallow water sources, discharge rates can vary dramatically from year to year or even from day to day. To address this issue, some springs were included in the Atlas even if their last discharge measurement had dropped below 10 gpm for major springs or 1 gpm for minor springs. For these springs, the date of measurement is an earlier date when the discharge was greater.

B.18 Stockponds

An estimate of the total number of stockponds is listed in a table for each basin (*Large and Small Reservoirs and Stockponds*) in Volumes 2-8. The estimates are based on analysis of the Department's registry of surface water rights and adjudication claims (ADWR, 2009b). The registry includes the following water right filings:

- Applications to appropriate public water, permits and certificates of water right (Department file numbers beginning with "33", also known as "33s");
- Water right registrations filed pursuant to the Water Rights Registration Act of 1974 ("36s");
- Stockpond registrations filed pursuant to the Registration of Stockponds Act of 1977 ("38s");
- Statement of claimants filed by Indian tribes, or the federal government on their behalf, as part of the Gila River and Little Colorado River Adjudications ("39s"); and,
- Court decreed water rights ("4As" and "BBs").

Only those filings for ponds with a capacity of 15 acre-feet or less were considered. Because the same stockpond can often have 2 or more associated filings, an effort was also made to avoid overcounting the number of ponds by comparing stockpond names and locations and eliminating duplicates. Stockpond locations were not verified through field investigations or by analysis of topographic maps and aerial photographs. As a result, it is unknown whether additional ponds exist but were never claimed, or whether the ponds that were claimed are still in use. In areas of the state where stockpond locations have been previously verified, estimates based only on water right filings appear to be within an order of magnitude.

B.19 Streams

Diversions (see Cultural Water Demands)

Flood Warning (ALERT) Gages

The location of flood warning gages is shown on basin-scale maps (*Surface Water Conditions*) and information related to these gages is summarized in a table for each basin (*Flood ALERT Equipment*) in Volumes 2-8. The tables include the name and identification number of the gaging stations, station types (precipitation, stage, repeater, or some combination of these), dates of installation, and who is responsible for operation and maintenance (flood control districts, cities, etc.).

This information was obtained from the Department's Surface Water Division, which maintains a database of flood warning equipment across Arizona (ADWR, 2005e). The Department's database was queried in fall 2005 and the information presented in the Atlas was accurate at that time. According to staff in the Surface Water Division, new flood warning gages are routinely added to the ALERT (Automated Local Evaluation in Real Time) network so the current number of stations may be greater than presented.

Flow Gages

The location of USGS streamflow gages is shown on basin-scale maps (*Surface Water Conditions*) and information related to the gages is summarized in a table for each basin (*Streamflow Data*) in Volumes 2-8. The tables include the following information for all continuous flow gages, active or discontinued, with at least one year of record:

- Name and identification number of the station;
- Drainage basin area and gage elevation;
- Period of record;
- Average seasonal streamflows, as a percentage of annual flow;
- Annual streamflow statistics (minimum, median, mean, and maximum); and,
- Number of years of annual streamflow data used to calculate statistics.

The Atlas does not include data from USGS peak flow gages or from continuous flow gages with less than one year of record.

Gage information was obtained from USGS sources including their National Water Information System (NWIS) on-line database (USGS, 2008a and 2005b), recent Water-Data Reports (USGS, 2003 and 2002), and a 1998 report that summarizes streamflow data and drainage basin characteristics for selected gaging stations (Pope and others, 1998). The Department calculated average seasonal streamflows using mean monthly streamflow data downloaded from NWIS. Note that mean streamflow values in the Southwest may be affected by a few large flows which are common in the region. Seasons were defined in the Atlas as follows:

- Winter – January through March;
- Spring – April through June;
- Summer – July through September; and
- Fall – October through December.

Annual streamflow statistics were calculated using mean annual streamflow data also downloaded from NWIS. These statistics were not necessarily run on a gage's entire period of record, as the USGS only calculates annual streamflows for years with a complete 12-month dataset. Also, annual statistics are only presented for gages with 3 or more years of record and all calculations are based on Calendar Year, not Water Year. Average seasonal streamflows and annual streamflow statistics were calculated using data retrieved in 2005 or 2007 (AMAs only).

Streamflow statistics are affected by the length of record (e.g. 3 years vs. 50 years of data) as well as the hydrologic conditions occurring when the data were collected (e.g. drought vs. wet period). In addition, isolated conditions may affect streamflow at one station but not at another station nearby. In light of these constraints, the statistics presented in the Atlas should only be used as a general indication of streamflow conditions in the basins and not for site-specific studies.

This volume includes a map (Figure 1-10) showing the location of USGS streamflow gages. The location of gages on major Arizona streams are shown on Figure 1-11 and an accompanying data are summarized in Table 1-5. Streams were considered major if calculated median or mean annual flows exceed 20,000 and 30,000 acre-feet, respectively.

Instream Flow
Information on instream flows is summarized in a table for each planning area (*Instream Flow Claims).* The location of instream flow claims are shown on planning-area maps *(Instream Flow Applications*) in Volumes 2-8 and on a statewide map in Figure 1-19 of this volume. The tables include the name of stream reaches with instream flow claims, the name of applicants who have filed for instream flow rights, application numbers and dates of filing and, whether applications have been permitted and certificated by the Department. This information was provided by the Permitting Unit of the Department’s Surface Water Division which maintains a database that tracks the status of instream flow applications (ADWR, 2008d).

Intermittent and Perennial Reaches
Recent perennial and intermittent streams are shown on basin-scale maps (*Perennial/Intermittent Streams and Major (>10 gpm) Springs)* in Volumes 2-8 and on a statewide map (Figure 1-12) in this volume.

Locations of perennial streams were primarily taken from a 1993 report prepared by the Arizona Game and Fish Department (AZGF) as part of the Statewide Riparian Inventory and Mapping (SRIM) Project (AZGF, 1993). In that report, AZGF identified perennial reaches based on an earlier AZGF map (Brown and others, 1981) that AZGF revised after consultation with several government agencies (the Department, ADEQ, BLM, and USFS), private sector hydrologists, and academics. Locations of intermittent streams were primarily taken from a 1997 AZGF report prepared during the last phase of the SRIM Project. Intermittent stream reaches were identified on topographic maps by staff of AZGF, BLM, NPS, and USFS (AZGF, 1997).

Due to the prolonged drought that has recently affected Arizona, some of the perennial stream reaches identified by AGFD may now be intermittent and some of the intermittent reaches may now be ephemeral. As climatic conditions change in the future, it is expected that many of these streams will likely return to their previously classified flow conditions, except where impacted by development.

Major Drainages
Major stream drainages are shown on basin-scale maps (*Surface Water Conditions*) in Volumes 2-8. Drainage locations were taken from ALRIS, which provides a GIS cover of Arizona streams (ALRIS, 2005a). The ALRIS stream cover is based on 1:100,000 scale USGS topographic maps that were enhanced with data from EPA and several state agencies.

ALRIS classifies streams into five cartographic orders based generally on drainage basin size. Cartographic Order 1 streams drain the largest areas and include major rivers like the Colorado, Verde, Salt, Gila, etc. The *Surface Water Conditions* maps show the location of Cartographic Order 1, 2 and 3 streams distinguished by width and include stream names for the first two orders.

Runoff

Average annual or 'unit' runoff contours are plotted on basin-scale maps (*Surface Water Conditions*). The contours show the magnitude and spatial variation in runoff, in inches per year, based on streamflow data collected by the USGS during 1951 through 1980. The data reflects the runoff in tributary streams, rather than in major rivers, as an indication of how runoff varies regionally with precipitation and other geographic features.

The streamflow data were compiled by the USGS in 1985 and, in 1987, a 1:2,000,000-scale unit-runoff contour map of the conterminous United States was published (Gerbert and others, 1987). The map has since been digitized and posted on the USGS website where the Department downloaded it for use in the Atlas (USGS, 2006c).

Watersheds

The USGS divides the United States into hydrologic units based on watershed size. From largest to smallest, these units consist of regions, subregions, accounting units and cataloging units. Each hydrologic unit is identified by a unique hydrologic unit code (HUC) consisting of two to eight digits depending on unit level. A 6-digit code corresponds to accounting units, which are used by the USGS for designing and managing their National Water Data Network (USGS, 2005a).

Watersheds delineated by USGS accounting units are shown on planning area maps (*USGS Watersheds)* in the overview of Volumes 2-8 and on a statewide map in this volume (Figure 1-10). Text that accompanies these maps summarizes the important features of each watershed including its drainage area, major streams and springs, large reservoirs, and flow conditions.

B.20 Surface Water Rights

An inventory of surface water right and adjudication filings for each basin is tabulated in the overview of Volumes 2-8. The number and type of filings were determined by querying ADWR's surface water right and adjudication registries in February 2009 (ADWR, 2009b). A file was only counted if it provided sufficient information to allow a Point of Diversion (POD) to be mapped within a given basin. If a file listed more than one POD in a basin, it was only counted once however multiple filings for the same POD were counted. Appendix C of Volumes 2-8 and Table 1-12 of this volume summarize the total number of these filings by planning area.

The location of PODs based on the surface water filings are shown on planning area maps (*Registered Wells and Surface Water Diversion Points)* in the overview of Volumes 2-8 and on statewide map in Appendix C of those volumes and in Figure 1-24 of this volume.

B.21 Water Protection Fund

Information on Water Protection Fund grants is summarized in a table (*Arizona Water Protection*

Fund Grant Summary) and shown on a statewide map *(Arizona Water Protection Fund Grant Locations)* in Appendix F of this Volume. The table includes grant numbers issued through FY 2008, project titles and categories, and associated groundwater basins. Similar information is also presented in tables by planning area in Appendix A of Volumes 2-8.

The tables and map are based on a database maintained by the Department's Office of Water Protection (ADWR, 2008c). For purposes of the Atlas, Water Protection Fund projects were grouped into categories by type (watershed restoration, revegetation, research, etc.) and organized by groundwater basin.

B.22 Water Quality

Water quality data are summarized in tables for each basin (*Water Quality Exceedences*) and sample locations are shown on basin-scale maps (*Water Quality Conditions*) in Volumes 2-8. The maps show the location of wells, springs, and mines that have equaled or exceeded drinking water quality standards and lakes and streams that are impaired for designated uses. Tables for the wells, springs, and mines list the type of sampling site, its location (township, range and section), and relevant water quality parameters. Tables for the lakes and streams list the name and type of impaired water body, its length (streams) or area (lakes), and which water quality parameters have exceeded designated uses standards. Sample dates and parameter concentrations are not included in the tables, but this information has been compiled by the Department and is available for review.

Water quality data for the wells, springs, and mines were obtained from the following primary sources:

- The Department's Groundwater Site Inventory (GWSI) database (ADWR, 2005f);
- USGS's National Water Inventory System (NWIS) database (USGS, 2005b);
- ADEQ's Safe Drinking Water (SDW), Rural Watershed Study, and Arsenic databases (ADEQ 2005h and 2004a,b,c); and
- Various technical reports prepared by the Department, ADEQ and USGS.

Data on impaired lakes and streams comes from ADEQ's 2006 report *The Status of Water Quality in Arizona – 2004, Arizona's Integrated 305(b) Assessment and 303(d) Listing Report* (Diroll and Marsh, 2006).

Several of the well, spring, and mine sites have been sampled more than once and/or results from the same sampling date are listed in more than one data source. An effort was made to remove duplicate data using available information on site location. The water quality data presented in the Atlas indicate areas where water quality exceedences have previously occurred. Additional areas of concern may currently exist where water quality samples have not been collected or sample results were not reviewed by the Department. For example, as part of ADEQ's Underground Storage Tank (UST) and Aquifer Protection Permit (APP) programs, thousands of water quality samples have been collected and analyzed. Results from these analyses were not included in the Atlas. What is included for these and other environmental programs is a 2006 map from ADEQ that shows the location of contaminated sites across the state (See *Contamination Sites)*.

Finally, note that the water quality data presented in the Atlas may not reflect the quality of water being supplied by public water systems. The latter are required by federal and state law to supply water that meets drinking water standards. The Atlas indicates areas where private well owners and surface water users may want to test the quality of their water or restrict its use. The distribution of common ground water quality exceedences in Arizona ground waters (arsenic, fluoride, nitrate and total dissolved solids) is shown in Figure 1-26 of this volume.

B.23 Wells

Automated Recorder Sites

The location of automatic water-level recorders (automated wells) across Arizona is shown in Figure 1-25 of this volume. Automated wells collect numerous measurements daily, filling in the gaps between annual measurements. Information on these well sites comes from the Department's Field Services Unit (ADWR, 2005g), USGS, and the Cities of Flagstaff and Williams and further discussed in the overview of Volumes 2-8.

Basin Sweeps

A well sweep refers to a large number of measurements of water levels in wells throughout a basin. While efforts are made to target specific wells, the process has been largely random in nature, and is intended to provide the best aerial and vertical coverage in the basin. It is not intended to, and does not include every well in the basin. The date of the most recent well sweep and the number of wells measured during the sweep is listed in a table for each basin (*Groundwater Data*) in Volume 2-8 and in Table 1-4 of this volume. Information on well sweeps comes from the Department's Groundwater Site Inventory (GWSI) database (ADWR, 2005f).

Index Sites

The number of index wells is listed in a table for each basin (*Groundwater Data*) in Volumes 2-8 and shown on a statewide map (Figure 1-25) in this volume. Water levels in index wells are measured manually at specific times, or continuously using automatic recording devices. These wells are representative of aquifer conditions over a large geographic area and their measurement allows a lower density of monitoring to occur in years between basin sweeps.

Information on index wells came primarily from the Department's GWSI database (ADWR, 2005f). This was supplemented outside of the AMAs with information from several organizations including the USGS, other federal entities (Fort Huachuca, NPS, and USBR), an Indian Tribe (Navajo Nation), a city (Flagstaff), and two utilities (SRP and TEPCO).

Registrations

Numbers of registered water supply wells are listed in a table for each basin (*Cultural Water Demand*) in Volumes 2-8. The tables include the total number of wells completed through 1980 and the number of new wells completed in 5-year increments from 1981 through 2005. Also included is the total number of wells drilled without completion dates.

Information on well completions comes from the Department's well registry, commonly referred to as the "Wells55" database (ADWR, 2005h). Wells in the registry were queried first by basin and reported pump capacity. This resulted in two well lists for each basin – wells with a maximum pump capacity of 35 gallons per minute (gpm) or less and wells with a maximum pump capacity greater than 35 gpm. In the AMAs, wells with a maximum pump capacity of greater than 35 gpm are "non-exempt" wells and wells with a maximum pump capacity of 35 gpm or less are "exempt" wells. The resulting well lists were then filtered to exclude registrations for wells that apparently were never drilled and/or those wells not used for water supply purposes.

The Department's wells registry only lists data for wells that have been registered with the Department, as required by statute. For the purpose of the Atlas, no attempt was made to verify the accuracy of the data or to conduct field surveys to determine whether additional wells have been drilled but never registered or whether the wells that were drilled and registered are still operable today. For example, wells drilled on Indian Reservations are generally not counted since the tribes have no requirement to register these wells with the Department.

Locations for the registered exempt and non-exempt wells are shown on planning area maps (*Registered Wells and Surface Water Diversion Points)* in the overview of Volumes 2-8 and plotted on statewide maps in Appendix C of those volumes and in Figure 1-24 of this volume.

Pumpage (see Cultural Water Demands)

Recent Water-Level Depths

Recent (2002-2005) depths to water in wells are shown on basin-scale maps (*Groundwater Conditions*) in Volumes 2-8 and a statewide summary map (Figure 1-9) is presented in this volume. Depth values, in feet below land surface, are presented on the maps next to each well symbol. Most of the water level data were taken from the Department's GWSI database (ADWR, 2005f). These data were supplemented outside of the AMAs with measurements made by the USGS, other federal entities (Fort Huachuca, NPS, and USBR), an Indian Tribe (NTUA), a city (Flagstaff), and two utilities (SRP and TEPCO).

Water levels were reviewed and data that appeared unreasonable were excluded from the Atlas. Some of the included data were adjusted first to ensure consistency and account for the different measurement methods used.

Water-level Changes

Water-level changes in wells are shown on basin-scale maps (*Ground-water Conditions*) and on hydrographs for each basin (*Hydrographs Showing Depth to Water in Selected Wells*) in Volumes 2-8. A summary map for the state is presented as Figure 1-9 of this volume. The maps use colored dots to show how water levels have changed over the period that began in the early-1990s and ended in the early- to mid-2000s. As many as eight different colors are used to represent the range of recorded water-level changes. A positive change indicates a rise in water level over the period and negative change indicates a decline. The hydrographs show water-level changes for selected wells over the 30-year period from 1975 to 2005. Included on the hydrographs are a well identifier (cadastral), well depth, principal aquifer (outside AMAs only), and water use. Care was taken to select wells that were representative of aquifer conditions both horizontally and vertically.

Most of the water-level data used to generate the maps and hydrographs were taken from the Department's GWSI database (ADWR, 2005f). These data were supplemented outside of the

AMAs with measurements made by the USGS, other federal entities (Fort Huachuca, NPS, and USBR), an Indian Tribe (Navajo Nation), a city (Flagstaff), and two utilities (SRP and TEPCO). All water levels were reviewed and data that appeared unreasonable were excluded from the Atlas. Some of the included data were adjusted to ensure consistency and account for the different measurement methods used.

An effort was made to use data collected during the period when the wells were not actively being pumped or only minimally pumped. This period was typically from about September through about May. However, in some areas, like the Navajo Reservation, water-level data from wells were less abundant and the data used in the Atlas may have been affected by pumping.

Yields

Wells yields are listed in a table for each basin (*Groundwater Data*) and shown on basin-scale maps (*Well Yields*) in Volumes 2-8. The maps use colored dots to show the location of well yields measured by the Department and USGS. Five different colors are used on the maps to represent the range of recorded well discharges. The tables list summary statistics for these and other estimates of well yield.

Information on well yields was primarily taken from databases maintained by the Department (GWSI and Wells55) and USGS (NWIS). Also used for basins outside of the AMAs was a 1990 internal report by the Department that summarizes water resources information by basin (ADWR, 1990) and a 1994 annual report by USGS on groundwater conditions across Arizona (Anning and Duet, 1994). To estimate well yields using the Wells55 database, only wells with a casing diameter greater than 10 inches were considered. It was assumed that such 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.

Many factors can affect well yields, including local and regional aquifer properties, well design, the size and condition of the pump, and the age of the well. The data presented in the Atlas provides a general indication of the quantity of water that can be produced from basin aquifers under optimal well conditions. Actual well yields may be significantly lower than those presented based on the factors described.

A map and table that summarize well yields across the state is presented in this volume as Figure 1-4` and Table 1-4, respectively.

B.24 Water Issues

Non-AMA

Rural water issues are summarized in separate tables (*Planning Area Issues Identified from the 2003 and 2004 Rural Questionnaires*) with explanatory text for each non-AMA planning area in the overview of Volumes 2-7. Issues were primarily identified through two questionnaires sent out by the Department in 2003 and 2004 (ADWR, 2005a). Results from the 2003 questionnaire are summarized in the Department's *Rural Water Resources 2003 Questionnaire Report* (ADWR, 2004). Other issues were identified through Arizona's Rural Watershed Initiative Program, through studies and other sources.

Data from the Department's questionnaires were entered into a database and queried for various attributes such as total responses, responses by location, issues ranking, type of respondent, etc. Note that the 2003 and 2004 questionnaires were not identical and some questions were asked differently. Also, the number of respondents did not represent a statistically valid sample. Therefore, any conclusions drawn from the questionnaires should, not be considered representative of all of rural Arizona or even representative of a given planning area or basin. Issues can vary dramatically by respondent and location.

AMA

Water resource issues in the AMA planning area were identified by the Department through its management plans, stakeholder meetings, government committees, an Arizona town hall, and numerous community water resource groups. These issues are described in the overview of Volume 8.

Issues are summarized by planning areas in Section 1.4.8 of this volume and statewide results from the 2004 Rural Questionnaire are listed in Table 1-16.

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APPENDIX C: SUMMARY OF ARIZONA WATER LAW AND MANAGEMENT

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Water management in Arizona is a complex system of laws, rules and management authorities that differ for each type and source of water. Surface water regulations are distinct from those governing groundwater. Arizona's Colorado River water apportionment is governed by interstate compact, federal Congressional acts and U.S. Supreme Court decisions, referred to as the "Law of the River". Indian water rights claims and settlements are an important component in water management in Arizona and are discussed in Appendix G. Effluent is regulated under a law separate from those that pertain to surface water or groundwater. There are also laws that regulate underground water storage, water exchanges and dams. The Arizona Department of Water Resources (Department) administers water management and water rights but several other Arizona governmental agencies, authorities and districts also affect aspects of water management and utilization.

C.1 Surface Water

Arizona has adopted the doctrine of prior appropriation to govern the use of surface water. This doctrine is based on the tenet of "first in time, first in right" which means that the person who first puts the water to a beneficial use acquires a right that is better than later appropriators of the water. Beneficial use is the "basis, measure and limit to the use of water" A.R.S. § 45-141(B). Prior to June 12, 1919, a person could acquire a surface water right simply by applying the water to a beneficial use and posting a notice of the appropriation at the point of diversion. On June 12, 1919, the Arizona surface water code was enacted. Known as the Public Water Code, this law requires that a person apply for and obtain a permit in order to appropriate surface water. Surface water is defined by statute as:

> *"Waters of all sources, flowing in streams, canyons, ravines or other natural channels, or in definite underground channels, whether perennial or intermittent, floodwaters, wastewater, or surplus water, and of lakes, ponds and springs on the surface."* A.R.S. § 45-101.

Water may be appropriated for domestic, municipal, irrigation, stock watering, water power, recreation, wildlife, including fish, nonrecoverable water storage or mining uses. A.R.S. § 45-151(A). Water cannot be wasted, and if not used by the senior appropriator, it must be allowed to flow to the next senior appropriator. Non-diversionary appropriation of surface water for recreation and wildlife, including fish, use is recognized as a beneficial use. (Arizona Court of Appeals decision, *Phelps Dodge Corp v. Arizona Dep't of Water Res.*, 211 Ariz.146, 118 P.3d 1110 (App.2005)). These rights are referred to as "instream flow rights."

The Department administers the surface water permit system, including permits for instream flow. Permits are issued for a specific location and amount of water. Surface water rights for municipal, domestic or irrigation may be severed and transferred to a new location but only pursuant to statutory procedures. A.R.S. § 45-172.

<u>Adjudication of Surface Water Rights</u>
A general stream adjudication is a judicial proceeding in which the nature, extent, and relative priority of the rights of all persons to use water in a river system and source are determined. Two general stream adjudications are in progress involving the Gila River and Little Colorado River systems. The Gila River Adjudication includes the Salt, Gila, San Pedro, and Verde River watersheds, which include most of southeastern and central Arizona. The Little Colorado River

Adjudication includes the Little Colorado River system in northeastern Arizona.
The Department provides technical and administrative support to the adjudication court and special master, "in all aspects of the general adjudication with respect to which the director possesses hydrological or other expertise." A.R.S. § 45-256(A). Thousands of claimants and water users are joined in these cases that will result in the Superior Court issuing a comprehensive final decree of water rights for both the Gila and Little Colorado river systems.

Surface Water Decrees
Decreed surface water rights are those that have been determined through judicial action in a state or federal court. Major court determinations in Arizona include the Kent, Benson-Allison, Norviel, Concho and Globe Equity decrees.

The Kent Decree (*Hurley v. Abbott* 1910) established rights to the Salt and Verde rivers for diversion by downstream landowners based on diversions occurring at that time from Granite Reef and Joint Head diversion dams. These lands are generally the Salt River Project service area, along with portions of the Salt River Pima-Maricopa and Fort McDowell Indian reservations. Rights to the lower Agua Fria River, the Salt River and the Gila River below the confluence were determined in the Benson-Allison Decree in 1917 for the Buckeye Irrigation District and a portion of the Gila River Indian Reservation. The Norviel Decree, which is comprised of four judicial actions (between 1914 and 1923) determined rights of landowners to divert surface water in and around St. Johns to the headwaters of the Little Colorado River. The Concho Decree (1927) determined the relative rights to use surface water from Concho Springs and Concho creek in Apache County. 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.

Indian Water Rights Claims and Settlements (See Appendix G)

Federal Reserved Rights
The United States Supreme Court's decision in Winters v. United States, 207 U.S. 564 (1908) established that when the federal government creates an Indian reservation, it impliedly reserves for the reservation a right to an amount of water sufficient to effectuate the purposes of the reservation (this doctrine is know as the "Winters Doctrine"). This concept of "federal reserved rights" has been claimed for other federal lands. Federal Reserved right claims have been filed in the Gila and Little Colorado River adjudications for national parks and monuments, national forests and for military bases.

C.2 Groundwater

The withdrawal, use and transportation of groundwater in the state are regulated under the Arizona Groundwater Code (Code), Title 45, Chapter 2, Arizona Revised Statutes. The Code has three primary goals: 1) to control groundwater overdraft in certain parts of the state; 2) to provide a means to allocate groundwater to meet the needs of the state; and 3) to augment groundwater supplies through the development of renewable water supplies. The Code established the Arizona Department of Water Resources to administer the Code provisions.

The Code contains regulatory provisions applicable statewide, such as well drilling requirements and restrictions on groundwater transportation. It also contains provisions applicable only in certain designated areas of the state. The most intensive regulation of groundwater is in the five areas of the state designated as active management areas (AMAs), where the focus is on conservation and achievement of the AMA's management goal. Outside of the AMAs, persons may generally withdraw and use groundwater for any reasonable and beneficial use, subject to the groundwater transportation laws. However, in areas designated as irrigation non-expansion areas (INAs), irrigation acreage expansion is prohibited and metering and reporting requirements apply to certain groundwater withdrawals.

<u>Statewide Provisions</u>
Statewide, all wells must be registered with the Department and new wells must be drilled by a licensed well driller and comply with well construction standards. With certain exceptions, wells proposed to recover water stored or saved underground pursuant to a storage permit must comply with well spacing requirements.

Arizona has been divided into hydrologic groundwater basins and sub-basins within some of those basins. Statutes governing the transportation of groundwater within and between basins are designed to protect hydrologically distinct sources of groundwater supplies and the economies in rural areas by ensuring the groundwater is not depleted in one groundwater basin to benefit another. In general, groundwater cannot be transported between groundwater basins outside of the AMAs or from a groundwater basin outside an AMA into an AMA except for certain transfers specified in statute. A.R.S. §§ 45-544 and 45-551 through 45-555. Groundwater can legally be transported within a sub-basin, or within a basin that has not been divided into sub-basins, without payment of damages. A.R.S. § 45-541 and A.R.S. § 45-544. Groundwater may also be transported between sub-basins in the same basin but is subject to payment of damages, except under certain conditions in AMAs. A.R.S. §§ 45-542 through 45-545.

<u>Active Management Areas</u>
The magnitude of overdraft in certain areas of the state led to the designation of four initial AMAs: the Prescott, Phoenix, Pinal and Tucson AMAs. In 1994, a southern portion of the Tucson AMA was separately designated as the Santa Cruz AMA. The geographic boundaries of AMAs are defined by groundwater basins and subbasins. The Phoenix, Prescott and Tucson AMAs have a management goal of safe-yield by 2025. A.R.S. § 45-562(A). Safe-yield, as defined in the Code, means "a groundwater management goal which attempts to achieve and thereafter maintain a long-term balance between the annual amount of groundwater withdrawn in an active management area and the annual amount of natural and artificial groundwater recharge in the active management area." A.R.S. § 45-561(12). The management goal of the Pinal AMA is to allow development of non-irrigation uses and to preserve existing agricultural economies in the AMA for as long as feasible, consistent with the necessity to preserve future water supplies for non-irrigation uses. A.R.S. § 45-562(B) The goal of the Santa Cruz AMA is to maintain a safe-yield condition and prevent local water tables from experiencing long-term declines. A.R.S.§ 45-562(C).
General water management requirements within AMAs include:

- Groundwater rights and permits including metering, reporting and fees
- Well regulations
- Agricultural land development restrictions
- Groundwater management plans, which include agricultural, municipal and industrial

water conservation programs, an augmentation program, groundwater quality assessment, and a water management assistance program
- Assured water supply program requirements for new subdivisions to have long-term dependable water supplies consistent with the management goal.

In the AMAs there are regulatory distinctions between wells that can pump more than 35 gallons per minute (gpm), "non-exempt wells" and those that pump less, "exempt wells." Withdrawal of groundwater from a non-exempt well requires a legal authority. The Code established grandfathered groundwater rights, service area rights and groundwater withdrawal permits to provide legal withdrawal authority. With certain exceptions, drilling a non-exempt well requires a drilling permit and is subject to well spacing requirements adopted by the Department to prevent unreasonably increasing damage to surrounding land and other water users. Also, with a few exceptions, any person withdrawing groundwater from a non-exempt well in an AMA must meter and report water use annually to the Department and is assessed an annual withdrawal fee based on the amount withdrawn and beneficially used. Withdrawal fees are used to fund conservation and augmentation programs and Arizona Water Banking Authority activities (described below). Information from the annual water use reports is used to estimate the volume of groundwater withdrawals, water stored, and water recovered in an AMA. Water budgets are constructed from these data to determine the relationship between water supply and demand and to gage progress toward meeting AMA management goals.

A person may withdraw groundwater from an exempt well for a non-irrigation use without a groundwater right or permit. However, a right or permit is required to withdraw more than 10 acre-feet of groundwater per year for non-irrigation uses other than domestic or stockwatering if the exempt well was drilled on or after April 28, 1983. Except under specific circumstances, not more than one exempt well can be drilled to serve the same purpose at the same location. Additionally, beginning on January 1, 2006, with certain exceptions, an exempt well may not be drilled on land if any part of the land is within 100 feet of the operating water distribution system of a municipal provider with an assured water supply designation as shown on a digitized service area map provided to the Department by the municipal provider. A.R.S. § 45-454. These restrictions do not apply outside AMAs as long as the groundwater is put to reasonable and beneficial use.

To help achieve the water management goal of each AMA, the Code directs the Department to develop and implement water conservation requirements for the agricultural, municipal and industrial water use sectors in five consecutive management periods (1980-2025). The Code generally requires that each consecutive management plan contain more rigorous water conservation requirements. These requirements are published in separate management plans for each AMA. A.R.S. §§ 45-564 through 45-568. In addition to conservation requirements, the management plans contain a water quality assessment and management program, an augmentation and recharge program and conservation assistance programs. Management plans contain water demand information and data and provide the framework for implementation of Code mandates and Department policies for each AMA.

Within the AMAs, new subdivisions must demonstrate to the Department that a 100-year water supply exists before the local platting authority (typically City or County Planning Departments) can approve a plat and before the Arizona Department of Real Estate will issue a public report allowing the land to be sold. The demonstration criteria include physical, legal and continuous availability of water of adequate quality for 100-years, the groundwater use must be consistent with the AMA management goal and management plan conservation requirements, and the developer must have the financial capability to construct the necessary delivery, storage and treatment systems.

Outside of the Active Management Areas

Outside of the AMAs, groundwater may generally be withdrawn and used for any reasonable and beneficial use, subject to the statewide provisions described above. In areas designated as INAs, however, additional restrictions and requirements apply (see *Irrigation Non-Expansion Areas* section below.

In 1973, the Arizona Legislature enacted a statewide water adequacy statute as a consumer protection measure. A.R.S. § 45-108. The law was passed in response to incidences of land fraud involving the sale of subdivision lots that were later found to have insufficient water supplies. This law required developers to obtain a determination from the State Land Department regarding the availability of water supplies prior to marketing new subdivision lots. When the Code was adopted in 1980, the provisions of A.R.S. § 45-108 were amended and now apply only to subdivisions located outside AMAs. Under A.R.S. § 45-108, the Department must evaluate a developer's water supply plans and determine whether there is an adequate water supply, unless the development will be served by a water provider that has been designated by the director as having an adequate water supply for its service area. The developer must provide a copy of the Department's evaluation to the State Real Estate Commissioner for disclosure to the public if water supplies are determined to be inadequate. However, the Department's evaluation does not affect whether lots may be platted or sold.

Legislation adopted in June 2007 (SB 1575) authorizes a county board of supervisors to adopt a provision by unanimous vote that 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. As of August, 2010 Cochise County, Yuma County, the Town of Patagonia and the Town of Clarkdale had adopted the provisions of SB 1575.

Irrigation Non-Expansion Areas

There are three INAs: Douglas, Joseph City and Harquahala. In an INA, irrigation is restricted to lands that were irrigated during the five-year period preceding designation of the INA. A.R.S. § 45-434. This restriction is intended to protect the remaining groundwater supply. Groundwater withdrawals for agricultural irrigation on more than 10 acres and non-irrigation withdrawals of more than 10 acre-feet per year from a non-exempt well must be measured and annually reported to the Department. A.R.S. § 45-437. Statewide provisions and the provisions applicable outside of the AMAs mentioned above also apply within INAs.

C.3 Colorado River Water and the Central Arizona Project

The Colorado River is a critical water supply for Arizona. Use of Colorado River water is primarily under the jurisdiction of the federal government and is discussed in more detail in Appendix D. The development of Colorado River water law is described in the "Law of the River", which includes a number of Congressional acts, Supreme Court decisions and multi state compacts, as well as an international treaty.

The "Law of the River" includes: the 1922 Colorado River Compact, which apportioned 7.5 million acre-feet (maf) per year to the Upper Basin States and 7.5 maf per year to the Lower Basin States; the Boulder Canyon Project Act of 1928, which authorized construction of Hoover Dam and established the individual lower basin state apportionments; the 1944 Water Treaty with Mexico, which guaranteed delivery to Mexico of 1.5 maf per year; the Upper Colorado River Compact of 1948 that divided the water apportioned to the Upper Basin between the five states with territory in the Upper Basin (including Arizona); the Colorado River Storage Project Act of 1956, which authorized several dams including Glen Canyon Dam in Arizona; the United States Supreme Court's decision in *Arizona v. California* (1964) that confirmed Arizona's apportionment under the Boulder Canyon Project Act and assigned any surplus; the Colorado River Basin Project Act (CRBPA) of 1968 which authorized the Central Arizona Project (CAP); and the Coordinated Operations and Shortage Criteria adopted in 2007 (see Appendix D). Ratification and text of the 1944 Lake Mead Delivery Contract, the Colorado River Compact and the Upper Colorado River Basin Contract are found at A.R.S. §§ 45-1301 to 1331.

Central Arizona Water Conservation District
Under provisions of the CRBPA, Arizona authorized the Central Arizona Water Conservation District (CAWCD) in 1971 to provide a means for Arizona to repay the federal government for the reimbursable costs of construction and to manage and operate the CAP. The CAP transports about half of Arizona's Colorado River water entitlement of 2.8 million acre-feet per year to central Arizona.

The CAP brings Colorado River water through a 336–mile system of aqueducts, pumping plants and siphons designed to carry 1.5 million acre-feet of water each year from Lake Havasu through Phoenix to south of Tucson. One reservoir, Lake Pleasant, located in the Phoenix AMA, provides storage. CAP delivers untreated water to cities and water utilities, industrial users, agricultural users and Indian communities.

CAWCD is a tax-levying public improvement district of the state responsible for system maintenance and operations, repayment obligations, and creating water resource management programs. Operations are managed by the General Manager and senior management team. The General Manager reports to the 15-member CAWCD Board of Directors who are popularly elected from the CAP three-county service area that includes Maricopa, Pima, and Pinal counties. Board members serve staggered six-year terms and are responsible for establishing policy. (See: www.cap-az.com).

Arizona Department of Water Resources
The director of the Department is authorized to "consult, advise and cooperate with the secretary of the interior of the United States" on behalf of the state of Arizona in several areas: the secretary's authorities under the Boulder Canyon Project Act; contracts for delivery of main stream Colorado river water for use within Arizona; powers and duties of the secretary under provisions of the 1944 treaty with Mexico; exercise by the secretary of any authority conferred by any legislation enacted by Congress; and in respect to the development, negotiation and execution of interstate banking agreements. A.R.S.§ 45-107.

Arizona Water Banking Authority
The Arizona Water Banking Authority (AWBA) was created in 1996 to protect Arizona's Colorado

River interests and to provide for interstate banking opportunities. A.R.S. § 45-2401 et.seq. The primary functions of the AWBA are: to provide a stored reserve of water to communities dependent on the CAP during times of drought on the Colorado River; to assist Colorado River communities during times of shortage by providing water exchange mechanisms; to replenish depleted aquifers with CAP water to meet water management goals; and to provide a pool of water for use in Indian water rights settlements. The AWBA can also contract with similar authorities in California and Nevada to allow these states to annually store unused Colorado River water in Arizona. In the future, Arizona users can recover (pump) the stored water (less a 5% "cut to the aquifer") and the interstate partner will draw a similar quantity directly from the Colorado River. The AWBA, the in-lieu recharge program and CAP pricing structures for agricultural users have promoted CAP utilization since the mid-1990s. Information about the Water Banking Authority is found at www.awba.state.az.us.

C.4 Effluent

Effluent is defined in A.R.S. § 45-101(4) as "water that has been collected in a sanitary sewer for subsequent treatment in a facility that is regulated pursuant to title 49, chapter 2. Such water remains effluent until it acquires the characteristics of groundwater or surface water." The determination that effluent is a separate kind of water was a result of an Arizona Supreme Court Decision in 1989, *Arizona Pub. Serv. Co. v. Long*, 160 Ariz. 429, 773 P.2d 988 (1989), in which the court held that, until it is returned to the ground as surface water or groundwater, effluent is neither surface water nor groundwater, and therefore a city that produces effluent is free to use it without regard to the laws governing surface water and groundwater. Because the supply is not groundwater, if 100% effluent is used to serve a use within an AMA, the use is not subject to regulations applicable to groundwater, such as conservation requirements and groundwater transportation laws. AMA management plans contain a number of regulatory incentives for effluent use, which is considered a renewable water supply.

C.5 Underground Water Storage

Underground water storage or recharge is a means of storing excess renewable water supplies (surface water, including CAP and Colorado River water, and effluent) for future use. The goals of the recharge program are to promote the use of renewable water supplies by allowing for storage and recovery, to allow water to be "transported" by storing water in one location but recovering a like quantity elsewhere, to reduce overdraft by storing water to prevent further water level declines, to use underground storage to address seasonal water demands and to augment the water supply.
The Underground Water Storage and Recovery program was established in 1986 by the Arizona Legislature. In 1994, the Legislature enacted the Underground Water Storage, Savings, and Replenishment Act, which further defined the recharge program. Persons wishing to store and/or recover water anywhere in the state through the recharge program must apply to the Department for the appropriate permits. Permit holders are required to file annual reports with the Department in which they must report the volume of water stored and/or recovered pursuant to the permit. A.R.S. §§ 45-801.01 through 45-898.01. Recharge and recovery is an increasingly important tool in the management of Arizona's water supplies, especially in meeting the goals of the Code.

C.6 Water Exchanges

Flexibility in accessing water supplies through exchanges can provide water management benefits.

The 1992 Water Exchange Act authorizes and regulates water exchanges with certain exceptions. A.R.S. § 45-1001 et seq. "Water exchange" is defined as "a trade between one or more persons, or between one or more persons and one or more Indian communities, of any water for any other water, if each party has a right or claim to use the water it gives in trade. This definition applies whether or not water is traded in equal amounts or other consideration is included in the trade." A.R.S. § 45-1001(6). The Act establishes four classifications of exchanges with different conditions applicable to each class. Regardless of the classification, every exchange is subject to the "giver rule", which generally provides that a person who receives water pursuant to an exchange: (1) may use the water without holding a right to that water; and (2) may use the water only in the same manner in which the person had the right to use the water that the person gave in the trade. Currently, water exchanges are most common within the Phoenix AMA.

C.7 Dams and Reservoirs

The director of the Department is responsible for supervision of the safety of dams in Arizona. A.R.S. § 45-1202(A). The statutory authority for the tasks performed under the Dam Safety Program is found in A.R.S. § 45-105(B)(3) and 45-1201, et seq. Rules for dam safety procedures are found in the Arizona Administrative Code, R12-15-1201 et seq. Statutes and rules define a jurisdictional dam as an artificial barrier over 25 feet in height or capable of storing more than 50 acre-feet of water, with certain exceptions. Dams owned and/or operated by the Federal government are generally exempt from state jurisdiction. Major dam safety program areas are rehabilitation of unsafe dams, inspection and oversight of existing dams, review of applications to construct, enlarge, alter or remove a dam and construction monitoring. Another responsibility is to review and assist dam owners in development of Emergency Action Plans.

C.8 Arizona Drought and Conservation Programs

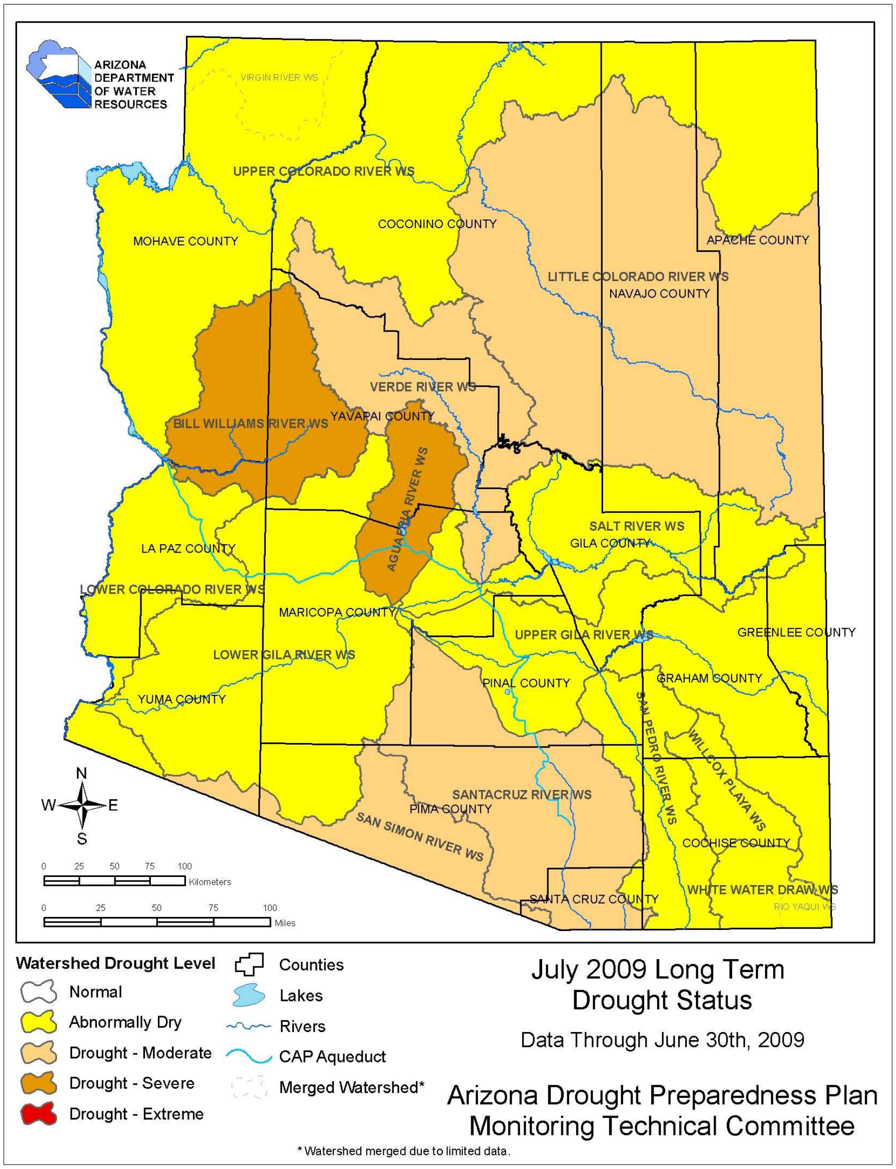
Governor Napolitano signed Executive Order 2003-12 in March 2003 to address the impact of prolonged drought conditions that began in 1998. The Executive Order established the Governor's Drought Task Force (Task Force) to develop a drought plan for Arizona, adopted in October 2004. The *Arizona Drought Preparedness Plan* (Plan) established a process to allow for ongoing drought monitoring, planning and response, and established state drought and conservation programs administered by the Department.

<u>Drought Program</u>
The Department's Drought Program coordinates implementation of the Plan and three groups formed to address drought preparedness efforts in Arizona - a State Drought Monitoring Technical Committee, local drought impact groups and the Governor's Drought Interagency Coordinating Group. Water use reporting and drought planning requirements for water providers located outside of the state's AMA are also administered through this program.

Drought Program Groups
The Plan focuses on drought planning by rural communities that often have fewer water supply options during drought. Ongoing drought monitoring is critical to the planning process and the State Drought Monitoring Technical Committee meets regularly for this purpose. The Committee gathers and evaluates climate data and distributes drought information to land managers, policy-makers and the public, and produces monthly drought status updates and a quarterly long-term drought status map (Figure C-1) to show drought levels by watershed (see ADWR's Drought

Status webpage). Percentile values for precipitation and streamflow are used to determine drought status in each of Arizona's watersheds. The long-term drought status map incorporates 24-, 36- and 48-month precipitation and streamflow percentiles.

Figure C-1 Long Term Drought Status Map



County-level local drought impact groups (LDIGs) monitor drought status and impacts in their area, increase drought public awareness, and develop local mitigation and response options. LDIGs provide important local information to the Monitoring Technical Committee that is used to determine drought conditions. In cooperation with county extension agents, county emergency managers, and other local coordinators, planning efforts for ten local drought impact groups have begun. Due to resource constraints, only two groups are currently active - Mohave County and Pima County.

The Governor's Drought Interagency Coordinating Group is an advisory body to the governor on Arizona drought issues. Comprised of state, federal, tribal and non-governmental organizations, this group meets in the spring and fall to evaluate drought conditions and consider recommendations to the governor for improving drought monitoring, implementation and response in Arizona.

Community water systems drought planning

Drought planning requirements for community water systems were established by H.B. 2277 passed by the Arizona legislature in 2005 and codified in A.R.S. Title 45, Chapter 1, Article 14. Community water system (CWS) is defined as a public water system that serves at least 15 service connections used by year-round residents or that regularly serves at least 25 year-round residents. The annual reporting and drought planning requirements were part of a larger set of recommendations made by the governor's Drought Task Force.

Every five years, CWS's are required to develop and submit a water system plan, which includes a water supply plan, drought preparedness plan and water conservation plan. Required components of the system water plan are found on the Department's CWS webpage. Each year, a water use report must be submitted that includes information on water pumped or diverted, water received, water delivered to customers, and effluent used or received. Annual water use data was first obtained from water providers outside the State's AMAs in 2006.

The reports and plans are intended to reduce community water systems' vulnerability to drought and ensure that water providers are prepared to respond to drought or water shortage conditions. The information submitted by the water systems will also allow the State to provide regional assistance for drought planning, mitigation and response.

Conservation Program

The Department's Conservation Program was created to provide an integrated approach to water conservation by combining regulations, assistance, outreach and education. ADWR staff coordinate efforts to meet the vision of creating a "culture of conservation" through activities that promote and encourage the wise and efficient use of water by providing assistance and resources throughout Arizona. Conservation staff develop conservation tools and resources, assist communities and water providers, collaborate with regional and national partners, and participate in outreach activities.

C.9 Statewide Water Resource Assessments

Prior to publication of this Atlas, the only Department document that provided a broad overview of water supply and demand conditions as well as an analysis of water resource management issues statewide was the Arizona Water Resources Assessment, 1994 (Assessment). The Assessment is composed of two Volumes: Volume I; Inventory and Analysis and Volume II; Hydrologic Summary (ADWR 1994a,b). The Assessment discusses statewide water issues and water supply, demand and management issues for six planning areas. The Atlas partially retains the purpose and content of the Assessment.

The 1994 Assessment was built upon the State Water Plan prepared by the Arizona Water Commission, the predecessor to the Department. The State Water Plan was published in three phases from 1975 to 1978 and was intended to provide necessary water resource information for water management decision-making. The three phases included: Phase I, Inventory of Resource and Uses; Phase II, Alternative Futures; and Phase III-Part 1, Water Conservation. Other Phase III reports were envisioned but not produced. The Plan pre-dates the formation of the AMAs and presented information on a state and county basis.

C.10 Water Replenishment Districts and Water Authorities

Central Arizona Groundwater Replenishment District
In 1993, the Central Arizona Groundwater Replenishment District (CAWCD) was given groundwater replenishment authority within the Phoenix, Pinal and Tucson AMAs. The division of CAWCD responsible for replenishing groundwater is the Central Arizona Groundwater Replenishment District (CAGRD). Membership in the CAGRD provides a mechanism for developers and water providers to satisfy the management goal criteria of the Assured Water Supply (AWS) rules. The CAGRD must replenish (recharge) the amount of groundwater used by members in excess of that allowed by the AWS rules. Water used for replenishment is primarily excess CAP water.

Mohave County Water Authority
The Mohave County Water Authority was formed in 1994 pursuant to legislative authorization. A.R.S. §§ 45-2201 through 45-2283. The Authority is authorized to acquire Colorado River water allocations on behalf of its members. Members of the Authority must have had a Colorado River contract as of January 1, 1993. The legislation approved the transfer of the right to delivery of 18,500 acre-feet per year of Colorado River water from a member for allocation to municipal and industrial uses.

Upper San Pedro Water District (proposed)
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 State Water Infrastructure Finance Authority to finance necessary projects. The date of the election is scheduled for November 2nd, 2010.

C.11 Water-Related Agencies and Commissions

Arizona Department of Environmental Quality
The mission of the Arizona Department of Environmental Quality (ADEQ) is to protect and enhance public health and environment in Arizona. Established by the Arizona Legislature in 1986 in response to growing concerns about groundwater quality, ADEQ administers a variety of programs to ensure that the quality of Arizona's air, land and water resources meets regulatory standards.

ADEQ has a programmatic Water Quality division. Core responsibilities include pollution control, monitoring and assessment, compliance management, cleanups of contaminated soil and water, education, outreach and financial assistance and policy development. Its programs influence water supply planning and operations at the local level. Effluent reuse, recharge projects and discharge of water to aquifers or stream beds must meet water quality standards. The Water Quality Assurance Revolving Fund (WQARF) was established to investigate and cleanup hazardous waste sites in Arizona. The Department has certain responsibilities under this program, including the adoption of provisions in its management plans and AWS rules to encourage the beneficial use of groundwater withdrawn pursuant to a remedial action project. (See: www.azdeq.gov)

Arizona Corporation Commission

The Arizona Corporation Commission (ACC) is a constitutionally formed commission with an elected 5- member board. It oversees the process of incorporating or registering companies to do business in the state, registers and oversees securities offerings and dealers, and enforces railroad and pipeline safety. Among its responsibilities is regulatory authority over private water and sewer companies. It regulates rates and authorizes curtailment tariffs that allow utilities to request that customers reduce water consumption when the demand is greater than the production. (See: www.cc.state.az.us)

Arizona Water Protection Fund Commission (See Appendix F)

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APPENDIX D: FEDERAL AGENCIES AND LAWS

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Federal agencies influence the use and management of water in Arizona. Federal agency authorities include the areas of flood control, water quality, and land and wildlife management. Many of the state's major water supply development projects were authorized and built by the federal government. Uses of the water from these projects are controlled by both federal and state laws. This appendix contains a brief summary of key federal agencies and laws that affect water resource management in Arizona.

D.1 Key Federal Agencies

<u>Army Corps of Engineers (COE).</u> The COE conducts flood control studies and dam, levee and channelization projects to protect communities from flood damage. The COE regulates the placement of dredged or fill material into water of the U.S. (CWA, Section 404). www.usace.army.mil

<u>Bureau of Indian Affairs (BIA)</u>. The BIA is responsible for protecting Indian trust lands water rights. The agency has developed irrigation distribution systems in communities along the Colorado River and coordinated construction of Coolidge Dam with the Secretary of Interior. www.doi.gov/bureau-indian-affairs

<u>Bureau of Land Management (BLM) and the National Park Service (NPS)</u>. These agencies manage over 17 million acres of land throughout the State. Management of these lands may involve federal reserved water rights, instream flow rights and land management activities that affect water runoff. The BLM manages the San Pedro Riparian National Conservation Area (SPRNCA). www.blm.gov, www.nps.gov

<u>Bureau of Reclamation (BOR).</u> The BOR administers the Colorado River Basin Project Act and contractual arrangements for the use of Colorado River Water. The BOR is responsible for construction of the major water supply development projects in Arizona (Hoover Dam and Power Plant, Glen Canyon Dam and Power Plant, Parker Dam and Power Plant, Davis Dam and Power Plant, the Salt River Project, Yuma Project and the Central Arizona Project). The BOR is also involved in regional planning activities, water conservation programs and water augmentation feasibility studies. www.usbr.gov

<u>Environmental Protection Agency (EPA).</u> The EPA has federal oversight over the implementation of surface water and drinking water quality programs. It has a regulatory role in governing some facilities that affect groundwater. This role involves oversight of state efforts regulating solid waste landfills, hazardous waste sites and underground storage tanks. The EPA also implements national programs on watershed management, toxic waste cleanup, and border-region environmental programs. www.epa.gov

<u>Natural Resource Conservation Service (NRCS).</u> The NRCS plays an active role in managing and mitigating agricultural non-point source pollution. NRCS conservation specialists assist individual operators through technical assistance and cost-sharing programs that help users develop best management practices to reduce water quality and quantity impacts. The NRCS is an important participant in implementation of the Arizona Drought Plan, particularly the operation of the local area impact assessment groups. www.nrcs.usda.gov

U.S. Fish and Wildlife Service (USFWS). The USFWS manages federal wildlife refuges, administers the Endangered Species Act, reviews environmental impact statements and Biological Assessments and issues Biological Opinions. www.fws.gov

U.S. Forest Service (USFS). The Forest Service manages watersheds through Forest Plans that include watershed management criteria to protect and enhance runoff. The Forest Service holds many surface water rights for various uses. www.fs.fed.us

U.S. Geological Survey (USGS). The USGS gages streamflows, and monitors the quantity and water quality of surface water and groundwater. It conducts scientific analysis of hydrologic resources and produces reports on Arizona water use by sector and source. www.usgs.gov

D.2 Colorado River Management

The "Law of the River" as described briefly below, is a collection of federal and state laws, interstate compacts, Supreme Court decisions and international treaties that govern the operation and use of the Colorado River. In the Lower Colorado River Basin, the United States Secretary of the Interior (Secretary) is the watermaster. Acting through the Bureau of Reclamation, the Secretary operates Colorado River dams and accounts for water use on an annual basis. Pursuant to Section V of the Boulder Canyon Project Act, the Secretary contracts with water users in the Lower Basin for water up to the total amount of each state's apportionment.

Colorado River Compact – 1922
In 1921, the seven Colorado River Basin states authorized the appointment of commissioners to negotiate a compact for the apportionment of the water supply of the Colorado River. Although the states were unable to negotiate an allocation of water for each state, an agreement was signed in November 1922, the Colorado River Compact (Compact) that divided the Colorado River Basin into the Upper Basin and the Lower Basin.

The Compact apportioned to the Upper Basin (Colorado, New Mexico, Utah, and a portion of Arizona) and to the Lower Basin (Arizona, California, and Nevada) the exclusive beneficial consumptive use of 7.5 million acre-feet of water to each basin annually. Because the Colorado River Basin includes a portion of Mexico, the Compact recognized Mexico's right to use River water. Water for this purpose was to be met from surplus water supplies in excess of the amounts apportioned to the Upper and Lower Basins. Any burden that might arise because of a water treaty with Mexico was to be shared equally by the two basins. The Compact recognized that the ability of the Upper Basin to meet the requirement to deliver 7.5 million acre-feet to the Lower Basin could be impacted by climatic factors, therefore the Compact only required the Upper Basin to restrict its use so that delivery to the Lower Basin would not be depleted below an aggregate of 75,000,000 acre-feet for any period of ten consecutive years.

Boulder Canyon Project Act - 1928
The Boulder Canyon Project Act (Project Act) authorized construction of the Hoover Dam and Power Plant and the All-American Canal. It also authorized Arizona, California and Nevada to enter into an agreement whereby the 7.5 million acre-feet of water apportioned to the Lower Basin by the Colorado River Compact would be apportioned as follows: to California, 4.4 million acre-feet per year; to Arizona, 2.8 million acre-feet per year; and to Nevada, 0.3 million acre-feet per year.

Mexican Treaty – 1945

In 1945, a treaty between the United States and Mexico involving waters of the Colorado, Rio Grande and Tijuana Rivers was enacted to address, among other things, a fixed entitlement for Mexico of 1.5 million acre-feet annually from the Colorado River. The Treaty also provided an additional 200,000 acre-feet in years of supply surplus. In years of extraordinary drought, Mexico's entitlement is to be reduced in the same proportion as consumptive uses in the U.S. are reduced.

Minute 242 was adopted and executed in 1973 in response to Mexico's concerns regarding the quality of Colorado River water being delivered to the Mexicali Valley. Minute 242 obligates the United States to implement measures that will maintain the salinity of the Colorado River waters delivered to Mexico at nearly the same quality as that diverted at Imperial Dam for use within the United States. The Colorado River Basin Salinity Control Act was signed into law on June 24, 1974, providing for the physical works necessary to implement Minute 242 without permanent loss of water to the Colorado River Basin states.

Upper Colorado River Basin Compact - 1948

This Compact divided the water apportioned to the Upper Basin by the Colorado River Compact between the five states with territory in the Upper Basin. Arizona was allocated 50,000 acre-feet per year with the remainder of the Upper Basin entitlement divided according to the following percentages: Colorado, 51.75; New Mexico, 11.25; Utah, 23.00; and Wyoming, 14.00.

Arizona v. California - 1964

On August 13, 1952, the State of Arizona filed a complaint with the U.S. Supreme Court against California and seven agencies within that state to resolve the contention by California that the Central Arizona Project should not be authorized. At California's insistence, the U.S. Congress would not authorize the Central Arizona Project until Arizona's right to the necessary Colorado River entitlement was clarified.

The Decree, handed down in 1964, confirmed that Congress had already apportioned, through the Boulder Canyon Project Act, the entitlement of water to the three Lower Basin states as follows: Arizona, 2.8 million acre-feet; California, 4.4 million acre-feet; and Nevada, 300,000 acre-feet. Any surplus above 7.5 million acre-feet was apportioned 50 percent to California and 50 percent to Arizona, except that Nevada was given the right to contract for 4 percent of the excess, which would come out of Arizona's share. The Decree also confirmed each of the Lower Basin state's entitlements to the flow of the tributaries within their boundaries, supporting Arizona's utilization of water from its in-state rivers, separate from its entitlement to its full 2.8 million acre-feet of Colorado River water.

The Decree left shortage allocation to the discretion of the Secretary after providing for satisfaction of present perfected rights in the order of their priority dates. These rights were defined as rights existing and used prior to the effective date of the Boulder Canyon Project Act.

Colorado River Basin Project Act - 1968

The Colorado River Basin Project Act on September 30, 1968 authorized construction of the Central Arizona Project and other water development projects in the Upper Basin. A significant concession was a provision that allowed existing California, Arizona, and Nevada Colorado River contractors to receive a priority over the Central Arizona project in times when the useable supply from the River was inadequate to provide 7.5 million acre-feet to the Lower Basin states, with California's priority limited to its 4.4 million acre-foot entitlement.

The Act directed the Secretary to propose criteria for the "coordinated long-range operation of the reservoirs" in the Upper Basin with the operation of the reservoirs in the Lower Basin. To accomplish this, the Act required the development of an Annual Operating Plan, in consultation with representatives of the seven Basin states.

Coordinated Operations and Shortage Criteria

In December 2007, Reclamation issued a Record of Decision (ROD) on interim operating criteria (2008-2026) including the coordinated operation of Lake Powell and Lake Mead and criteria for implementing shortage reductions in the Lower Basin. Historically, the reservoirs were operated independently; annual Lake Powell water releases were determined based on applicable law and relevant factors contained in the Long-Range Operating Criteria. The ROD adopted four key elements: 1) establishes rules for shortages; 2) allows coordinated operation of Lake Powell and Lake Mead to avoid Lower Basin shortages and avoid curtailment of Upper Basin water use; 3) establishes rules for surpluses; and 4) address ongoing drought by encouraging new initiatives for water conservation. If regional drought conditions continue, shortage operations could begin as early as 2011. The ROD could have implications for water supply availability in the planning area.

D.3 Federal Reserved Rights

In addition to the reserved water rights associated with Indian reservations under the "Winters" doctrine (described in Appendix G), federal reserved rights can be asserted on most federal, non-Indian lands. For example, surface water rights have been claimed in both the Gila River and Little Colorado River adjudications for national parks and monuments, military bases and national forests (Pearce, 2002). Federal reserved rights to groundwater have also been asserted. An Arizona Supreme Court Decision found that the federal reserved rights doctrine applied to groundwater as well as surface water. The decision found that a reserved right to groundwater could be found only where other waters are inadequate to accomplish the purpose of the reservation. *In Re: The General Adjudication of All Rights to Use Water in the Gila River System and Source*, 989 P.2d 739 (Ariz. 1999) *(Gila III); cert. denied* 120 Sup. Ct. 2705 (2000) (Pollack, 2003).

D.4 Summary of Key Federal Water Laws

The Clean Water Act (CWA) 33 U.S.C. Section 121 et seq. (1977)

The CWA of 1977 is an amendment to the Federal Water Pollution Control Act of 1972, which set the basic structure for regulating pollutant discharge to waters of the United States. This law gave the Environmental Protection Agency the authority to set effluent standards and continues the requirements to set water quality standards for all surface water contaminants. Under the CWA, it is unlawful to discharge any pollutant from a point source into navigable waters unless a National Pollutant Discharge Elimination Standard (NPDES) permit is obtained. The CWA provides a mechanism for EPA to delegate many of the permitting, administrative and enforcement aspects of the law to states (e.g. Arizona Department of Environmental Quality) while retaining oversight responsibilities. NPDES permits are usually required for effluent or industrial wastewater being disposed of by discharge to waters of the state.

Impaired Waters

Section 303(d) of the Clean Water Act establishes a process for states to identify waters where implementing technology-based controls are inadequate to achieve water quality standards. States establish a priority ranking of these waters and, for the priority waters, develop total maximum daily loads (TMDLs). A TMDL identifies the amount of a specific pollutant or property of a pollutant, from point, nonpoint, and natural background sources, that may be discharged to a water body and still ensure that the water body attains water quality standards.

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) 42 U.S.C. Section 9601 et seq. (1980)

CERCLA, commonly referred to as the "Superfund" Program authorized the investigation and remediation of groundwater contaminated by releases of hazardous substances from waste sites and due to accidents, spills and other emergency releases of contaminants. EPA is required to annually update the National Priority List of Superfund sites. In Arizona, CERCLA establishes a comprehensive response program that is administered by ADEQ in cooperation with the EPA. The Department of Water Resources maintains an advisory role in this process (ADWR, 1999).

The Endangered Species Act (ESA) 7 U.S.C. 136; 16 U.S.C. 460 et seq. (1973)

The ESA provides a program for the conservation of threatened and endangered plants and animals and their habitats. This may involve aquatic and riparian habitat. All species of plants and animals, except pest insects, are eligible for listing as threatened or endangered. The Act is administered by the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration - Fisheries for marine species. Species are protected through partnerships with the states and Section 6 of the ESA encourages each State to develop and maintain conservation programs for resident listed species. Section 9 of the ESA makes it unlawful for a person to "take" a listed species which includes significant habitat modification or degradation. The ultimate goal of the law is to recover species so that they no longer need protection under the ESA (USFWS, 2005).

The Safe Drinking Water Act (SDWA) 43 U.S.C. Section 300f et seq. (1974)

The SDWA is the primary federal law regulating drinking water quality from all sources. The Act authorizes EPA to establish safe standards and requires all owners or operators of public water systems to comply with primary (health-related) maximum contaminant level standards. National secondary drinking water regulations set non-enforceable standards for the aesthetic quality of water such as taste, odor or color. ADEQ may adopt more stringent standards than those set by EPA.

Arsenic

In 2001, EPA lowered the allowable arsenic content in drinking water from 50 parts per billion to 10 ppb, effective January 23, 2006. This was a major issue for many of Arizona's communities because Arizona's aquifers have naturally high levels of arsenic. Approximately one-third of the states drinking water systems exceeded the standard at the time, including 287 small systems (serving fewer than 10,000 people). In response, ADEQ developed a strategy in conjunction with a coalition of business, academia, municipal government agencies and the scientific community to develop a compliance strategy called the Arsenic Master Plan. The plan is intended to identify effective low-cost methods to comply with the standard.

APPENDIX E: ARIZONA CLIMATE AND DROUGHT

Appendix E
Arizona Climate and Drought

Climate

Arizona's climate is characterized by five main features: warm temperatures, aridity, strong precipitation seasonality, high year-to-year (interannual) variability and strong decade-to-decade persistence. The wide elevational differences result in significant climate variability between the mountains of the Central Highlands Province and the low elevation deserts. The Plateau Uplands Province, although relatively high in elevation, is very dry. Average annual rainfall in Arizona ranges from 3 inches in Yuma to over 36 inches in the higher elevations along the Mogollon Rim and in the White Mountains. State precipitation variability is shown in Figure 1-14.

There are two climatically unrelated precipitation seasons: the summer, "monsoon" season, generally from July to mid-September and a winter season from November through mid-April. This seasonality is more pronounced in the east-central (Central Highlands Planning Area) and southeastern (Southeastern Arizona Planning Area) parts of the state where the summer precipitation can account for up to 60 percent of the annual total. By contrast, the Upper Colorado River Planning Area receives the majority of precipitation in the winter. Statewide, mid-April through June are reliably dry, as westerly winds shift to the north and the monsoon circulation begins to develop. Mid-September through early November is usually dry, but eastern Pacific tropical storms can cause high precipitation during this time of year.

The summer precipitation season occurs when moist, tropical, unstable air from the Gulf of Mexico moves northwest into Arizona. Storms of short duration but high intensity occur in the afternoon and evening as the warm, moist air is forced up mountain slopes and sufficiently cooled. These storms are typically most intense over the mountainous sections of the state. Winter rains occur when middle latitude cyclonic storms originating in the Pacific Ocean move east across the state. More than 75% of the winter precipitation falls as snow in the higher elevations. (ADWR, 1994a).

The El Niño-Southern Oscillation (ENSO), a multi-season to multi-year variation in equatorial Pacific Ocean temperatures and associated atmospheric circulation, is the strongest and most important influence on interannual climate and weather variations in Arizona. When El Niño-Southern Oscillation is in the El Niño phase, Arizona frequently receives above average winter precipitation. When El Niño-Southern Oscillation is in the La Niña phase, Arizona is frequently dry due to a more northern storm track. These phases recur every 3 to 7 years on average and can persist for months to years, impacting precipitation totals over Arizona. During the past two decades, several La Niña episodes (e.g. 1989-90, 1995-96, 1998-2001) have initiated Arizona droughts (GDTF, 2004). The La Niña of 2005-2006 resulted in virtually no snowpack in Arizona until mid-March, with 29 of the 34 snow measuring sites monitored by the NRCS reporting no snow as of March 1, 2006, the least amount recorded since measurements began in the late 1930's.

Arizona's Colorado River water supplies derive primarily from snow in the Rocky Mountains of Wyoming, Colorado, and Utah, whereas Arizona surface water supplies, such as in the Salt and Verde River systems, derive chiefly from snow along the Mogollon Rim and high peaks on the Colorado Plateau.

Temperature and associated evapotranspiration rates also vary widely in Arizona. Average daily temperatures range from the mid 90's (˚F) below 500 feet elevation to the high 50's (˚F) at elevations above 8,000 feet. In most areas of the state, temperatures increase 30 to 40 degrees between January and July (ADWR, 1994a). Climate can also vary widely within planning areas. Measured climate data are described in detail in the planning area volumes.

The most significant feature of temperature records is the trend toward increasing temperatures during the last 30-40 years (Figure 1-5). In some regions, increased temperatures are due primarily to the urban heat island effect from heat-retaining paved area and buildings replacing desert landscapes in major urban areas. Temperatures in rural communities have also increased, though not at the same rate and not in every town. The mid-to-late twentieth century is the warmest period in a southern Colorado Plateau tree-ring temperature reconstruction (Salzer and Kipfmueller, 2005), as well as in reconstructions of summer season precipitation for a region stretching from west Texas to eastern California (Sheppard and others, 2002).

Drought

Decadal-scale Pacific Ocean circulation persistence can result in long-term drought, which can drastically reduce water supplies as demonstrated in the extremely dry conditions between 1999 and 2005 and during the 1950s. Table E-1 shows that 2004 was the year of lowest capacity in most of the state's reservoirs during the period of 1971-2005. When these sustained circulation patterns are characterized by warm tropical Pacific Ocean temperatures, the result can be above average precipitation such as the post-1976 wet period which lasted until approximately 1998 (Figure E-1). This wet period is also reflected in the high capacity reservoir level data in Table E-1. Some reservoirs, including Lake Powell and Lake Mead, exceeded their maximum useable capacity during this period and spilled.

When Arizona's high interannual precipitation variability is superimposed on persistent decadal variations, the result is individual wet years during periods of prolonged drought. This is shown in Figure E-1.

Table E-1 Arizona mean, high capacity and low capacity reservoir levels from 1971 through 2005, expressed in percent of total reservoir capacity (design flood pool)

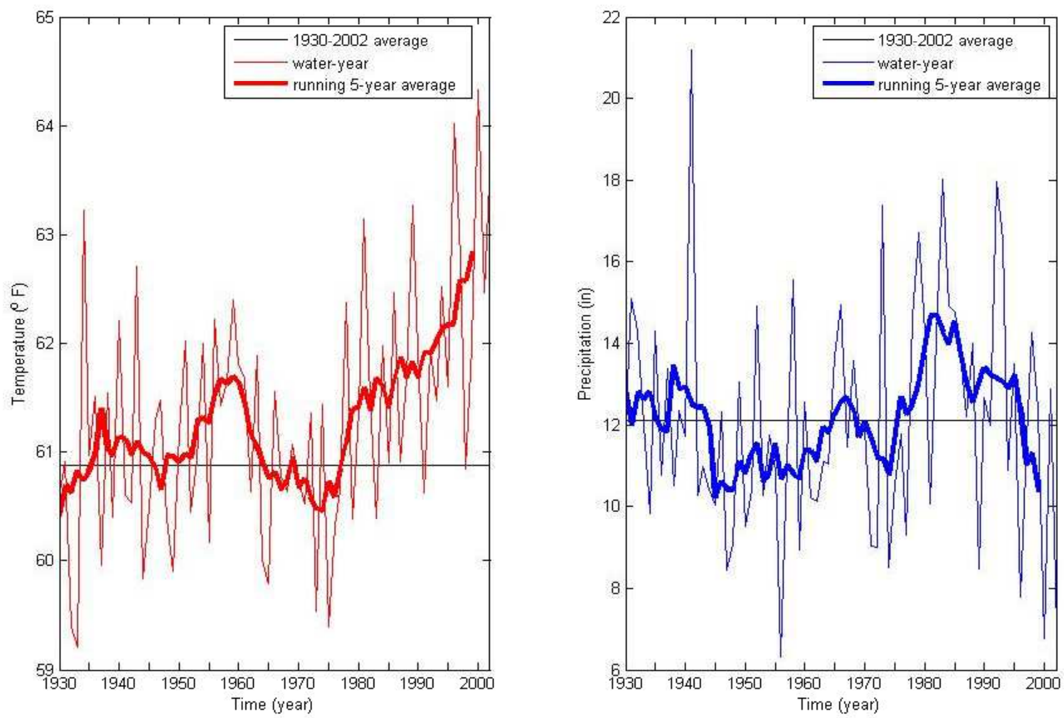
Reservoir Name	Average Capacity	High Capacity	High Capacity Year	Low Capacity	Low Capacity Year
Lake Powell	70%	98%	1983	31%*	2005
Lake Mead	77%	98%	1983	51%	2004
Lake Mohave	89%	98%	1971	74%	2000
Lake Havasu	88%	96%	1982	77%	1980*
Show Low Lake	62%	100%	1993	58%	2004
Lyman Reservoir	45%	86%	1985	11%	2004
San Carlos	42%	100%	1980	3%	2004
Verde River Basin System	56%	91%	1992	43%	2004
Salt River Basin System	59%	77%	1979	43%	2004

Sources: USDA Natural Resources Conservation Service, CLIMAS. BOR, and ADWR
* Lake Havasu 2004 low capacity was 79%

Tree-ring records of drought and winter precipitation show dry episodes longer and more severe than any that have occurred during the last 100 years. In Arizona, notable multi-year droughts occurred in almost every century in the last 1,000 years. Particularly notable are winter-season droughts during the 1100s, the 1200s, the early 1400s, the late 1500s, the late 1600s, the late 1700s, the late 1800s and the mid-1900s (Figure 1-16). Tree-ring records of Colorado River streamflow show periods of extended low flows, such as those in the 1580s, the early 1620s to 1630s, the 1710s, the 1770s, and the 1870s (C. Woodhouse, NOAA Paleoclimate Program, personal communication to G. Garfin, CLIMAS).

2005). These episodes were either more severe or longer in duration than low flow periods experienced in more recent times. The low flow period of the late 1500s is associated with widespread drought conditions across North America (Stahle et al., 2000).

Figure E-1 Average water-year (October-September) temperature (left) and total water-year precipitation in Arizona from 1930-2002

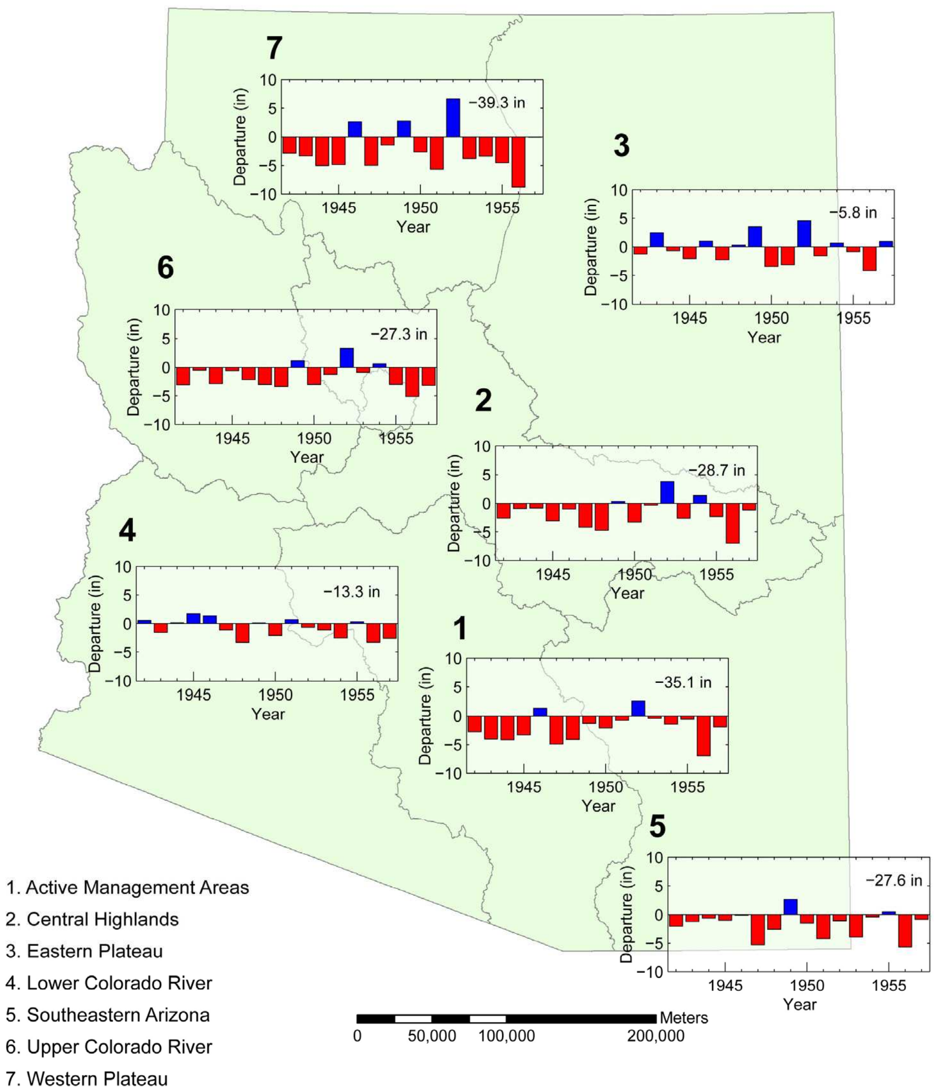


Horizontal lines are average temperature (60.9 °F) and precipitation (12.1 in), respectively. Light lines are yearly values and highlighted lines are 5-year moving average values. Data are the average of monthly records from 25 U.S. Historical Climate Network (HCN) stations from the National Climate Data Center. CLIMAS, 2006.

Such periods of widespread drought are characterized by low stream flows in the Upper Colorado River Basin as well as interior Arizona river basins, such as the Salt-Verde-Tonto river system. Records show that the Upper Colorado River Basin streamflow is seldom out of synch with Salt-Verde-Tonto river system streamflow (Hirschboeck and Meko, 2005). This has serious implications for water supply availability in parts of Arizona.

Planning area and AMA water deficits for the prolonged drought of 1942-1957 are shown in Figure E-2. It is evident that planning areas were affected to varying degrees during this period. For example, the Eastern Plateau Planning Area was the least impacted, with many years of above normal precipitation and a modest cumulative deficit of -5.8 inches over the drought period. While the current drought may reflect similar precipitation conditions to those of the drought of the late 1940s to 1950's, temperatures during the last decade are almost 2 degrees higher (see Figure E-1). This warming trend will affect the severity of drought conditions.

Figure E-2 Planning area water-year (October-September) precipitation departures from average for the 1942-1957 drought period



For each planning area, data from U.S. Historical Climate Network (HCN) stations from the National Climatic Data Center were used to calculate the total departure (upper right of each bar graph). CLIMAS, 2006.

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APPENDIX F: ARIZONA WATER PROTECTION FUND

APPENDIX F: ARIZONA WATER PROTECTION FUND

The Arizona Water Protection Fund (AWPF) was established in 1994 by the Arizona State Legislature (A.R.S. § 45-2101 et seq.) in order to provide a source of funding for "a coordinated effort for the restoration and conservation of the water resources of the state….designed to allow the people of this state to prosper while protecting and restoring this state's rivers and streams and associated riparian habitats, including fish and wildlife resources that are dependent on these important habitats".

Riparian areas provide wildlife habitat, support biodiversity and serve many essential functions including water quality improvement, water quantity improvement, flood control and recreation. These conditions provide economic benefits including increased property values.

The AWPF is administered by a 15-member Commission appointed by the Governor, the President of the Senate and the Speaker of the House of Representatives. The composition of the Commission is specified by statute (A.R.S. § 45-2103(A)) and is intended to represent a variety of land, water use and riparian issue perspectives. In addition there are two ex officio members, the director of the department of water resources and the state land commissioner.

The AWPF funds projects through a competitive grant process. Any person, agency or organization can apply. All projects must be in Arizona, be consistent with state water law and support the overall goals of the AWPF. Grants may be used to:

- Develop or implement capital projects or specific measures that directly maintain, enhance and restore rivers and streams and associated riparian resources;
- Acquire CAP water or effluent for the purpose of protecting or restoring rivers and streams;
- Develop, promote and implement water conservation programs outside of the five active management areas;
- Support research and data collection, compilation and analysis; or
- Fund man-made water resource projects if the project benefits a river or stream and creates or restores riparian habitat.

Monies for the AWPF are from three sources: 1) the Arizona State Legislature; 2) Central Arizona Project fees for each acre-foot of water sold to out-of-state CAP water lessees and purchasers, and; 3) private gifts, grants or donations. By statute, the AWPF is to receive $5 million annually from the legislature. The Commission encumbers all of the funds necessary to ensure the funding of multi-year projects. Money is disbursed on a reimbursable basis.

As of FY 2008, 164 projects had been funded. Table F-1 lists the grant number, project title and type of project, organized by planning area and groundwater basin. The table includes a map number, which refers to grant locations shown on Figure F-1.

TABLE F-1
AWPF Funded Projects through FY 2008 by Planning Area

VOLUME 2: EASTERN PLATEAU PLANNING AREA				
Groundwater Basin	**Map Number**	**AWPF Grant #**	**Project Title**	**Project Category**
Little Colorado River Plateau	**25**	96-0003	Hoxworth Springs Riparian Restoration Project	Stream Restoration
Little Colorado River Plateau	**44**	96-0022	Saffell Canyon and Murray Basin Watershed Restoration	Feasibility Study
Little Colorado River Plateau	**46**	96-0025	Tsaile Creek Watershed Restoration Demonstration	Watershed Restoration
Little Colorado River Plateau	**24**	96-0002	Completion Phase: Hi-Point Well Project	Fencing
Little Colorado River Plateau	**50**	97-029	Demonstration Enhancement of Pueblo Colorado Wash at Hubbell Trading Post	Stream Restoration & Revegetation
Little Colorado River Plateau	**58**	97-037	Talastima (Blue Canyon) Watershed Restoration Project	Exotic Species Control & Fencing
Little Colorado River Plateau	**65**	98-046	EC Bar Ranch Water Well Project	Fencing & Water Developments
Little Colorado River Plateau	**69**	98-051	Evaluation of Carex Species for Use in Riparian Restoration	Research
Little Colorado River Plateau	**79**	99-067	EC Bar Ranch Wildlife Drinker Project	Livestock & Wildlife Water Developments
Little Colorado River Plateau	**91**	99-079	Little Colorado River Riparian Restoration Project	Constructed Wetland & Revegetation
Little Colorado River Plateau	**94**	99-084	Assessments of Riparian Zones in the Little Colorado River Watershed	Research
Little Colorado River Plateau	**99**	99-089	Town of Eager/Round Valley Water Users Association Pressure Irrigation Feasibility Study & Preliminary Design	Feasibility Study
Little Colorado River Plateau	**102**	99-092	Little Colorado River Enhancement Demonstration Project	Stream Restoration
Little Colorado River Plateau	**105**	99-095	Brown Creek Riparian Restoration	Fencing & Water Developments

VOLUME 2: EASTERN PLATEAU PLANNING AREA (cont)				
Groundwater Basin	**Map Number**	**AWPF Grant #**	**Project Title**	**Project Category**
Little Colorado River Plateau	**114**	00-104	Continued Enhancement of Pueblo Colorado Wash at Hubbell Trading Post National Historic Site	Exotic Species Control & Stream Restoration
Little Colorado River Plateau	**115**	00-105	Hubbell Trading Post Riparian Restoration with Treated Effluent	Revegetation
Little Colorado River Plateau	**117**	00-108	Lake Mary Watershed Streams Restoration	Channel Restoration
Little Colorado River Plateau	**119**	00-110	Upper Fairchild Draw Riparian Restoration	Fencing & Revegetation
Little Colorado River Plateau	**121**	00-112	Town of Eagar/Round Valley Water Users Association Pressure Irrigation Feasibility Study and Preliminary Design – Additional Mapping for Water Quality Improvements in the Watershed	Feasibility Study
Little Colorado River Plateau	**122**	00-113	Polacca Wash Grazing Management	Fencing & Exotic Species Control w/ Revegetation
Little Colorado River Plateau	**128**	03-119	Wet Meadows for Water Quality and Wildlife – A Riparian Restoration Project	Fencing & Habitat Protection
Little Colorado River Plateau	**134**	05-125	Wilkins' family Little Colorado River Riparian Enhancement Project	Stream Restoration
Little Colorado River Plateau	**135**	05-126	X Diamond Ranch LCR Riparian Enhancement Project	Stream Restoration
Little Colorado River Plateau	**136**	05-127	EC Bar Ranch Reach 8 Water Well and Drinker Project	Water Developments
Little Colorado River Plateau	**145**	06-136	The Arboretum at Flagstaff Wetland Habitat Enhancement	Habitat Restoration
Little Colorado River Plateau	**150**	07-141	Picture Canyon Rio de Flag Meander Restoration Project	Stream Restoration
Little Colorado River Plateau	**152**	07-143	Little Colorado River & Nutrioso Creek Riparian Enhancement Project	Stream Restoration
Little Colorado River Plateau	**155**	07-146	Little Colorado River Project on H-Y Ranch River Recovery Project	Fencing & Habitat Restoration

VOLUME 2: EASTERN PLATEAU PLANNING AREA (cont)				
Groundwater Basin	**Map Number**	**AWPF Grant #**	**Project Title**	**Project Category**
Little Colorado River Plateau	**163**	07-154	Billy Creek Natural Area Riparian Restoration Project	Stream Restoration
Little Colorado River Plateau	**168**	08-159	Hoxworth Springs Stream Channel Restoration Project	Fencing & Stream Restoration

VOLUME 3: SOUTHEASTERN ARIZONA PLANNING AREA				
Groundwater Basin	**Map Number**	**AWPF Grant #**	**Project Title**	**Project Category**
Aravaipa Canyon	**36**	96-0014	Klondyke Tailings Response Strategy Analysis (RSA)	Research
Cienega Creek	**14**	95-016	Refinement of Geologic Model, Lower Cienega Basin, Pima County, Arizona	Research
Cienega Creek	**28**	96-0006	Hydrogeologic Investigation of Groundwater Movement and Sources of Base Flow to Sonoita Creek and Implementation of Long-Term Monitoring Program	Research
Cienega Creek	**42**	96-0020	Cienega Creek Stream Restoration	Stream Restoration & Revegetation
Cienega Creek	**55**	97-034	Oak Tree Gully Stabilization	Upland Channel Restoration
Cienega Creek	**67**	98-049	Empire/Cienega/Empirita Fencing Project	Fencing
Cienega Creek	**80**	99-068	Lower Cienega Creek Restoration Evaluation Project	Research
Cienega Creek	**100**	99-090	Redrock Riparian Improvement	Fencing & Water Developments
Douglas	**78**	98-066	Hay Mountain Watershed Rehabilitation	Watershed Restoration
Duncan Valley	**12**	95-014	Gila Box Riparian and Water Quality Improvement Project	Fencing & Upland Water Developments
Duncan Valley	**164**	08-155	Restoration of the Gila River at Apache Grove	Stream Restoration

VOLUME 3: SOUTHEASTERN ARIZONA PLANNING AREA (cont)				
Groundwater Basin	**Map Number**	**AWPF Grant #**	**Project Title**	**Project Category**
Lower San Pedro	**60**	97-040	Bingham Cienega Riparian Restoration Project	Revegetation
Lower San Pedro	**63**	97-044	San Pedro River Preserve Riparian Habitat Restoration Project	Habitat Restoration
Lower San Pedro	**81**	99-069	Riparian and Watershed Enhancements on the A7 Ranch – Lower San Pedro River	Fencing & Upland Water Developments
Lower San Pedro	**151**	07-142	Reduction of Erosion and Sedimentation along the Lower San Pedro River Through Hydrologic Restoration of Modified Ephemeral Washes	Habitat & Stream Restoration
Lower San Pedro	**118**	00-109	Lower San Pedro Watershed Project	Feasibility Study
Lower San Pedro	**120**	00-111	Cooperative Grazing Management for Riparian Improvement on the San Pedro	Fencing & Upland Water Developments
Morenci	**89**	99-077	Blue Box Crossing	Channel Restoration
Morenci	**112**	00-102	Upper Eagle Creek Restoration on East Eagle Allotment: 4 Drag Ranch	Fencing & Upland Water Developments
Morenci	**138**	05-129	Georges Lake Riparian Restoration Project	Fencing & Habitat Protection
Morenci	**144**	06-135	Double Circle Ranch Riparian Fencing Project	Fencing
Morenci	**154**	07-145	Kaler Ranch Erosion Control Project, Phase II	Habitat Stream Protection
Safford	**34**	96-0012	Eagle Creek Watershed and Riparian Stabilization	Fencing & Upland Water Developments
Safford	**40**	96-0018	San Carlos Spring Protection Project	Fencing
Safford	**37**	96-0015	Abandonment of an Artesian Geothermal Well	Habitat Protection
Safford	**49**	97-028	Creation of a Reference Riparian Area in the Gila Valley – Discovery Park	Habitat Restoration

VOLUME 3: SOUTHEASTERN ARIZONA PLANNING AREA (cont)				
Groundwater Basin	**Map Number**	**AWPF Grant #**	**Project Title**	**Project Category**
Safford	**70**	98-052	Tritium as a Tracer of Groundwater Sources and Movement in the Upper Gila River Drainage	Research
Safford	**71**	98-054	Fluvial Geomorphology Study and Demonstration Projects to Enhance and Restore Riparian Habitat on the Gila River from the New Mexico Border	Research
Safford	**96**	99-086	Abandonment of Gila Oil Syndicate Well #1	Habitat Protection
Safford	**109**	00-099	Gila Reference Riparian Area, Discovery Park	Revegetation
San Rafael	**64**	97-045	Santa Cruz Headwaters Project	Fencing & Upland Water Developments
San Rafael	**106**	99-096	Upper Santa Cruz Watershed Restoration	Fencing & Upland Water Developments
Upper San Pedro	**9**	95-009	Regeneration and Survivorship of Arizona Sycamore	Research
Upper San Pedro	**5**	95-005	Preservation of the San Pedro River Utilizing Effluent Recharge	Constructed Wetland
Upper San Pedro	**13**	95-015	San Pedro Riparian National Conservation Area Watershed Rehabilitation/ Restoration Project	Revegetation & Upland Channel Restoration
Upper San Pedro	**16**	95-018	Autecology and Restoration of *Sporobolus Wrightii* Riparian Grasslands in Southern Arizona	Research
Upper San Pedro	**18**	95-020	Teran Watershed Enhancement	Upland Channel Restoration
Upper San Pedro	**35**	96-0013	Happy Valley Riparian Area Restoration Project	Fencing
Upper San Pedro	**23**	96-0001	San Pedro Riparian National Conservation Area Watershed Protection and Improvement Project	Fencing
Upper San Pedro	**48**	97-027	Lyle Canyon Allotment Restoration Project	Fencing & Upland Water Developments
Upper San Pedro	**82**	99-070	Lyle Canyon Allotment Riparian Area Restoration Project --- Phase 2	Fencing & Upland Water Developments
Willcox	**125**	03-116	Cottonwood Creek Restoration	Upland Channel Restoration
Upper San Pedro	**160**	08-151	Test of Riparian Recovery Following Cessation of Groundwater Pumping	Research

VOLUME 4: UPPER COLORADO RIVER PLANNING AREA				
Groundwater Basin	**Map Number**	**AWPF Grant #**	**Project Title**	**Project Category**
Big Sandy	**110**	00-100	Willow Creek Riparian Restoration Project	Revegetation
Bill Williams	**39**	96-0017	Big Sandy River Riparian Project	Fencing
Bill Williams	**43**	96-0021	Riparian Vegetation and Stream Channel Changes Associated with Water Management along the Bill Williams River	Research
Bill Williams	**95**	99-085	Kirkland Creek Watershed Resource Assessment	Feasibility Study
Bill Williams	**116**	00-106	Tres Alamos Dirt-Tanks-To-Aquatic-Habitat-Conversion	Fencing & Upland Channel Restoration
Lake Mohave	**85**	99-073	Colorado River Nature Center Backwater --- Phase 2	Feasibility Study

VOLUME 5: CENTRAL HIGHLANDS PLANNING AREA				
Groundwater Basin	**Map Number**	**AWPF Grant #**	**Project Title**	**Project Category**
Agua Fria	**29**	96-0007	Ash Creek Riparian Protection Project	Stream Restoration
Agua Fria	**126**	03-117	Lynx Creek Restoration at Sediment Trap #2	Stream Restoration
Salt River	**19**	95-021	Lofer Cienega Restoration Project	Fencing & Habitat Protection
Salt River	**20**	95-022	Gooseberry Watershed Restoration Project	Stream Restoration
Salt River	**93**	99-083	Cherry Creek Enhancement Demonstration Project	Stream Restoration
Salt River	**137**	05-128	Canyon Creek Riparian Restoration Project, Reach 4-5	Fencing & Habitat Protection
Tonto Creek	**17**	95-019	Quantifying Anti-Erosion Traits of Streambank Graminoids	Research
Tonto Creek	**107**	99-097	Dakini Valley Riparian Project	Fencing & Revegetation
Upper Hassayampa	**98**	99-088	Wickenburg High School Stream Habitat Creation	Constructed Wetland Restoration

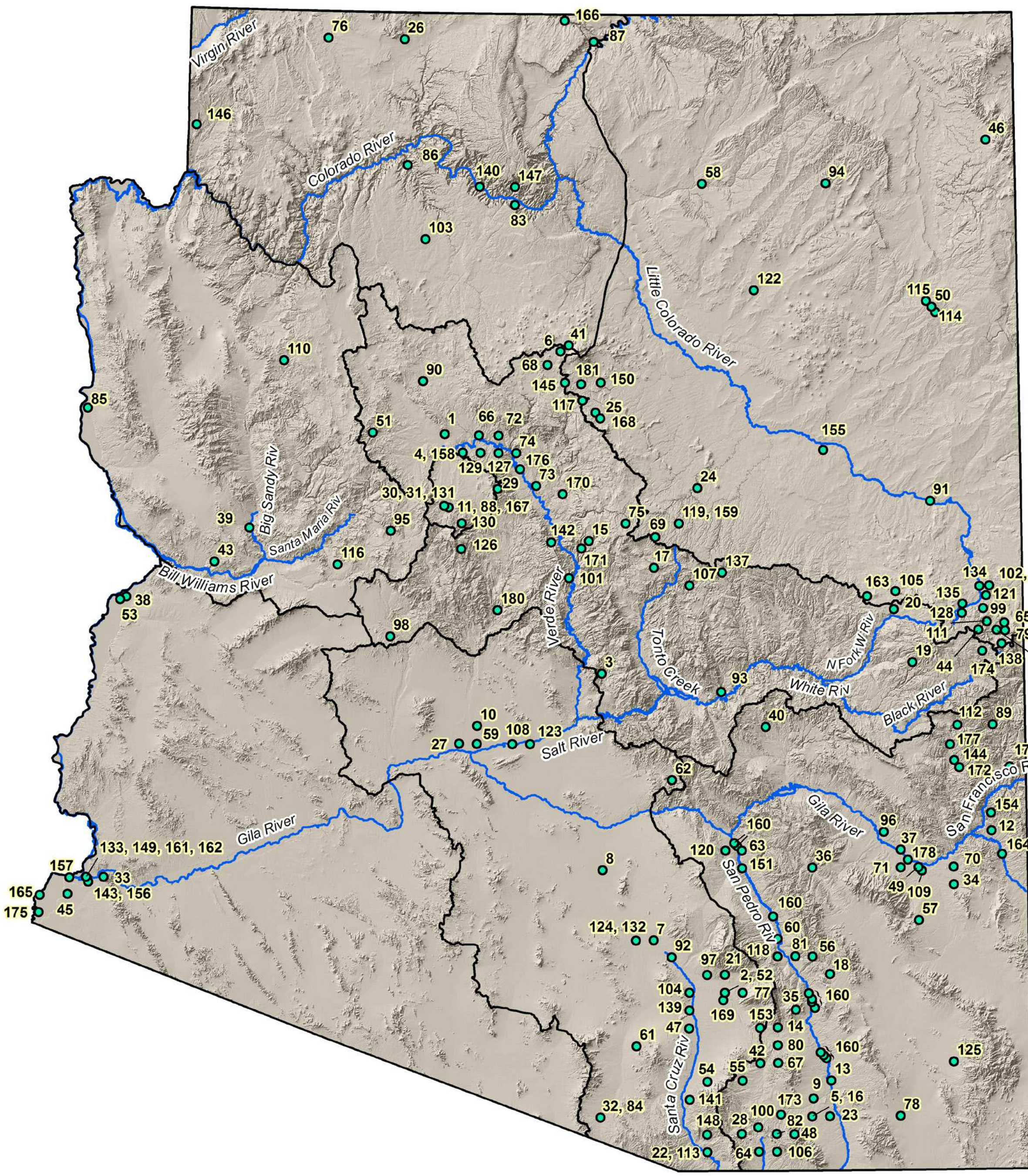
VOLUME 5: CENTRAL HIGHLANDS PLANNING AREA (cont)				
Groundwater Basin	**Map Number**	**AWPF Grant #**	**Project Title**	**Project Category**
Verde River	**3**	95-003	Sycamore Creek Riparian Management Area	Fencing
Verde River	**4**	95-004	Road Reclamation to Improve Riparian Habitat Along the Hassayampa and Verde Rivers	Revegetation
Verde River	**6**	95-006	Critical Riparian Habitat Restoration Along a Perennial Reach of a Verde River Tributary	Stream Restoration
Verde River	**15**	95-017	Restoration of Fossil Creek Riparian Ecosystem	Research
Verde River	**51**	97-030	Walnut Creek Center for Education and Research – Biological Inventory	Research
Verde River	**66**	98-047	Upper Verde Adaptive Management Unit	Fencing
Verde River	**68**	98-050	Watershed Restoration of a High Elevation Riparian Community	Watershed & Stream Restoration
Verde River	**72**	98-055	Horseshoe Allotment: Verde Riparian Project II	Fencing & Upland Water Developments
Verde River	**73**	98-057	Upper Verde Valley Riparian Area Historical Analysis	Research
Verde River	**74**	98-058	Effects of Removal of Livestock Grazing on Riparian Vegetation and Channel Conditions of Selected Reaches of the Upper Verde River	Research
Verde River	**75**	98-059	Verde River Headwaters Riparian Restoration Demonstration Project	Channel Restoration
Verde River	**90**	99-078	Aquifer Framework and Ground-Water Flow Paths in Big and Little Chino Basins	Research
Verde River	**101**	99-091	Effects of Livestock Use Levels on Riparian Trees on the Verde River	Research
Verde River	**127**	03-118	Verde River Riparian Area Partnership Project	Exotic Species Control
Verde River	**129**	04-120	Verde River Headwaters 3-D Hydrogological Model Framework and Visualization	Research
Verde River	**142**	05-133	Verde Wild and Scenic River Fence Exclosure	Fencing
Verde River	**158**	07-149	Control of Tamarisk on 12 Miles if the Upper Verde River	Habitat Protection
Verde River	**170**	08-161	Montezuma Well Riparian Pasture Restoration Project	Habitat Restoration

VOLUME 6: WESTERN PLATEAU PLANNING AREA				
Groundwater Basin	**Map Number**	**AWPF Grant #**	**Project Title**	**Project Category**
Coconino Plateau	**41**	96-0019	Response of Bebb Willow to Riparian Restoration	Stream Restoration
Coconino Plateau	**83**	99-071	Protection of Spring and Seep Resources of the South Rim, Grand Canyon National Park by Measuring Water Quality, Flow, and Associated Biota	Research
Coconino Plateau	**86**	99-074	Proposal to Inventory, Assess, and Recommend Recovery Priorities for Arizona Strip Springs, Seeps, and Natural Ponds	Research
Coconino Plateau	**103**	99-093	Coconino Plateau Regional Water Study	Research
Coconino Plateau	**140**	05-131	Management & Control of Tamarisk and Other Invasive Vegetation at Backcountry Seeps, Springs, and Tributaries in Grand Canyon National Park	Exotic Species Control
Coconino Plateau	**147**	06-138	Management and Control of Tamarisk and Other Invasive Vegetation at back County Seeps, Springs, and Tributaries in Grand Canyon National Park – Second Year Phase II	Habitat Restoration
Grand Wash	**146**	06-137	Pakoon springs Restoration Design and Implementation Project	Habitat Restoration
Kanab Plateau	**26**	96-0004	Hydrologic Investigation & Conservation Planning: Pipe Springs	Research
Kanab Plateau	**76**	98-061	Watershed Enhancement on the Antelope Allotment	Upland Water Developments
Kanab Plateau	**87**	99-075	Glen and Grand Canyon Riparian Restoration Project	Exotic Species Control & Revegetation
Paria	**166**	08-157	Paria River Exotic Removal Project	Habitat Restoration

VOLUME 7: LOWER COLORADO RIVER PLANNING AREA				
Groundwater Basin	**Map Number**	**AWPF Grant #**	**Project Title**	**Project Category**
Parker	**38**	96-0016	‘Ahakhav Tribal Preserve	Habitat Restoration & Revegetation
Parker	**53**	97-032	‘Ahakhav Tribal Preserve – Deer Island Revegetation	Exotic Species Control & Revegetation
Yuma	**33**	96-0011	Lower Colorado River – Imperial Division Restoration	Wetland Restoration
Yuma	**45**	96-0023	Watershed Restoration at the Yuma Conservation Gardens	Watershed Restoration
Yuma	**133**	04-124	Yuma East Wetlands Riparian Revegetation Project	Exotic Species Control & Revegetation
Yuma	**143**	05-134	Quechan Indian Nation Yuma East Wetlands Restoration Project – Phase I	Exotic Species Control & Revegetation
Yuma	**149**	06-140	Yuma Crossing National Heritage Area Yuma East Wetlands Restoration Project – Phase I	Wetland Restoration
Yuma	**156**	07-147	The Effects of Restoration on Wildlife Recovery at the Yuma East Wetlands Restoration Project	Research
Yuma	**157**	07-148	South Channel Phase II Restoration Project	Wetland Restoration
Yuma	**161**	08-152	AWPF Yuma East Wetlands 68-Acre Riparian Revegetation	Wetland Restoration
Yuma	**162**	08-153	The Effects of Restoration on Herpetophaunal and Mammalian Community Recovery Project	Research
Yuma	**165**	08-156	Cocopah Colorado River Restoration	Habitat & Stream Restoration

VOLUME 8: AMA PLANNING AREA				
Groundwater Basin	**Map Number**	**AWPF Grant #**	**Project Title**	**Project Category**
Phoenix AMA	10	95-010	Assessment of the Role of Effluent Dominated Rivers in Supporting Riparian Functions	Research
Phoenix AMA	27	96-0005	Tres Rios River Management & Constructed Wetlands Project	Research
Phoenix AMA	59	97-038	Tres Rios Wetland Heavy Metal Bioavailability Design for Denitrification and Microbial Water Quality	Research
Phoenix AMA	62	97-042	Queen Creek Restoration and Management Plan	Research
Phoenix AMA	108	99-098	Rio Salado Habitat Restoration Project	Constructed Wetland & Revegetation
Phoenix AMA	123	00-114	The Papago Park Greenline Project	Exotic Species Control & Revegetation
Pinal AMA	**8**	95-008	Picacho Reservoir Riparian Enhancement Project	Habitat Protection
Prescott AMA	11	95-012	The Comprehensive Plan for the Watson Woods Riparian Preserve	Feasibility Study
Prescott AMA	30	96-0008	Watson Woods Vegetation Inventory	Research
Prescott AMA	31	96-0009	Watson Woods Riparian Preserve Visitor Management	Research
Prescott AMA	88	99-076	Watson Woods Preserve Herpetological Interpretive Guide and Checklist	Research
Prescott AMA	130	04-121	Lynx Creek Restoration	Stream Restoration
Prescott AMA	131	04-122	Watson Woods Riparian Preserve Restoration Feasibility Project	Feasibility Study
Prescott AMA	167	08-158	Watson Woods Riparian Preserve Restoration Project	Habitat & Stream Restoration
Santa Cruz AMA	22	95-024	Potrero Creek Wetland Characterization and Management Plan	Research
Santa Cruz AMA	61	97-041	Altar Valley Watershed Resource Assessment	Research
Santa Cruz AMA	113	00-103	Riparian Restoration on the Santa Cruz River – Santa Fe Ranch	Fencing & Revegetation
Santa Cruz AMA	141	05-132	Esperanza Ranch Riparian Restoration Project	Fencing & Revegetation
Santa Cruz AMA	148	06-139	Coal Mine Fence	Fencing & Habitat Protection

VOLUME 8: AMA PLANNING AREA (cont)				
Groundwater Basin	**Map Number**	**AWPF Grant #**	**Project Title**	**Project Category**
Tucson AMA	7	95-007	High Plains Effluent Recharge Project	Wetland Restoration
Tucson AMA	21	95-023	Sabino Creek Riparian Ecosystem Protection Project	Research
Tucson AMA	32	96-0010	Rehabilitating the Puertocito Wash on the Buenos Aires National Wildlife Refuge	Stream Restoration
Tucson AMA	47	96-0026	Riparian Restoration on the San Xavier Indian Reservation Community	Habitat Restoration & Revegetation
Tucson AMA	52	97-031	Lincoln Park Riparian Habitat Project (f.k.a. Atturbury Wash Project)	Habitat Restoration
Tucson AMA	54	97-033	Proctor Vegetation Modification	Exotic Species Control
Tucson AMA	77	98-062	Partnership for Riparian Conservation in Northeastern Pima County II	Revegetation
Tucson AMA	84	99-072	Leopard Frog Habitat and Population Conservation at Buenos Aires National Wildlife Refuge	Habitat Restoration
Tucson AMA	92	99-080	Cortaro Mesquite Bosque	Habitat Restoration & Revegetation
Tucson AMA	97	99-087	Rillito Creek Habitat Restoration Project	Habitat Restoration & Revegetation
Tucson AMA	104	99-094	Santa Cruz River Park Extension	Habitat Restoration & Revegetation
Tucson AMA	124	00-115	Tucson Audubon Society North Simpson Farm Riparian Recovery Project	Revegetation
Tucson AMA	132	04-123	Tucson Audubon Society, Santa Cruz River Habitat Project, North Simpson Site, Phase 2	Revegetation
Tucson AMA	139	05-130	Riparian Restoration on the San Xavier District – Project Two	Revegetation
Tucson AMA	153	07-144	Evaluation of Riparian Habitat and Headcutting on Lower Cienega Creek	Research
Tucson AMA	169	08-160	Atturbury Wash Riparian Stewardship Project	Habitat Restoration



123 AWPF Grant Location/Map Key

Major Streams

Planning Area Boundary

Figure F-1
Arizona Water Protection Fund Grant Locations

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ARIZONA DEPARTMENT OF WATER RESOURCES

Data Source: ADWR 2008c

APPENDIX G: INDIAN WATER RIGHTS CLAIMS AND SETTLEMENTS

APPENDIX G:

INDIAN WATER RIGHTS CLAIMS AND SETTLEMENTS

The role of Indian reservations in Arizona water supply and management has become increasingly important. With approximately 28% of Arizona lands held in trust by the federal government on behalf of Native Americans, determination of Indian water rights and water use by Indian communities can have a significant impact on other State water users. Active Management Areas (AMA) affected by Indian water right claims include Phoenix, Pinal and Tucson. Non-AMAs affected by these claims include the Coconino Plateau, Little Colorado River, Lower San Pedro, Parker, Verde River and Yuma basins as well as northwestern Arizona and areas on the Mogollon Rim and along the upper Gila River.

In Arizona, as in most states, negotiation of Indian water rights claims has been litigation driven. Indian water right claims are based on "reserved water rights" for federal reservations established under the "Winters Doctrine." When the federal government established Indian reservations it did not expressly claim associated water rights. In 1908, the U.S. Supreme Court in *Winters v. United States* found that a federal reservation includes an amount of water necessary to fulfill the reservation's purpose. Priority dates are based on the date of the enactment of the treaty, act of Congress, or Executive Order establishing the reservation. In 1963, the U.S. Supreme Court in *Arizona v. California* further defined reserved water rights for Indian reservations by including the standard of practicably irrigable acreage (PIA) as a method of quantifying the right. In 2001, the Arizona Supreme Court in *Gila V* rejected PIA as the sole standard for quantification and found that Indian reserved rights must account for the present and future needs of the reservation as a tribal homeland. Although limited to the "minimal needs" of the reservation, quantification should consider several factors including historic and cultural water uses, tribal resources and economic base, development plans, and current and future populations.

Litigation to quantify Indian water rights claims is usually a lengthy and expensive process. Settlement of tribal claims benefits private and public parties by providing the water certainty necessary to plan long-term economic development. Also, settlement may be less expensive than litigation. However, the greatest benefit of settlements may be the goodwill created by neighboring communities working together for Arizona's future.

When the settlement process begins, parties potentially impacted by the Indian water rights claims identify the sources of water necessary to satisfy the tribal needs. A federal negotiating team works with the parties to assure that federal requirements, including local cost contribution, are met. ADWR participates in the settlement discussion, offering technical assistance and ensuring state water laws and policies are followed.

When local parties agree on a settlement, the issue is taken to the United States Congress for approval and funding. Generally, the congressional act ratifies the agreement among the parties, authorizes congressional appropriations, and may require a state contribution. The parties then finalize the implementing agreement, seek any necessary state appropriation, and, as necessary, seek approval of the court in either the Gila River General Stream Adjudication or the Little Colorado General Stream Adjudication.

The remainder of this appendix is divided into four sections. Section G-1 lists Colorado River entitlements that were decreed to Arizona Indian tribes through *Arizona v. California*. Sections G-2 and G-3 describe Indian water right settlements in Arizona that were authorized by Congress and are currently under negotiation, respectively. Other tribes in Arizona with unresolved water right claims are listed in Section G-4

G.1 Colorado River Entitlements

Arizona v. California decreed four Indian reservations along the Colorado River with entitlements to divert water from the river. The reservations and their annual Colorado River entitlements in acre-feet (AF) are listed below:

- Cocopah – 8,821 AF (Priority 1) and 2,026 AF (Priority 4)
- Colorado River Tribes – 662,402 AF (Priority 1)
- Fort Mohave – 103,535 AF (Priority 1)
- Fort Yuma – 6,350 AF (Priority 1).

G.2 Congressionally Authorized Settlements

<u>Ak Chin Indian Community</u>
By Congressional action in 1978 and 1984, the Ak Chin Indian Community was awarded an annual entitlement to 75,000 AF (85,000 AF in wet years) of Central Arizona Project (CAP) and other Colorado River water. In 1992, Congress amended the 1984 Act to authorize the Community to lease any unused CAP water to off-reservation users within the Tucson, Pinal and Phoenix AMAs.

<u>Tohono O'odham Nation</u>
In 1982, the Southern Arizona Water Rights Settlement Act (SAWRSA) was enacted by Congress to address the water right claims of the San Xavier and Shuck Toak Districts of the Tohono O'odham Nation. SAWRSA awarded the districts an annual entitlement to 37,800 AF of CAP water and 28,200 AF of settlement water to be delivered by the Secretary of the Interior to the two districts. The districts may also pump annually up to 13,200 AF of groundwater from non-exempt wells. In addition to state and local financial contributions, the City of Tucson contributed 28,200 AF annually of effluent to be used by the Secretary to facilitate deliveries to the districts (through sale or exchange).

In December 2004 the President signed into law P.L. 108-451, the Arizona Water Settlements Act. Title III of the Act amended the 1982 SAWRSA and provided a mechanism to implement the settlement. The amendment identified the source of the settlement water as CAP Non-Indian Agricultural priority water. The Nation may lease its CAP water within the CAP service area. State law was amended to provide additional protection to groundwater resources on the San Xavier Reservation, and allow the Nation to store its CAP water in an in lieu fashion. The settlement was implemented in December 2007 and includes dismissal of claims against non-Indian parties in U.S. and State courts, and approval of the settlement by the Gila Adjudication Court for incorporation into the final decree in that case.

The Nation's water right claims will not be completely satisfied until the claims of the Sif Oidak District in Pinal County, commonly known as Chui Chu, are addressed. While that district currently has a contract for 8,000 AF of CAP water, it has stated a need of nearly 100,000 AF. The Nation has requested that a federal negotiating team be established so that negotiations can be commenced.

Salt River-Pima Maricopa Indian Community

In the Salt River-Pima Maricopa Indian Community Water Rights Settlement Act of 1988, Congress approved an agreement which gave the Community an annual entitlement to 122,400 AF of water plus storage rights behind Bartlett and modified Roosevelt Dams. The parties to the agreement were: Salt River Project (SRP), Roosevelt Water Conservation District (RWCD), Roosevelt Irrigation District, Chandler, Glendale, Mesa, Phoenix, Scottsdale, Tempe, Gilbert, the Central Arizona Water Conservation District (CAWCD), the United States and the State of Arizona.

Sources of water for the Community under the settlement include the Salt and Verde rivers, groundwater and CAP water. The Community is allowed to pump groundwater, but must achieve safe-yield when the East Salt River sub-basin in the Phoenix Active Management Area does so. The Community has leased its 13,000 AF CAP allocation to the Phoenix valley cities from 2000 to 2099. The Arizona State Legislature appropriated $3 million, which was added to $47 million from the United States for the Community's trust fund. This settlement was approved by the Gila River Adjudication Court for incorporation into the final decree in that case.

Fort McDowell Indian Community

In 1990, Congress ratified an agreement between the Fort McDowell Indian Community (FMIC) and neighboring non-Indian communities, including SRP, RWCD, Chandler, Mesa, Phoenix, Scottsdale, Tempe, Gilbert, CAWCD, the United States and the State of Arizona. Under that agreement, FMIC is provided an annual entitlement to 35,950 AF of water from the Verde River and CAP. The 18,233 AF of CAP in the water budget may be leased for 100 years or less off-reservation within Pima, Pinal, and Maricopa counties. A lease of 4,300 AF to Phoenix has already been signed. This settlement also provides for a minimum stream flow on the Lower Verde River of 100 cfs. In accordance with the 1990 Act, a development fund was created with $23 million from the United States and with a $2 million appropriation by the Arizona State Legislature. This settlement was approved by the Gila River Adjudication Court for incorporation into the final decree in that case.

San Carlos Apache Tribe

The water rights claims of the San Carlos Apache Tribe to the Salt River side of their reservation were settled through congressional enactment of the San Carlos Apache Tribe Settlement Act of 1992. The Tribe was awarded an annual entitlement to 71,435 AF of water from the CAP and Salt, Gila and Black rivers. The 64,135 AF of CAP water may be leased off-reservation within Pima, Maricopa, Pinal, Yavapai, Graham, and Greenlee counties. Groundwater may also be pumped from under the reservation.

Settlement parties include: SRP, RWCD, Phelps Dodge Corporation, the Buckeye Irrigation Company, the Buckeye Water Conservation and Drainage District, Chandler, Glendale, Globe, Mesa, Safford, Scottsdale, Tempe, Gilbert, Carefree, CAWCD, the United States and the State of Arizona. The agreement includes a 100-year lease with the City of Scottsdale for a portion of the Tribe's CAP water.

In 1994, the Arizona State Legislature appropriated $3 million, which was added to $38.4 million from the United States for the Tribe's development trust fund and in 1997, the Gila River Adjudication Court approved the settlement for incorporation into the final decree in that case. The water right claims of the San Carlos Apache Tribe to the Gila River side of the reservation will be the subject of separate negotiations or litigation.

<u>Yavapai-Prescott Indian Tribe</u>
In 1994, Congress enacted the Yavapai-Prescott Indian Tribe Water Settlement Act. The Act settled the Tribe's water rights claims by: 1) confirming the Tribe's right to pump groundwater within the boundaries of the reservation; 2) providing for relinquishment of the Tribe's CAP contract, the proceeds to be used for a water service contract with the City of Prescott; and 3) providing that the Tribe may divert a portion of water from Granite Creek currently diverted by the Chino Valley Irrigation District.

The Act also provided authorization to the Tribe and the City of Prescott to market their CAP water to the City of Scottsdale, which has been completed. The Act required a state appropriation of $200,000, which was made in the 1994 session of the Arizona State Legislature and was added to the Tribe's CAP proceeds fund. The Gila River Adjudication Court approved this settlement for incorporation into the final decree in that case.

<u>Zuni Indian Tribe</u>
In June 2003, the President signed into law P.L. 108-34, the Zuni Indian Tribe Water Rights Settlement Act. The Act awards the tribe a right to use annually 5,500 AF of surface water from the Little Colorado River (LCR) and up to 1,500 AF of underground water, both for wetland restoration at the Zuni Heaven Reservation. It also grandfathers existing surface and ground water uses in the area, restricts future wells near the reservation and facilitates local state environmental programs. Parties to the settlement include SRP, Tucson Electric Power Company, local irrigation companies, cities and towns, the United States and the State of Arizona.

A total of $26.9M was authorized by the settlement for water rights acquisition and wetlands restoration and maintenance work. The settlement was implemented in December 2006 and includes a broad waiver of Zuni claims against future water uses as well as approval by the LCR Adjudication Court for incorporation into the final decree in that case.

<u>Gila River Indian Community</u>
In December 2004 the President signed into law P.L. 108-451, the Arizona Water Settlements Act. Title II of the Act provided approval of the Gila River Indian Water Settlement Agreement. The settlement awarded the Community an annual entitlement to 653,500 AF of water from various sources including CAP allocations, effluent (through CAP exchange), groundwater, and surface water from the Gila, Verde and Salt rivers,. It also established a funding mechanism for on-reservation development of the Community's farming operations and gave leasing authority to the Community for its CAP water as long as the water is leased within Arizona. Parties to the settlement include many non-Indian neighbors: SRP, RWCD, San Carlos Irrigation and Drainage District, Hohokam Irrigation District, New Magma Irrigation District, Phoenix valley cities, Central Arizona Irrigation and Drainage District, Maricopa-Stanfield Irrigation District, Gila Valley Irrigation District, Franklin Irrigation District, upper Gila valley towns and cities, the

United States, CAWCD and the State of Arizona.

The Indian and non-Indian water users who are parties in the *United States v. Gila Valley Irrigation District, et al., Globe Equity No. 59* (entered June 29, 1935), also known as the Globe Equity Consent Decree, have been in continuing litigation over the management and interpretation of the Decree since 1935. The Settlement Agreement and Title II of the Act include settlement of these difficult issues. The State also enacted legislation to better protect certain water resources of the Community. The settlement was implemented in December 2007 and includes dismissal of Community claims in U.S. and State courts, and approval by the Gila River Adjudication Court for incorporation into the final decree in that case.

G.3 Current Settlement Negotiations

White Mountain Apache Tribe

In January 2009, U.S. Senator Kyl (R-AZ) introduced legislation (S. 313) to settle the water right claims of the White Mountain Apache Tribe (WMAT) in the Salt River Basin. The WMAT Water Rights Quantification Act would authorize $290M for water projects including a dam on the White River at Miner Flat, a treatment plant and pipeline to distribute potable water supply from the reservoir to most of the Fort Apache Indian Reservation, and other smaller projects. Under the settlement, WMAT would be entitled to an annual depletion of 27,000 AF of surface water from the White River and 25,000 AF of CAP water previously set aside for future Indian tribal settlements. Major parties to the settlement include WMAT, SRP, CAWCD, RWCD, and several Phoenix valley cities.

In September 2009, the Senate Indian Affairs Committee cleared S. 313 and in January 2010, the House passed a companion bill (H.R. 1065) introduced by U.S. Representative Kirkpatrick (D-AZ). S. 313 may be considered by the full Senate in late 2010.

Navajo Nation and Hopi Tribe

The Navajo Nation and Hopi Tribe have been negotiating with non-Indian water users in the Little Colorado River Basin, the State of Arizona and the federal government for several years in a settlement committee appointed by the LCR Adjudication Court during the 1990s. Negotiations broke down in 2000 and in 2003 the Navajo Nation filed a lawsuit against the Secretary of the Interior over its operation of the Colorado River. A Federal judge entered a stay in that case until October 2010 to allow negotiations with the United States, State of Arizona and intervening parties about possible Navajo Nation claims to the Colorado River.

Negotiations resumed a few years ago and are now nearing completion concerning Navajo and Hopi claims to both the mainstem Colorado River and the Little Colorado River. Drafting of federal and state legislation is currently underway for possible introduction in 2011 or 2012.

Yavapai Apache Tribe

A federal assessment level team has been assembled to consider the water right claims of the Yavapai Apache Tribe. Details on the team's activities and the status of any settlement negotiations are not available at this time.

G.4 Unresolved Claims

The water claims of the following Arizona Indian tribes are not subject to active settlement negotiations and remain unresolved at this time:

- Havasupai
- Hualapai
- Kaibab Paiute
- Pascua Yaqui
- San Carlos Apache (Gila River tributaries)
- Tohono O'odham (Sif Oidak District)
- Tonto Apache.

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APPENDIX H: SURFACE WATER RIGHT AND ADJUDICATION FILINGS

APPENDIX H
SURFACE WATER RIGHT AND ADJUDICATION FILINGS

Surface water is defined in Arizona as "waters of all sources, flowing in streams, canyons, ravines or other natural channels, or in definite underground channels, whether perennial or intermittent, floodwaters, wastewaters, or surplus water, and of lakes, ponds and springs on the surface" (A.R.S. § 45-101).

In 1864, the first territorial legislature of Arizona adopted the doctrine of prior appropriation to govern the use of surface water. The doctrine is based on the tenet of "first in time, first in right" which means that the person who first puts the water to beneficial use acquires a right that is superior to later appropriators of the water. Since the population and water use were both relatively small at that time, no method was initially specified by the legislature for filing surface water right claims or granting rights. By the late 1800s, rapid development of irrigated agriculture combined with drought years had resulted in severe water shortages along the Salt and Gila Rivers. The territorial legislature responded in 1893 with a requirement that new water appropriations be posted at the point of diversion. However, until 1919, a person could acquire a surface water right simply by applying the water to beneficial use and recording a notice of appropriation at the state and country recorder's office. There still was not a mechanism for granting surface water rights (ADWR, 1992).

On June 12, 1919, the state legislature enacted a surface water code. Now known as the Public Water Code, the law generally requires that a person apply for and obtain a permit in order to appropriate surface water. There is an exception for water use from the mainstem of the Colorado River, which requires a contract with the Secretary of the Interior. In addition, most persons claiming surface water rights prior to the code have been required to file a statement of claim under the Water Rights Registration Act of 1974, although the act did not provide a process for determining the validity of these claims. The legislature also enacted the Stockpond Registration Act in 1977 to recognize certain unpermitted stockponds constructed after 1919 that had not gone through the application process.

The Public Water Code provides that beneficial use shall be the basis, measure and limit to the use of water within the state. Beneficial uses are domestic (which includes the watering of gardens and lawns not exceeding one-half acre), municipal, irrigation, stockwatering, water power, recreation, wildlife including fish, nonrecoverable water storage, and mining uses (A.R.S. § 45-151(A)). The quantity of water that is reasonable for a particular beneficial use depends on a number of factors, including the location of the use.

The Department maintains a registry of surface water right applications and claims filed in Arizona since the Public Water Code was enacted. Each filing is assigned a unique number with one of the following prefixes

- "3R" – application to construct a reservoir filed before 1972;
- "4A" – application to appropriate surface water filed before 1972;
- "33" – application for permit to appropriate public water or construct a reservoir filed after 1972. In addition to surface water diversions and reservoirs, instream flow maintenance

can be applied for and is defined as a surface water right that remains in-situ or "in-stream", is not physically diverted or consumptively used, and is for maintaining the flow of water necessary to preserve wildlife, including fish, and/or recreation;

- "36" – statement of claim of rights to use public waters of the state. To make this claim, an applicant or predecessor-in-interest must have initiated a water use based on state law before March 17, 1995;
- "38" – claim of water right for a stockpond and application for certification filed for stockponds constructed after June 12, 1919 and before August 27, 1977. To file this claim and application, the stockpond should have been used exclusively for watering of livestock and/or wildlife, have a maximum capacity of 15 acre-feet, and not be subject to water rights litigation or protests prior to August 27, 1977;
- "39" – statement of claimant filed in *The General Adjudication of the Gila River System and Source* (Gila Adjudication) and *The General Adjudication of the Little Colorado River System and Source* (LCR Adjudication). As explained further below, the Department maintains a separate registry of these filings on behalf of the Superior Court of Arizona; and,
- "BB" – decreed water rights determined through judicial action in state or federal court.

These filings specify the source of water, its point of diversion (POD) and place of use (POU), the type and quantity of water use, and date of first use or priority.

If, after moving through a number of administrative steps, an application to appropriate surface water or construct a reservoir (3R, 4A, or 33) is determined to be for beneficial use and not conflict with vested rights or be a menace to public safety or against the interests and welfare of the public, it may be approved and the applicant issued a permit to appropriate. The permit allows the permit holder to construct diversion works, as needed, and put the water to beneficial use. If the terms of the permit are met, the applicant can submit proof of appropriation through an application of certification and may be issued a Certificate of Water Right (CWR). The CWR has a priority date that relates back to the date of application and is evidence of a perfected surface water right that is superior to all other surface water rights with a later priority date, but junior to all rights with an earlier (older) priority date. The CWR also specifies the extent and purpose of the right and may be subject to abandonment and forfeiture if not beneficially used. There are currently approximately 850 applications to appropriate pending with ADWR, and approximately 420 permits and over 7,000 certificates have been issued by ADWR or its predecessors.

A CWR may also be issued based on a stockpond claim (38) if it is found that the facts stated in the claim are true and entitle the claimant to a water right for the stockpond. The priority date depends on the date that the owner of the stockpond filed the claim. If filed prior to March 17, 1996, the priority date is the date of construction. Otherwise, the priority date is the date of filing the claim. Regardless of the date, the CWR for a stockpond claim is junior to (a) Colorado River and other court decreed rights; (b) other rights acquired prior to June 12, 1919 and registered as a statement of claim; and (c) any other CWR issued pursuant to an application filed before August 27, 1977. To date, nearly 20,000 stockpond claims have been filed of which over 3,000 stockpond certificates have been issued by ADWR or its predecessors.

Unlike a CWR, the act of filing a statement of claim (36) does not in itself create a water right, nor does it constitute a judicial determination of the claim. Statements of claim are subject to challenge, but can be admitted "in evidence as a rebuttal presumption of the truth and accuracy of the information contained in the claim" (A.R.S. § 45-185). To date, nearly 30,000 statements of claim have been filed in Arizona.

In addition to the applications and claims described above, ADWR's registry of surface water right filings includes several rights determined through judicial action in state or federal court. These 'adjudications', in which a water right is determined by court action, may be initiated when one or more water users seek to know how their rights compare to the rights of other water users and/or seek judicial relief from alleged interference with their rights by other water users. The court process establishes or confirms the validity of surface water rights and claims, determines whether these have been properly maintained over the years, and ranks them according to their priority. The result is a decree that may, in addition to establishing and confirming rights, specifies terms under which the decreed rights may be exercised if water shortages occur. Court decreed rights are considered the most valued or certain surface water rights because in the absence of abandonment or forfeiture, they are normally accepted as to their validity. More than 1,000 court-decreed rights are listed in ADWR's registry and given the prefix "BB".

Although several surface water uses have been decreed, many claims and rights established before and after statehood have still not been examined to see if they remain valid. In addition, many water rights established under federal law and claimed by Indian tribes and the United States have not been quantified or prioritized. To better manage water resources in the state, these diverse rights and claims have been joined into large, comprehensive determinations.

Arizona currently has two general stream adjudications – the Gila Adjudication and the LCR Adjudication. The purpose of these judicial proceedings is to determine the nature, extent, and priority of water rights across the entire river systems. In addition to confirming existing state-based surface water rights, the adjudications will quantify and prioritize reserved water rights for Indian and non-Indian federal lands. The latter include military bases, national parks and monuments, and national forests. The adjudications will also determine which wells are pumping appropriable underground water (subflow) and therefore are subject to the jurisdiction of the court. The Gila and LCR Adjudications are being conducted in the Superior Court of Arizona in Maricopa and Apache Counties, respectively. ADWR provides technical, legal and administrative support to the adjudication court, as described in A.R.S. § 45-256.

The Gila Adjudication was initiated in 1974 when SRP filed a petition to determine the water rights in the Salt River Watershed above the Granite Reef Diversion. Since that time, the adjudication area has grown and now covers over 53,000 square miles. It is divided into 7 watersheds and includes 12 Indian reservations and over 24,000 parties. The LCR Adjudication was initiated by a petition filed by Phelps Dodge in 1978. This adjudication now covers 27,000 square miles and includes 3 watersheds, 5 Indian reservations, and over 3,000 parties. A party is a person or entity that has filed one or more statement of claimant (SOC) in the adjudication.

All parties who claim to have a water right within the river systems are required to file an SOC or risk the loss of their right. Well owners are also encouraged to file an SOC since the adjudication process may include water use from a well depending on the well's location relative to streams and other factors. However, a person does not obtain a right to use water by filing an SOC nor is an SOC a legal permit to use water. Rights to use water must be acquired in accordance with state or federal law.

Each year, ADWR sends summons to new surface water appropriators and well owners in the adjudication areas that direct them to file an SOC. In response, the number of SOCs filed in the adjudications continues to increase as new water uses are initiated. To date, nearly 81,000 SOCs have been filed in the Gila Adjudication and over 14,000 SOCs have been filed in the LCR Adjudication. ADWR maintains a separate registry of these adjudication filings on behalf of the Superior Court and assigns each a unique number with the prefix "39".

Figure H-1 General Stream Adjudications in Arizona

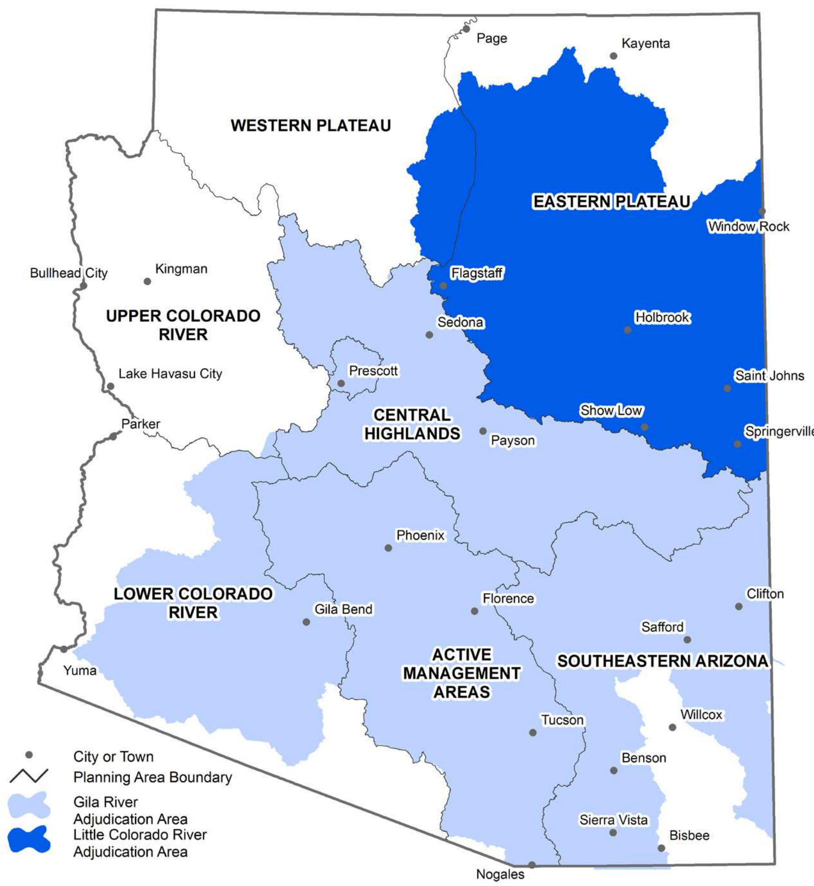

Table C-1 summarizes the number of surface water right and adjudication filings for each planning area. The table was generated by querying ADWR's surface water right and SOC registries in February 2009. Files are only counted in the table if they include sufficient locational information (Township, Range, and Section) to allow a POD and/or POU to be mapped within the planning area. If a file lists more than one POD or POU in a planning area, it is only counted once in the table for that planning area. However, no attempt was made to avoid counting multiple filings for the same POD/POU which can result if a landowner or lessee has two or more filings or if different applicants each have at least one filing. Since many SOCs list surface water right filings as their basis of claim, multiple filings are common and account, in part, for the large number of filings. Sorting through multiple filings is one of the challenges facing the Department and the adjudication courts. Results from the Department's investigation of surface water right and adjudication filings are presented in Hydrographic Survey Reports (HSRs).

Figure H-2 shows the location of surface water diversion points listed in the Department's surface water rights registry. The numerous points mapped reflect the relatively large number of stockponds and reservoirs that have been constructed across the state as well as diversions from streams and springs. Locations for registered wells, many of which are referenced as the basis of claim in SOCs, are also shown in Figure 1-24. Instream flow filings are not shown as these filings do not have points of diversion.

Table H-1 Count of Surface Water Right and Adjudication Filings by Planning Area[1]

PLANNING AREA	TYPE OF FILING							TOTAL
	BB[2]	3R[3]	4A[3]	33[3]	36[4]	38[5]	39[6]	
Eastern Plateau	134	163	196	373	3,289	3,275	12,099	**19,529**
Southeastern	483	395	716	898	8,288	6,415	19,288	**36,483**
Upper Colorado River	0	224	329	469	2,858	2,084	0	**5,964**
Central Highlands	1	287	625	897	8,517	3,928	25,443	**39,698**
Western Plateau	0	415	207	554	1,177	1,270	324	**3,947**
Lower Colorado River	0	26	48	86	355	304	2,323	**3,142**
Active Management Areas	1	269	341	687	4,072	2,913	27,134	**35,417**
Total	**619**	**1,779**	**2,462**	**3,964**	**28,556**	**20,189**	**86,611**	**144,180**

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 planning area. If a file lists more than one POD or POU in a given planning area, it is only counted once in the table for that planning area. 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.

APPENDIX I: RURAL WATERSHED INITIATIVE

APPENDIX I: RURAL WATERSHED PARTNERSHIPS ISSUE SUMMARY (2008)

The Department has provided technical and financial assistance to non-AMA watershed partnerships since the late 1990's through its Rural Watershed Initiative Program. In 1999, the Rural Watershed Initiative (Initiative) received an appropriation of $1.2 million from the Legislature to assist the groups with development of information to support water resources planning in their areas. Although funding has diminished since then, matching funds from other entities have sustained key projects partially funded by the Initiative. A key component of the Initiative approach is that it helps local citizens find solutions that match the specific problems in their own regions. Seventeen watershed groups have formed to conduct water resource studies and evaluate management options (Figure I-1).

Several of the watershed groups were already in place as part of a water quality planning effort by the Arizona Department of Environmental Quality (ADEQ).

The watershed groups vary substantially in terms of resources, staff support, and accomplishments. In some areas, especially those with significant resources such as the Upper and Middle Verde, Coconino Plateau and the Upper San Pedro, efforts have already produced results in the form of completed and on-going studies, plans, and specific activities to address availability of water. Because of the lack of technical and financial resources and the limited availability of hydrologic data, efforts in other areas may take longer to produce tangible results. Studies and other information associated with these groups have been incorporated into the Atlas and a summary of participants, issues and projects is provided in Table I-1.

Table I-1 RURAL WATERSHED PARTNERSHIPS ISSUE SUMMARY (2008)

Rural watershed partnership participants, projects, accomplishments and issues are summarized below and grouped by planning area. Some partnerships include more than one planning area as noted.

MULTI-PLANNING AREA - Eastern Plateau, Western Plateau and Central Highlands			
Watershed Partnership	**Primary Participants**	**Projects & Accomplishments**	**Issues**
Coconino Plateau Water Advisory Council	Flagstaff Coconino County Williams Sedona Page Tusayan Doney Park Water Co TNC Grand Canyon Trust Navajo Nation Hopi Tribe Havasupai Tribe Hualapai Tribe ADWR ADEQ ASLD AZGF NRCD NAU USGS USBOR USFS National Parks US Fish and Wildlife Grand Canyon National Park .	• 4 categories of potential water augmentation projects have been identified along with their associated costs. • Groundwater study and conceptual model completed • Phase I Water Demand Study for Coconino Plateau • Growth Impacts Study • Western Navajo Pipeline Study • Development of study for importing C aquifer groundwater east of Flagstaff has been completed. • Flagstaff, Hopi and Navajo are exploring cooperative opportunities for developing C aquifer groundwater. • Flagstaff purchased Red Gap Ranch for possible future development of groundwater. • Hopi HSR initiated. • Water Supply Appraisal Study Completed, which identifies current & future demands and alternatives for meeting projected demands.	• Continued growth throughout entire plateau region • Limited and deep groundwater supplies. • Drought sensitive surface water supplies of Williams, Flagstaff and others • Groundwater salinity issues in northeastern part of plateau • Numerous water haulers with few hauling stations that are sometimes cutoff during drought • Unable to get adequate water supply designation under current definition • Growth in Page with no current means of additional supply • ESA issues with groundwater usage and impacts on perennial streams • Potential limitation of groundwater usage resulting from reserved groundwater rights of Indians • Uncertainty of Indian water right settlements (LCR & Colorado River) • Proposed San Juan Paiute reservation west of Flagstaff • Potential impacts on springs in Grand Canyon and also on supplies to Havasupai and Hualapai reservations • Access to water development on public lands

MULTI-PLANNING AREA - Eastern Plateau, Western Plateau and Central Highlands			
Watershed Partnership	**Primary Participants**	**Projects & Accomplishments**	**Issues**
Coconino Plateau Water Advisory Council (cont)		• Numeric Groundwater Model completed • Strategic Plan has been completed to address water conservation and management on the Plateau • Attempting to obtain Congressional Authority to complete a Feasibility Study of the water alternatives identified	• Limited groundwater data for entire region • Minor Arsenic issues in Woody Mtn. Well field (9-14 ppb) • Unregulated lot splits • Limited funding resources for planning, projects, infrastructure and studies • Extremely high cost of water augmentation projects • Competition from Phoenix/Tucson for CAP reallocation water and other Colorado River supplies • Congressional Support for completion of a Feasibility Study • Modifications to the current definition of an adequate water supply resulting from the passage of SB1575
Northern Arizona Municipal Water Users Association (NAMWUA)	Prescott Prescott Valley Flagstaff Williams Cottonwood Clarkdale Sedona Payson Chino Valley	• Projected water demands through 2040 have been identified • A request for 70,000 acre-feet of CAP reallocation water has been submitted to ADWR for consideration. • Completed Colorado River Supply Study	• Limited supplies to meet projected demands • ESA issues impacting potential ground and surface water supplies • Limited funding resources for planning, projects, infrastructure and studies • Competition from Phoenix/Tucson for CAP reallocation water and other Colorado River supplies • Funding for Colorado River infrastructure • Water quality issues in Verde Valley and Flagstaff • Upper Basin/Lower Basin issues with Colorado River affect potential for use • Modifications to the current definition of an adequate water supply resulting from the passage of SB 1575

VOLUME 2: EASTERN PLATEAU PLANNING AREA			
Watershed Partnership	**Primary Participants**	**Projects & Accomplishments**	**Issues**
Little Colorado Watershed Coordinating Council (Formerly Little Colorado River Multi-Objective Management Partnership (LCRMOM))	Winslow Holbrook Navajo County NRCD/RCD NAU USBOR COE	• Development and Ecosystem Restoration Program study for the Montane Forest Regimes completed. • Watershed reconnaissance study completed • Completed Watershed Based Plan	• Potential impacts on groundwater from power plants • Water quality issues involving arsenic and TDS • Unresolved adjudication and Indian water rights settlements • Limited groundwater data for entire region • Invasive species (Tamarisk) • ESA issues • Drought impacts on surface water supplies • Limited funding resources for planning, projects, infrastructure and studies • Modifications to the current definition of an adequate water supply resulting from the passage of SB1575
Navajo Nation	NDWR NTUA NDEQ NHA ADWR USBOR COE BIA IHS	• Survey of agricultural lands in Upper Basin • Groundwater elevation survey of NTUA wells • Water Quality ATLAS • Navajo Drought Report • Western Navajo Water Supply Study	• Lack of technical groundwater data • Limited groundwater supplies to meet projected demands • Water quality issues • Prone to impacts from drought • Unresolved water right claims to LCR, Colorado R. & San Juan R. • Upper Basin/Lower Basin issues with Colorado River • Gallup to Window Rock Pipeline in jeopardy (financial, upper/lower basin issues, ESA and others)

VOLUME 2: EASTERN PLATEAU PLANNING AREA			
Watershed Partnership	**Primary Participants**	**Projects & Accomplishments**	**Issues**
Pinetop-Lakeside Watershed Enhancement Partnership	Show Low Lakeside Pinetop Navajo County Show Low Creek Irrigation District Local Citizenry LCRWCC ADWR AZGF	• Groundwater elevations study • GPS survey of agricultural lands • Preliminary water budget completed. • Received 319 Grant to address water quality issues in Rainbow Lake • Water Protection Fund Grant for Billy Creek Project • Completed Watershed Based Plan • Obtained TRIF Grant to conduct groundwater age dating	• Drought impacts on surface water supplies and springs resulting in impacts on agriculture and cattle ranching • Seasonal demands impacting peak demands • Growth • Unresolved adjudication and Indian water rights settlements • Limited funding resources for planning, projects, infrastructure and studies • Modifications to the current definition of an adequate water supply resulting from the passage of SB1575
Silver Creek Watershed Partnership	Snowflake Holbrook Show Low Taylor Winslow Navajo County Silver Creek ID Show Low Creek Watershed Partnership LCRWCC ADWR NAU	• Silver Creek channel and riparian restoration study completed. • Value Engineering Analysis of Unsafe Dams completed • Silver Creek HSR	• Limited groundwater data • Potential impacts on groundwater system from Cholla Power plant • Drought impacts on surface water supplies for agriculture • Several high hazard unsafe dams • Unresolved adjudication and Indian water rights settlements • Perception of no real supply problem • Water quality concerns in some areas (salinity) • Limited funding resources for planning, projects, infrastructure and studies • Modifications to the current definition of an adequate water supply resulting from the passage of SB1575 •

VOLUME 2: EASTERN PLATEAU PLANNING AREA			
Watershed Partnership	**Primary Participants**	**Projects & Accomplishments**	**Issues**
Upper Little Colorado River Watershed Partnership	Springerville Eagar Greer Nutrioso Apache County Round Valley Irrigation District Local Citizens and Special Interest Groups LCRWCC ADWR ADEQ AZGF NRCS/RCD USFS USBOR	• Aerial mapping survey and GIS coverage of the Little Colorado River and tributaries completed. • Geomorphic and biological assessment of the LCR completed. • Stream riparian restoration project • Round Valley Irrigation Delivery System partially upgraded. • Preliminary water budget completed • Reconstruction of River Reservoir Dam completed. • Interconnection of Springerville and Eagar's wastewater treatment facilities is complete • Completed Watershed Based Plan	• Limited groundwater data • Potential impacts to the groundwater system from TEPCO generating station. • Unresolved adjudication and Indian water rights settlements • Proposed development in Greer and impacts on Little Colorado River • Drought impacts on forage for grazing and surface water availability for agriculture • Potential impacts on tourism due to drought • Funding issues for water delivery infrastructure • Political differences between Springerville and Eagar • Limited funding resources for planning, projects, infrastructure and studies • Modifications to the current definition of an adequate water supply resulting from the passage of SB1575

VOLUME 3: SOUTHEASTERN ARIZONA PLANNING AREA			
Watershed Partnership	**Primary Participants**	**Projects & Accomplishments**	**Issues**
Community Watershed Alliance/ Middle San Pedro Watershed	Cochise County Benson J-Six Mescal HOA St. David Irrigation District Pomerene Irrigation District Local Citizenry TNC ADWR NRCD ADEQ Coop Extension USGS USDA/ARS USBOR	• Cursory groundwater study completed. • AMA evaluation completed. • Active agricultural fields identified and surveyed • HSR completed • 7-year comprehensive groundwater study and numeric model development initiated. • Completed Watershed Based Plan • Obtained TRIF Grant to conduct groundwater age dating	• Growth proposed in the Benson area • Limited groundwater data • Different perceptions of issues and goals within the area between Benson, irrigation districts, local citizenry, and the Upper San Pedro Partnership • Unable to get principle players to the table to discuss water • Unregulated lot splits • New arsenic drinking water standard • Limited funding resources for planning, projects, infrastructure and studies • ESA issues • Superfund site/poor quality groundwater conditions • Potential impact of adjudication court subflow definition • Limited funding resources for planning, projects, infrastructure and studies • Mandatory water adequacy required for all new subdivisions
Eagle Creek Partnership	Local ranchers & special interest groups ADWR	• Stream Reconnaissance study completed.	• Little or no groundwater data available • Unresolved Indian water rights settlements • Limited funding resources for planning, projects, infrastructure and studies

VOLUME 3: SOUTHEASTERN ARIZONA PLANNING AREA			
Watershed Partnership	**Primary Participants**	**Projects & Accomplishments**	**Issues**
Gila Watershed Partnership	Safford Thatcher Pima Graham County Greenlee County Duncan ADWR AZGF ADEQ Coop Extension BLM USFS USBOR NRCS/RCD	• Fluvial Geomorphology Study • Completed water demand study • Capped several saline wells contributing to the degradation in water quality of the Gila River • Resin bush eradication project completed. • Obtained several DEQ 319 grants for Gila River related projects • Initiated San Simon legacy database project • Completed Watershed Based Plan • Completed Point of Pines restoration project • Awarded several Water Protection Fund grants	• Indian water rights settlement issues • Poor quality surface and groundwater • Growth associated with new Phelps Dodge mine and unregulated lot splits • ESA issues throughout the watershed, critical habitat designation, and mitigation efforts • Desire to maintain rural setting and especially maintaining agriculture at current or higher levels • Lack of technical data on the groundwater system • Invasive species issues impacting the surface water supply (tamarisk) • Potential impacts of adjudication court subflow definition • New arsenic drinking water standard • Drought impacts on surface water supplies, agriculture and cattle ranching • Numerous high hazard unsafe dams in area • Limited funding resources for planning, projects, infrastructure and studies • Regular flooding in the Duncan-Virden area •
Lower San Pedro Watershed Partnership-Redington NRCD	Cascabel Redington Local ranchers ADWR NRCD/RCD	• Watershed reconnaissance study completed.	• Unresolved adjudication and Indian water rights settlement issues • Little or no groundwater data • Opposition to government assistance in obtaining groundwater information • Potential impacts of adjudication court subflow definition • Limited funding resources for planning, projects, infrastructure and studies

VOLUME 3: SOUTHEASTERN ARIZONA PLANNING AREA			
Watershed Partnership	**Primary Participants**	**Projects & Accomplishments**	**Issues**
Upper San Pedro Partnership	Sierra Vista, Ft. Huachuca Cochise County, Huachuca City Bisbee, Tombstone TNC Huachuca Audubon Bella Vista Water ADWR, ADEQ AACD, NRCD ASLD USFWS, USFS BLM, USDA/ARS USGS, USBOR Coronado National Monument	• Comprehensive groundwater study • Completed numeric groundwater model • Decision Support System model completed. • SPRNCA Water Demand study • Recharge study of detention basins completed • Engineering design to transfer effluent from Huachuca City to Ft. Huachuca for treatment and recharge completed • Bisbee wastewater treatment plant upgrade for use by Turquoise Valley golf course and other uses. • Water conservation & management plans completed. • Section 321 Report to Congress submitted annually. • Funded more than $1,000,000 in conservation projects • Public outreach and educational forums • Completed Water Supply Appraisal study. • Feasibility study commenced • Preliminary Upper San Pedro Water District formed	• Impacts on endangered species • Federal mandate to achieve sustainability by 2011 • Lawsuits from environmental groups • Anticipated growth • Potential impacts on riparian regime by continuation of current pumping • Political obstacles from potential water augmentation projects • Potential loss of Ft. Huachuca • Interbasin transfer prohibition • Potential impacts of adjudication court subflow definition • Pumping impacts by Mexico on the San Pedro River and downstream users • Unregulated lot splits • Limited funding resources for planning, projects, infrastructure and studies • High cost of augmentation projects • Mandatory water adequacy required for all new subdivisions

VOLUME 3: SOUTHEASTERN ARIZONA PLANNING AREA			
Watershed Partnership	**Primary Participants**	**Projects & Accomplishments**	**Issues**
Willcox Playa Watershed Group	Willcox Cochise County Cooperative Extension Local Citizenry	• Initiated multiple year comprehensive groundwater study • Initiated the collection of relative gravity data	• Approximately 100,000+ af of annual groundwater overdraft • Potential for subsidence • Limited funding resources • Increased agricultural production • Little or no groundwater data • Water quality concerns • Mandatory water adequacy for new subdivisions

VOLUME 4: UPPER COLORADO RIVER PLANNING AREA			
Watershed Partnership	**Primary Participants**	**Projects & Accomplishments**	**Issues**
Northwest Arizona Watershed Council	Kingman Mohave County Dolan Springs Dolan Springs Water Co. Local citizens Hualapai Nation ADWR ADEQ Cooperative Extension BLM USFS USFS	• Groundwater reconnaissance survey of 3 basin area. • Coordinated clean-up of numerous wildcat dumpsites. • Comprehensive groundwater study and conceptual model initiated. • Relative gravity survey of Detrital, Sacramento, and Hualapai Basins initiated. • Completed sampling of groundwater for age dating study • Established micro-gravity data collection stations for monitoring changes in groundwater elevations	• Limited groundwater supplies • Huge growth projected for all three basins. • Detrital Basin envisioned as bedroom community of Las Vegas with completion of Colorado River bypass bridge. • Drought impact on private water suppliers, which impacts water haulers • Subsidence potential from proposed development • Limited groundwater data. • Potential impact from large industrial users in the Big Sandy Basin • Water quality concerns (hexavalent Chromium) • Potential problems from proposed developments within Colorado River accounting surface area • Mohave County claims they will deny any subdivision that cannot obtain adequate water supply determination • Limited funding resources for planning, projects, infrastructure and studies

VOLUME 4: UPPER COLORADO RIVER PLANNING AREA			
Watershed Partnership	**Primary Participants**	**Projects & Accomplishments**	**Issues**
Mohave County Water Authority	Lake Havasu Kingman Bullhead City Mohave County Mohave Valley Irrigation Dist	• Obtained a portion of the Cibola Irrigation District's Colorado River Allocation • Obtained Kingman's Colorado River Allocation	• Growth • Limited Colorado River water supplies • Competition from Phoenix/Tucson for additional Colorado River supplies • Water quality concerns

VOLUME 5: CENTRAL HIGHLANDS PLANNING AREA			
Watershed Partnership	**Primary Participants**	**Projects & Accomplishments**	**Issues**
Mogollon Highlands Partnership	Payson Pine Strawberry Gila County Brooks Utilities Rim Trails WID Pine Strawberry WID Local citizens and special interests Tonto Apache Nation ADWR SRP USFS USBOR USGS	• Comprehensive groundwater study and conceptual model completed. • Water Supply Appraisal Study completed - identifies current & future demands and alternatives for meeting projected demands. • Strategic Plan completed • Feasibility study and cost estimates for Blue Ridge Reservoir pipeline completed • Obtained approximately 3,500 ac-ft of surface water from C.C. Cragin Reservoir. • Numeric groundwater model completed. • Finalizing the Mogollon Rim Water Resources Management Study	• Limited water resources to meet current demands. • Environmental, supply, treatment, transportation and financing costs associated with augmentation from Blue Ridge reservoir • Numerous private water companies, Arizona Corporation Commission and Domestic Water Improvement District conflicts • Inter-basin transfer conflicts from Payson's ability to pump from two different basins • Seasonal demand issues; peaking problems • County support of growth in Pine, Strawberry • Pine, Strawberry drought sensitive water supplies • Unresolved Indian water rights settlements • Environmental issues pertaining to Fossil Creek • Limited groundwater data for entire region • Costs associated with hauling water • Access to water development on public lands • Infrastructure needs for private water companies • Limited funding resources for planning, projects, infrastructure and studies

VOLUME 5: CENTRAL HIGHLANDS PLANNING AREA			
Watershed Partnership	**Primary Participants**	**Projects & Accomplishments**	**Issues**
Upper Agua Fria Watershed Partnership	Mayer Black Canyon City Cordes Lakes Yavapai County Spring Valley Local Citizens ADWR ADEQ Cooperative Extension State Lands BLM/Agua Fria Nat. Monument USFS	• Watershed Reconnaissance studies • Active recharge site identification study. • Corp of Engineers watershed appraisal study completed • Corp of Engineers watershed feasibility study initiated • Completed wet dry mapping of Agua Fria R. • Groundwater quality study completed	• Proposed growth in the Mayer, Bensch Ranch and Spring Valley areas • Limited groundwater supplies • Little or no groundwater data • Groundwater and surface water supplies are very drought sensitive • Potential water quality attributed to local septic systems and discharges from Prescott Valley • Poorly constructed and maintained infrastructure in some areas • Limited funding resources for planning, projects, infrastructure and studies
Yavapai Water Advisory Committee	Prescott Prescott Valley Chino Valley Paulden Yavapai County Sedona Camp Verde Clarkdale Cottonwood Jerome 24 local special interest groups TNC Yavapai Apache Yavapai Prescott ADWR ADEQ SRP NRCD Cooperative Extension NAU USFS USGS USBOR USFWS	• Comprehensive groundwater study and conceptual model • Study of geologic framework of aquifer units and groundwater flow paths of Verde River headwaters using aeromagnetic and gravity data. • Verde River Watershed Study. • Water educational forum conducted for WAC and public with ultimate goal of developing water management plan for Verde watershed area. • Big Chino Subbasin Historical and Current Water Uses and Water Use Projections study. • Riparian demand study of Middle Verde	• Potential impacts resulting from the transfer of 8,717 ac-ft from Big Chino to Prescott and Prescott Valley • 25,000 to 30,000 approved lots still outstanding in Prescott AMA • Multiple developments currently under construction in the tri-city region of the AMA • ESA issues/protected areas on the Verde • Critical habitat area in Verde Valley for Willow Fly Catcher • New arsenic standards • Pending subflow decision • Competition between watershed groups for funding and technical support • Countywide growth and unregulated lot splits • Indian water rights • Thousands of private domestic wells already permitted and more being requested daily

VOLUME 5: CENTRAL HIGHLANDS PLANNING AREA			
Watershed Partnership	**Primary Participants**	**Projects & Accomplishments**	**Issues**
Yavapai Water Advisory Committee (cont)		• Numeric groundwater model completed. • Prescott AMA groundwater model. • Study of groundwater flow paths for upper and middle Verde using stable isotopes. • Prescott purchased JWK Ranch in Big Chino to import 8,717 ac-ft annually to Prescott and Prescott Valley • Groundwater monitoring program in Big Chino initiated. • Developed water demand scenarios to run on groundwater model • Initiated Water Supply Appraisal Study with BOR/ADWR • Initiated Central Highlands Water Resource Management Study with BOR/ADWR	• Potential water quality impacts on groundwater system from the thousands of septic systems • Potential development rumors of the CVCF Ranch in the Big Chino • Limited funding resources for planning, projects, infrastructure and studies

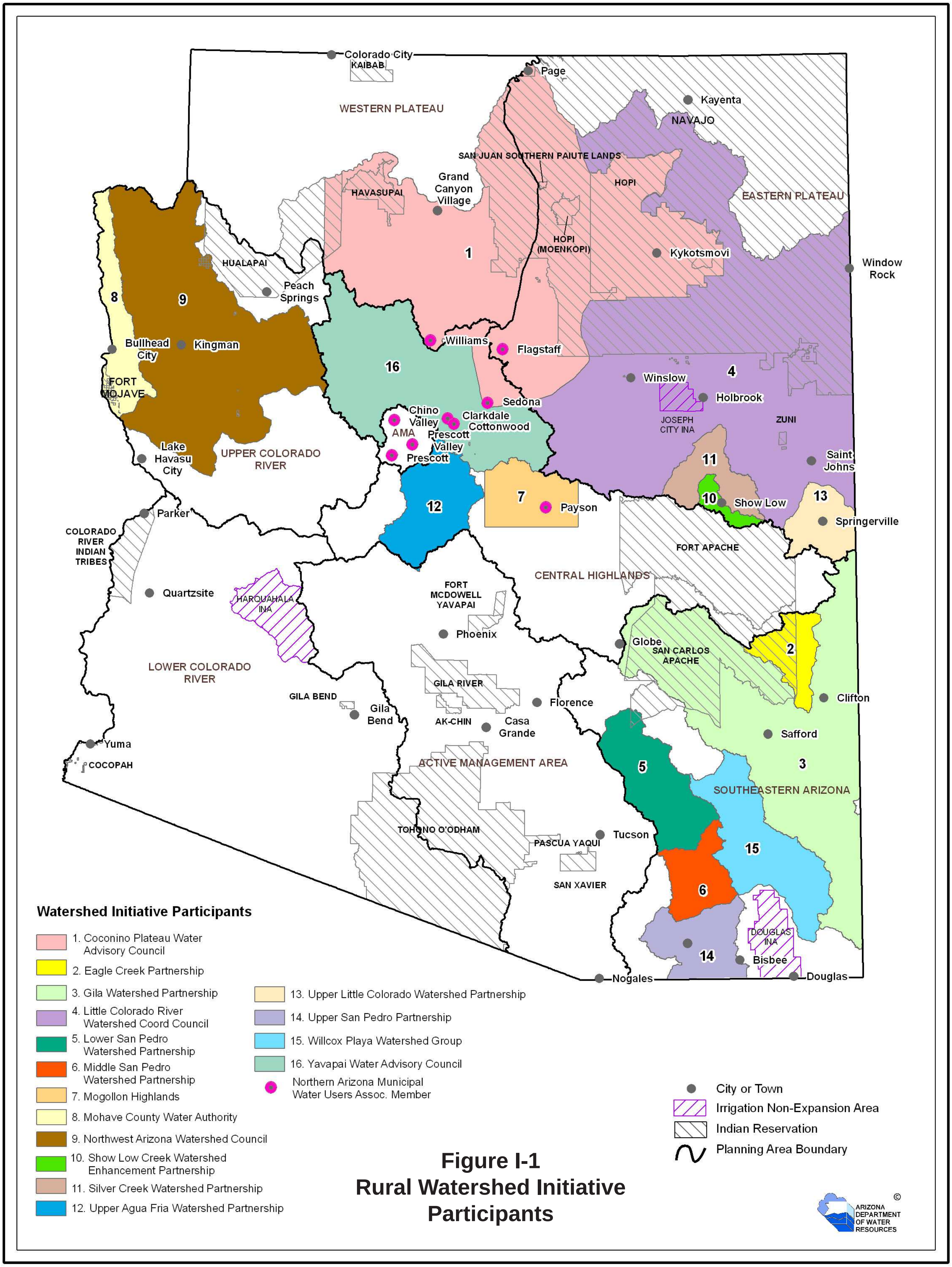

Figure I-1
Rural Watershed Initiative Participants

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