REGIONAL & STATE WATER MANAGEMENT

By Robert Emanuel

"Whiskey is for drinking, water is for fighting." –Mark Twain

INTRODUCTION

Water in Arizona is precious. Having water means life to anyone living in the desert—and that fact means we will go to great lengths to get it, keep control of it, and use it for our own purposes. This chapter will teach you about some of these means and ends involved in water management. This includes an introduction to the array of different laws, agencies, and technologies that attempt to control and manage water as well as how society uses water.

Despite the fact that water is precious for all life—particularly in a desert environment, modern humans tend to take it for granted. While 3,000 years ago, Anazazi, Puebloan and Hohokam peoples prayed for rain and constructed elaborate irrigation systems to capture it when it did fall, a contemporary homeowner in Arizona has only to walk to the tap and turn it on. As Robert Glennon writes in *Water Follies*, "We've been spoiled by excess." That excess comes with a price—ignorance of the process whereby we have easy water. Hence a major goal of this chapter is to educate you to process of acquiring, controlling, and transporting water from watersheds to your tap.

This chapter deals with water management in Arizona, but also in the greater southwest, because water does not stop at political boundaries. It flows across them ignorant of whether it is in California, New Mexico, Nevada, Utah, or Mexico.

Water sits in underground deposits that may underlie several, if not thousands of individual property holders above. Water resources are what scientists call a **common pool resource**, meaning it can be used singly but not easily controlled by any single individual. This is particularly true of rivers, but also of ground water, lakes, ponds, or irrigation canals.

In this chapter you will learn:

- What sources supply Arizona's water.
- Who manages those supplies.
- Major uses of water in Arizona.
- About water policy and law.
- About the major sources of water conflict.
- How to conserve water.

Water is not only vital and scarce in Arizona, it is also an often hotly contested natural resource worldwide. While fossil fuels, timber, minerals, or rich farmland have been at the heart of many a war in historic or modern times, water remains at the heart of modern legal or historically physical battles across the arid west. This is especially true as we reduce its availability and quality through poor management practices or as we face drought. Fortunately, Arizonans are not shooting each other over our water resources, but we do litigate frequently over access to and management of water. This chapter will talk briefly about some of the legal arguments that govern who gets water and how they can use it.

ARIZONA'S WATER SUPPLY

There are basically four categories of water supplies available in Arizona: surface water other than Colorado River water, Colorado River water, ground water, and treated waste water effluent. The utility of each type of water depends on its quantity, quality, reliability and

economic feasibility. Ground water accounts for 40% of total water available, while Colorado River water accounts for 39%, other surface water sources supply 19% of Arizonan's needs, and 2% of our water comes from reclaimed sources.

Surface water

Surface water from lakes, rivers and streams is an important renewable resource, dependent on climatic conditions and subject to drought. However, because of our desert climate, the amount of surface water available can vary dramatically from year to year, season to season, and place to place. In order to make the best use of the surface water when and where it is needed, storage reservoirs and delivery systems have been constructed throughout the state. Most notable are the major reservoir storage systems located on the Salt, Verde, Gila and Agua Fria rivers. Almost all of the natural surface water in Arizona has been appropriated.

Colorado River Water

A separate category of surface water in Arizona is the water supplied through the Colorado River. The federal government constructed a system of reservoirs on the River to harness its supplies for use in several states. Arizona, California, Nevada, New Mexico, Utah, Colorado, Wyoming and Mexico share the River's resources. Rights to use Colorado River water are quantified by a collection of legal authorities known as the "Law of the River." Many of these legal authorities (court decisions) were established between 1922 and 1974 although some were still in contention until 2003 when California was forced to adhere to its allocation. Based on this body of law, Arizona has the right to use 2.8 million acre-feet annually of Colorado River water. Mohave, La Paz and Yuma county water users rely on Colorado River as their principal water supply. Central Arizona Project is designed to deliver 1.8 million acre-feet of Colorado River water to Maricopa, Pinal and Pima Counties.

Ground water

About 40 percent of the state's water use comes from ground water sources. Ground water is found in the subsurface, within the fractures and cracks of bedrock or within the porous sands and alluvial basins across the state. An aquifer is a body of saturated geologic material that is sufficiently permeable to conduct ground water and to yield economically significant quantities of water to wells and springs. In most cases the water stored in these reservoirs has been in place for hundreds of years. Ground water that has been pumped out more rapidly than it is being replenished creates a condition called overdraft, and reliance on ground water resources in an area of overdraft is not sustainable. Though a large amount of water remains available in Arizona's aquifers, its availability is limited by location, depth and quality. By continuing to overdraft ground water supplies, we challenge our ability to ensure a secure water supply for the future. In recognition of this threat, Arizona implemented the Ground water Management Act in 1980. The Act promotes using surface water, like Colorado River water, instead of ground water, water conservation and long-range planning of our ground water resources.

Figure 1. Dredging a canal in the Salt River Valley, circa 1900. Photo courtesy of SRP.

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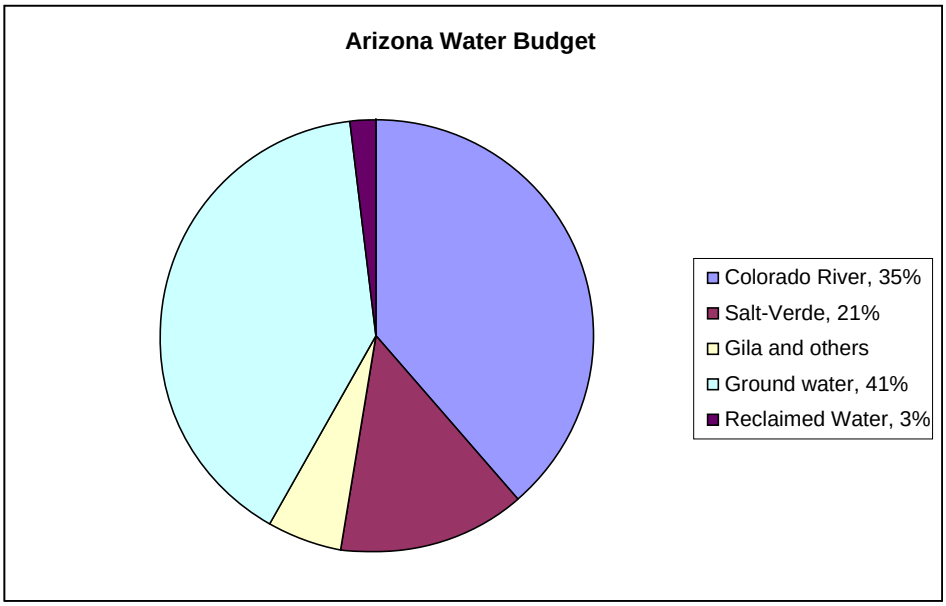


Figure 1. Arizona's water budget.

Treated Waste Water Effluent

Reclaimed water, or effluent, is considered by some water managers the one increasing water source in our state. As our population and water use grows, more treated wastewater will be available. However, treated waste water is only produced as water is extracted elsewhere, used and then discharged to a treatment plant. Reclaimed water is treated to a quality that can be used for a range of purposes such as agriculture, golf courses, parks, industrial cooling, or maintenance of wildlife areas. Several rivers in the state are entirely or partially dependent upon waste water for their current flows including the lower Gila and Santa Cruz Rivers.

HOW MUCH WATER ARE WE USING IN ARIZONA?

Arizona uses approximately 7.24 million acre-feet of water per year, under non-drought conditions. One acre-foot is the amount of water it would take to cover one acre one foot deep, or 325,851 gallons. An acre-foot is about enough water to serve the needs of a family of five for one year. In some parts of Arizona an acre foot serves 2 families for a year.

Over 70% of that 7.24 million acre-feet of water goes to agriculture, while the remaining 30% is divided among municipal providers (23%), industrial users (7%) and environmental applications such as maintaining stream base flow for sustaining riparian habitat.

WHAT IS WATER USED FOR IN ARIZONA?

Water has many uses in Arizona. Water is important for producing cotton, citrus, lettuce, alfalfa, and dairy products in the deserts of central and southern Arizona. It is cooling children and adults as they play in public pools and water parks. It is watering landscaping, golf courses, and gardens across the state. Water is producing electricity in various dams along the Colorado and Salt Rivers. It is flushing wastes away from homes and businesses. It is moving coal slurry and producing steam in power plants. It is watering verdant riparian vegetation and forests and providing habitat for fish, birds and other wildlife.

Here are the larger priorities for Arizona's water resources:

- Water goes to **Municipal and Industrial uses** (referred to as **M & I** by water managers and experts). That water goes for household, landscaping, sanitation, and business uses.
- Water is used in the production of agriculture (irrigation, stock watering, food and fiber).
- Water goes to power, mining and the environment. It also provides recreational opportunities for Arizonans and visitors to the state.
- Water is stored underground for future use, a process called recharge.

CONTROLING WATER: RIGHTS & TECHNOLOGY

First off, it is important to establish that water is not just a luxury—but a necessity. Everyone, regardless of their age, creed, sex, or race needs water to survive. How that water is distributed among all of these competing people is critical for all of us to understand.

Arizona, like many western states, considers water a public commodity, accessible by public documentation of right to access. That means it can be divided up, bought, sold or leased. However, since all humans need it for basic survival, the State and local governments often incorporate access to water as within their governmental obligation, and they then supply it, often at cost of development and infrastructure cost, to citizens. That cost includes treatment, delivery, and administration These decisions are generally made at the local level.

On the other hand, in some locations individuals are dependent upon their own wells, hauling water from other sources or private utilities. Until the Assure Water Supply and Adequate Water Supply Rules were established (see below) in the late 1970s, many Arizonan's bought property without adequate water sources. The resulting scandals led to new legislation.

Surface Water Rights & Early Water Law

Rights to the use of and control of water in Arizona are governed by whether it is surface water or ground water. **Water rights** are more than just the prioritization of rights of access and control of the particular resource, but also include obligations that go with the right. Because settlers to Arizona first encountered surface water and because ground water extraction was impractical until the early 20th century, surface water rights were the first to be adjudicated.

Early in its history, Arizona 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 to that water that has a legal priority over and is senior to later appropriators of the water. 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. Now known as the Public Water Code, this law provides that a person must apply for and obtain a permit in order to appropriate surface water, thus documenting the volume, use, and date of right to access to that water.

This doctrine of prior appropriation water law is very different than that practiced in Europe or the Eastern United States, where most settlers to Arizona originated. There, surface water rights were associated with the stream, lake or other water body and land owners bordering the water were guaranteed (within the constraints of the law) the "natural flow without diminution or alteration," meaning that water should be left in place—it could not be moved or removed from the water body.

This riparian law was fine in the days when a family might use water for household use, but in arid western North America, water was envisioned as means to tame a "wild" landscape. Early explorers, miners, bureaucrats and settlers understood water was a key ingredient in settlement of the arid

west, imperative for sustained development. Conflicts over the use of this limited resource would inevitably ensue—and certainly did in the gold fields of California where miners claimed the rights to remove and use water to sluice their gold. So the doctrine of prior appropriation was developed, giving each user a chance to claim water based on whether they were **senior rights holder** or **junior rights holder** to the rest of the rights holders.

The Public Water Code requires that Arizonans apply for a permit to use surface water and in that permit they demonstrate that they will use the water for a "**beneficial use**" including: domestic water use (household use, landscape or garden irrigation of no more than one half-acre), recharge, stockwatering, irrigation, mining, municipal use, and for wildlife including fish. The Arizona Department of Water Resources (ADWR) manages surface water permits. Beneficial use allows regulators to sort out who has priority—of two people making a claim at the same time, the person who harnesses the river first for "beneficial" use therefore gets the higher priority. This policy has the effect of encouraging the rapid development and use of all available surface water and occasional over-appropriation of the water.

Lastly, with the growing importance of naturally flowing streams, a new water right has appeared in public debate and law. **Instream flow rights** are surface water rights that remain "in-stream," meaning that water is not physically diverted or consumptively used. Instead, that water right is maintained for the flow of water necessary to preserve wildlife, including fish and for recreation. So far, fewer than 20 permits for instream flow rights have been issued by the Arizona Department of Water Resources—a testament to the difficulty in securing these rights when water is so scarce.

Technology: Canals, Dams and Pumps

A key issue, however, with harnessing water is the ability to move it to where you need it, when you need it. This is where dams, irrigation canals, and even Central Arizona Project come in. Engineered water infrastructures are expensive to build and usually complex to maintain without common effort on the part of individuals or communities.

The first attempts to build irrigation canals began with the Hohokam culture at least 4,000 years ago in what is now eastern Pima County, Pinal, and southeastern Maricopa County. Spaniards in the late 17th century drew on their European experience and blended it with Native approaches to develop their own systems for channeling water from streams to community or private fields. The system of canals called *acequias* ran from a take-out point on the stream, around the community fields and back into the original waters from which it came. Spanish water law demanded that water be shared where needed and that users had obligations to deal equitably with thirsty neighbors.

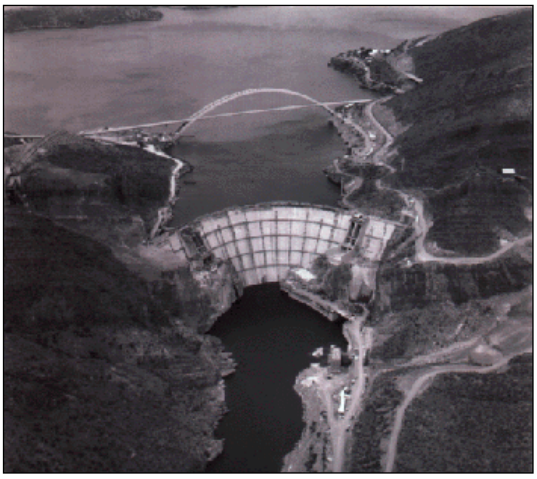


Figure 2. Roosevelt Dam on the Salt River was Arizona's first large-scale impoundment. Photo courtesy of SRP.

Other settlers of European-origin to the region set up more complicated irrigation districts. Most early attempts in the State of Arizona were by Mormon communities in places like St. Johns, Joseph City, or St. David. Communal efforts by these communities assured that irrigation ditches were maintained and water was shared equitably. By the late 19th century, large-scale irrigation districts were constructed in the Salt River Valley, the lower Gila River

THE COLORADO RIVER: LIFEBLOOD OF ARIZONA

The Colorado River is essential to our lives and livelihoods in Arizona. It is water supply to burgeoning cities, irrigation water for some of the best farmland in the U.S., electricity for many people, recreation for rafters, birders, hikers, fishers and hunters, and home to a diverse population of animals and plants. Almost all of Arizona is within the 242,000 square mile Colorado River watershed and it forms the western boundary of our state.

Overall the Colorado River Watershed covers seven states. In the Rocky Mountains of Colorado, the river starts as a trickle gathering force from tributaries and runoff as it flows over 1,400 miles before making it's way toward the Sea of Cortez. The river cuts through arid western lands some of which average less than 3 inches of rain annually.

Currently, there are 10 major dams and storage reservoirs in the watershed. The Morelos Diversion Dam located on the Mexico Arizona border is the southernmost dam on the Colorado serving agriculture in Mexico. These days, with all of the competing upstream uses combined with an on-going drought, the river rarely reaches the Sea of Cortez.

Water management on the Colorado River began with native peoples thousands of years ago, while the first large-scale diversion dam was built a full century ago for agriculture in Yuma. Back in 1922, an interstate compact divided the use of the Colorado River between Upper and Lower basins allocating 7.5 million acre-feet for each basin.

In 1928, the Boulder Canyon Project Act ratified the Colorado River compact, authorized construction of Hoover Dam and its power plant. The act also established the All American Canal and basic apportionments among Arizona, California, and Nevada. At the end of the line, Mexico had no legal right to Colorado River water until 1944 when a binational treaty was signed allocating annually 1.5 million acre feet to Mexico. It took 36 years until 1964 for the individual allocations of the lower basin states to be determined by U.S. Supreme Court Decree (California - 4.4 million acre feet, Arizona - 2.8 million acre feet and Nevada - 300,000 acre feet). Ironically, Glen Canyon Dam—one of the major lynch-pins for storing water for these states—had been approved and was completed one year before!

Valley, the Colorado River near Yuma, and along the Verde River. Funds for the construction and maintenance of these canal systems were generated by outside investors—mostly from the East, and by awarding local farmers who helped pay for them with a "share" of the water.

These early efforts generally failed because of structural failure during times of floods, a lack of sufficient financial investment, or unsound business practices. With the exception of the SRP, the Federal government—in the form of the Bureau of Reclamation eventually took over these efforts. Even in the case of SRP, the dam at the head of the canal system—Roosevelt Dam—was constructed by the Federal government.

In the fall of 1907 in Yuma, the Bureau of Reclamation began a massive re-building of the early canal system in order to irrigate thousands of acres of rich farmland on both sides of the Arizona-California border. The first large-scale dam of the Colorado River—the Laguna dam was constructed to store and distribute impounded waters of the state's biggest river.

Arizona has 439 dams (permanent, constructed diversions) according to the National Inventory of Dams. Conditions in the West favor the building of dams to regulate and distribute the flow of water. Since the region is generally dry, the limited resource must be managed. Dams for capturing and storing water were viewed as a partial solution to the problem. The dominant perspective for much of the 20th century was that without them the water would be wasted, flowing off and out of the reach of farmers, miners and others who could put it to good practical use.

Because the flow of all western rivers is seasonal, water resource management is best accomplished by controlling the river flow with dam building. Much of the annual flow of some of these rivers—often upwards of 40 percent or more—derives from spring snowmelt occurring in April, May and early June. In Arizona, many of our rivers are also dependent upon intense, variable summer precipitation. The water, however, is most needed during the irrigation season, from roughly mid-May through mid-September. Dams help even out supply for use during times of need.

As a result, in the West, where stream flow is seasonal, subject to drought, and water needs expanding, most rivers were dams waiting to happen.

Dams are such a common feature on Arizona rivers today that a river without a dam is renown for its absence. The San Pedro River is celebrated as the state's largest undammed or free-flowing river. In other cases, utilities, agencies, environmental advocacy groups, and communities are evaluating decommissioning, "notching", and removing dams when it is determined that they are no longer needed, are dangerous, or when stream restoration would serve another, higher purpose. One example is the removal of two Fossil Creek dams in the Verde River watershed.

Dugout stockponds are also common throughout Arizona, and were typically constructed in dry washes to capture and contain seasonal flow. Most of these are on Federal land, although their water rights and construction costs are associated with the individual using them. State Trust lands, Indian Reservations, and private lands are also frequent sites for stockponds. These usually fill with less than 15 acre feet of rainwater, snowmelt, or in a few cases, ground water. New stock ponds are not permitted except under special circumstances unless a rights holder can demonstrate that they existed in a location prior to August 27, 1977 when the Stock Pond Registration Act was passed.

The last, perhaps most important ingredient in Arizona's arsenal of water technology has been the ground water pump. The earliest models are the simple windmills that are still used today in remote locations with shallow depths to water. But the more effective wood-burning steam generators became more prevalent in the late 19th century. Later, ground water extraction became commonplace by the 1940s as cheap, oil or electrified pumping drew water from greater depths and with greater cost efficiency. Ground water extraction freed water seekers from the constraints of living near surface water, having to transport water over long distances, or battling over rights to access. Later, however, ground water pumping would prove to produce its own problems and conflicts.

Ground water Issues

Ground water pumping, however, comes with its own legal, environmental, and political challenges. Ground water currently supplies more than 7 million acre-feet across the state—about 40% of the total water demand. **Ground water overdraft** (removing more water than is replenished by natural or artificial means) is now common in agricultural and urban areas relying on ground water. This creates several problems.

- When water is pumped faster than it can be replenished, the water table drops in areas geologically susceptible, land **subsidence** happens. Aquifers which contain a high proportion of clay, which is typically in Arizona, are more susceptible to subsidence as the clay is squeezed and compacted as water is removed. Compacted clay is non-elastic, meaning that the compaction is permanent, and the capacity of the aquifer to store water is reduced. Subsidence of several feet have been reported in Arizona, and have resulted in damage to roads and foundations.
- As ground water is drawn down, wells need to be drilled deeper. This costs more energy—and more money—to pump water back to the surface. A related problem is that water quality may decrease with depth (several deep Arizona aquifers overlay layers of salt). With increasing depth of extraction, this

water then becomes more expensive to treat for human consumption.

- Ground water overdraft contributes to the loss of riparian habitat along Arizona's rivers and streams. As ground water is drawn down, stream base flow is decreased and riparian plant roots may not be able to reach the lower water table. Fish, amphibians, insects and other life that depend upon free-flowing streams have also disappeared as ground water overdraft has literally sucked the water out from their habitats.

Ground water Law & Policy

Ground water rights of access by permit may be held by individuals, communities, municipal water providers, or businesses. A well permit is required to install a well, and restrictions are placed on wells that are to pump more than 35 gallons per minute (gpm). Wells that are designed to pump less than 35 gpm are typically for domestic well use, and are exempt from permit constraints. Like surface water, ground water must be put to "reasonable use" according to Arizona law, however, outside of the Active Management Areas (AMAs) there is no legal mechanism by which to restrict or prohibit your neighbor from installing a well deeper than and adjacent to yours, and pumping the water table below your well intake.

In 1980, prompted by concerns over declining water tables aquifers in areas dependent upon ground water supplies, the state legislature passed the landmark Ground Water Management Act (GMA). This law established a framework for managing ground water, created the Arizona Department of Water Resources, and formed the State's five AMAs. The AMAs were established to provide long-term management and conservation of their limited ground water supplies within their defined jurisdictional areas. One of the key issues is getting the collective users of water to sustain the safe yield of the aquifer, by assuring that the volume of water withdrawn from the aquifer does not exceed the volume recharged by natural or artificial means The AMAs administer state laws, explore ways of augmenting water supplies to meet future needs, and routinely work to develop public policy in order to promote efficient use and an equitable allocation of available water supplies. These are the five AMAs:

- Tucson AMA is a mixed rural and urban area encompassing most of eastern Pima County, Avra Valley, Tucson and Green Valley. Until the arrival of the CAP canal, this area was one of the heaviest users of ground water due to population growth and agriculture. Water from the CAP is artificially recharged in the Avra Valley to offset ground water overdraft, and to assist in meeting safe yield.
- Phoenix AMA is an urban area encompassing most of the Phoenix metro area and into western Maricopa County. It is the fastest growing region of the state with the biggest water demands but also with more surface water resources than other AMAs. Artificial ground water recharge is also a significant component of the Phoenix AMA's efforts to meet safe yield.
- Pinal AMA covers an area of largely rural character where ground water overdraft to meet agricultural demand has caused large-scale land subsidence. Currently the AMA is experiencing rapid housing development and increased municipal water demand.
- Santa Cruz AMA is the second smallest AMA in the state covering the upper Santa Cruz River Valley, a largely rural area. This AMA was established to protect flows in the Santa Cruz River and deal with extraction of water in this border region.
- Prescott AMA is the smallest AMA and covers an area including Prescott, Prescott Valley, Chino Valley and several small communities. It is experiencing rapid housing development and increased municipal or private well water demand as well as moderate agricultural water use.

The GMA also requires that new housing developments in the AMAs comply with the **Assured Water Supply** program. In an AMA, every developer is required to demonstrate an assured water supply that

will be physically, legally, and continuously available for the next 100 years before the developer can record plats or sell parcels. The Arizona Department of Real Estate will not issue a public report, which allows the developer to sell lots, without a demonstration of an assured water supply. The developer must prove a 100 year supply by satisfying the requirements to obtain a Certificate of Assured Water Supply or by a written commitment of service from a water provider with a Designation of Assured Water Supply.

The Adequate Water Supply program, first created in 1973, operates outside of the Active Management Areas as a consumer protection program. Developers are required to obtain a determination from the Department concerning the quantity and quality of water available before the ADRE will allow any lot sales. If the application for a Water Adequacy Report successfully demonstrates that water of sufficient quality will be physically, legally, and continuously available for the next 100 years, then the Department will determine the water supply to be adequate. If the water supply is determined to be inadequate, the developer may still sell lots, but the inadequate determination must be disclosed to initial potential buyers in a public report. If the proposed subdivision will be served by a provider with a Designation of Adequate Water Supply, then the developer only has to provide a written commitment of service from the designated provider.

Arizona's ground water law and public policy poses a major problem: it does not yet officially acknowledge the connection between ground water and surface water. This means as water is pumped from aquifers, it may also impact surface water—and surface water rights—but the law cannot easily deal with this hydrologic fact. For example, a well drilled into the floodplain of a river will draw water that is considered ground water but under Arizona law it may be considered legally surface water. Under Arizona law, water drawn from the **Holocene alluvium** and adjacent to a river, is considered to be subflows of the river—therefore surface water, not ground water. Holocene alluvium is that portion of the river channel that is 8,000 years or younger, but because Holocene-aged alluvium cannot be measured or identified as anything other than an interpretive land form, the classification is currently under legal debate and will continue to be the basis of conflict across the AMAs.

WHO'S WHO: ARIZONA'S MAJOR WATER MANAGERS

Besides a galaxy of small and large water providers in towns, cities and counties across the state, Arizona has five major water managers.

Arizona Department of Water Resources (ADWR)

The Arizona Department of Water Resources manages the state's water and is the enforcement agency for issues relating to water rights.mission ranges from licensing well drillers, assuring the safety of dams, and developing mandatory conservation requirements for all water use sectors to protecting the state's Colorado River allocation and facilitating Indian water rights negotiations among tribal representatives, local interests, federal and state officials and members of Congress. A division of the department also assists the Central Arizona Project with banking Colorado River water in underground aquifers.

Figure 3. Zanjero or ditch guard in the Salt River Valley, circa 1900. Photo courtesy of SRP.

Arizona Department of Environmental Quality, Water Quality Division

The mission of the Water Quality Division is to protect and enhance public health and the environment by ensuring safe drinking water and reducing the impact of pollutants discharged to surface and ground water.

The agency works with a variety of partners in managing the quality of water resources within the natural boundaries of the state's watersheds. They regulate the discharge and treatment of wastewater as well as monitor the quality of surface and groundwater throughout the state. ADEQ staff identify water pollution problems and establish standards to address them. As a regulatory agency, the ADEQ also issues permits to protect Arizona waters from point sources of pollution and investigate complaints or violations of Arizona's water quality laws, rules and permits.

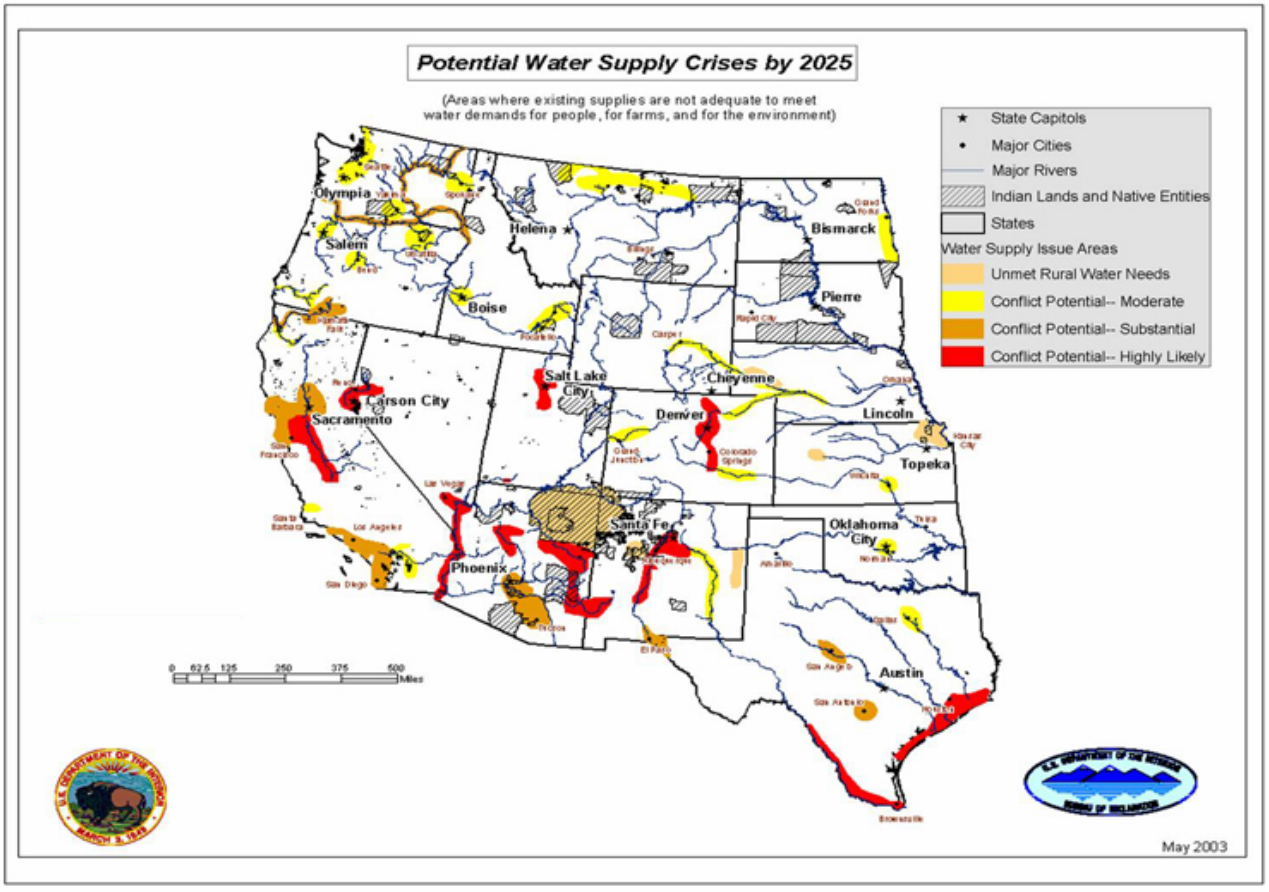
Salt River Project

The Salt River Project (SRP) has been delivering water to central Phoenix since 1903 and was the first multi-purpose federal reclamation project in the State. The SRP currently delivers more than 1 million acre-feet of water per year to its service area of 240,000 acres. The SRP also operates an electric utility as well as six dams, 260 water supply wells, 131 miles of canals and 2 major ground water recharge facilities (where surface water and effluent is used to percolate back into the aquifer).

Central Arizona Project

The Central Arizona Project (CAP) is an important addition to Arizona's renewable

Figure 4. Potential water supply crises in the western United States. Graphic courtesy of Bureau of Reclamation.



water supply. The CAP is designed to bring 1.5 million acre-feet of Arizona's 2.8 million acre-feet per year allocation from the Colorado River into central and southern Arizona. Deliveries to Phoenix began in 1985, and in Tucson in 1992. CAP also operates 5 recharge facilities, with two more under development. The CAP system interconnects with the SRP system, providing flexibility to water managers and providers in the Phoenix area. CAP has built and manages 5 recharge projects and expects 2 more to be operational by 2006.

Bureau of Reclamation

Established in 1902, the Bureau of Reclamation is best known for the dams, powerplants, and canals it constructed across the 17 western states in its mission to reclaim the arid west with engineered water resource management. These water projects led to homesteading and promoted the economic development of the West. Reclamation has constructed more than 600 dams and reservoirs including Hoover Dam on the Colorado River and Grand Coulee on the Columbia River. The Bureau of Reclamation, organizationally, is made up of five regions. Administratively, Arizona is part of the Lower Colorado Region. Local offices for that region are located in Phoenix, Yuma and Boulder City.

ARIZONA & REGIONAL WATER CONFLICTS

As Mark Twain wryly noted in the phrase quoted at the start of this chapter, water is often the source of conflict.

Early Conflicts

The first conflicts over water originated between neighbors—and usually in the context of old neighbors verses the new neighbors. Primary among these conflicts were for water rights between American Indian and transplanted European peoples. Indian people in many locations lost their water rights to the Europeans.

A good example of this was the conflict between upstream farmers on the upper and middle Gila River and the Gila River Indian Community. When growing non-Indian communities dependent upon farming and mining withdrew too much water from the river in the late 19th century, downstream Indian communities suffered starvation as their crops failed without irrigation water. Today, that conflict has been largely settled by the courts, Valley cities, as well as Arizona and Federal agencies.

It has taken decades for Indian people to reclaim water rights under treaties and from the courts—such as the now famous **Winters Rights Decision** of 1908. Also known as the **Winters Doctrine**, it declared that in establishing Indian reservations, the United States implicitly reserved enough water to fulfill the purposes of those reservations. The priority of those federal reserved water rights dates back to the establishment of the reservation, regardless of whether the water was actually put to beneficial use. But that court decision did not immediately produce water for most Indian tribes. To this day, some tribes such as the Navajo, San Carlos Apache, San Juan Southern Paiute and Gila River Indian Community are still in court or negotiating for quantification of their water rights allocations under the doctrine.

Fights over water also transformed into conflicts between sectors of the growing frontier, territorial, and early state economy. For example, ranchers and miners fought each other for control of streams that might be used for livestock watering for the former, and for mineral extraction by the latter. Even amongst themselves, farmers, ranchers, miners and homesteaders fought ferocious, often violet battles for control of water. Prolonged drought—a common occurrence in Arizona's variable climate—usually exacerbated these fights.

In 1864 and 1893, Arizona's territorial legislature stepped in and attempted to create a system for appropriating water rights—though it was largely unenforceable. It was not until the doctrine of prior appropriation was developed and regulated through the Arizona Public Water Code in 1919 that the fighting began to diminish.

Water in the Courts

Today, however water conflicts continue—only the battleground is now the courtroom. Water lawyers, judges and special water masters, and agency personnel now argue over who gets how much water.

Perhaps the single most significant court case over water has been *Arizona vs. California*. The dispute began in 1922, when rapidly growing California looked to the Colorado River as a source of water to supply its growing nearby cities including Los Angeles and San Diego. The seven states within the Colorado River basin (Wyoming, Colorado, Utah, New Mexico, Nevada, California and Arizona) negotiated a complicated compact to divide up the river's water. By 1923, all of the basin states except Arizona had ratified the compact.

Five years later, Congress approved the Boulder Canyon Project Act and the 1922 Compact, putting in motion the largest dam building project in the world. By 1934, the Boulder Dam rose from the bottom of Boulder Canyon to exert control on the Colorado.

Later, in 1930, Arizona chose instead to fight it out and asked the U.S. Supreme Court to block implementation of the Boulder Canyon Project Act. The high court refused. By 1939, the Metropolitan Water District of Southern California (MWD) had constructed a 242-mile long aqueduct to deliver Colorado River water to Los Angeles and the Bureau of Reclamation had constructed canals into California's Imperial Valley.

By 1944, forced into talks with Mexico and the federal government over the last of the Colorado River water, the Arizona legislature ratified the Compact on the condition that the state would receive federal assistance in constructing what would become the Central Arizona Project canal system. However, the state still refused to back down from its dispute with California, and California was using more than 4.4 maf, capturing and transporting the unclaimed, surplus portion of Arizona's and Nevada's water because insufficient infrastructure was available prior to the construction of CAP.

Arizona would not resolve its differences with California until 1963, when the Supreme Court held that Arizona would be apportioned 2.8 maf and California would receive 4.4 maf of river water. The dispute continued, with California asserting their reliance on the surplus water translated to a prior right to the water, until October, 2003, when the courts finalized California's right to 4.4 maf, and no more. Lasting over four decades, this dispute is truly the "case of the century."

Today, water remains a hot topic in the courts. Due to the need to deal with myriad competing claims, the Superior Court of Arizona has jurisdiction for two **adjudications**—the Gila River (with 26,500 litigants) and the Little Colorado River (with 3,211 litigants). These adjudications attempt to settle claims made by multiple parties to the same surface water. The process is obviously complicated by uncertain hydrology and competing economic interests.

WATER LAW MEETS ARIZONA'S HYDROLOGY

Water law in the state of Arizona has many implications for the sustainability of water resources. Water law essentially defines the resource itself and can determine the ultimate end use of that resource by people. Law—like water itself—is fluid and can be changed through court decisions, legislation, and agency rulings. The social and environmental impacts of these changes must always be considered when analyzing water law.

Many streams across Arizona are dependent on shallow ground water, and the stream base flow is maintained at an elevation equal to the shallow water table elevation. If the water table falls below the base flow of the stream (or its sources), then the stream may stop flowing regularly. This loss of instream flow has occurred in many of Arizona's rivers, particularly those flowing through areas of heavy ground water pumping such as farming regions and urban areas.

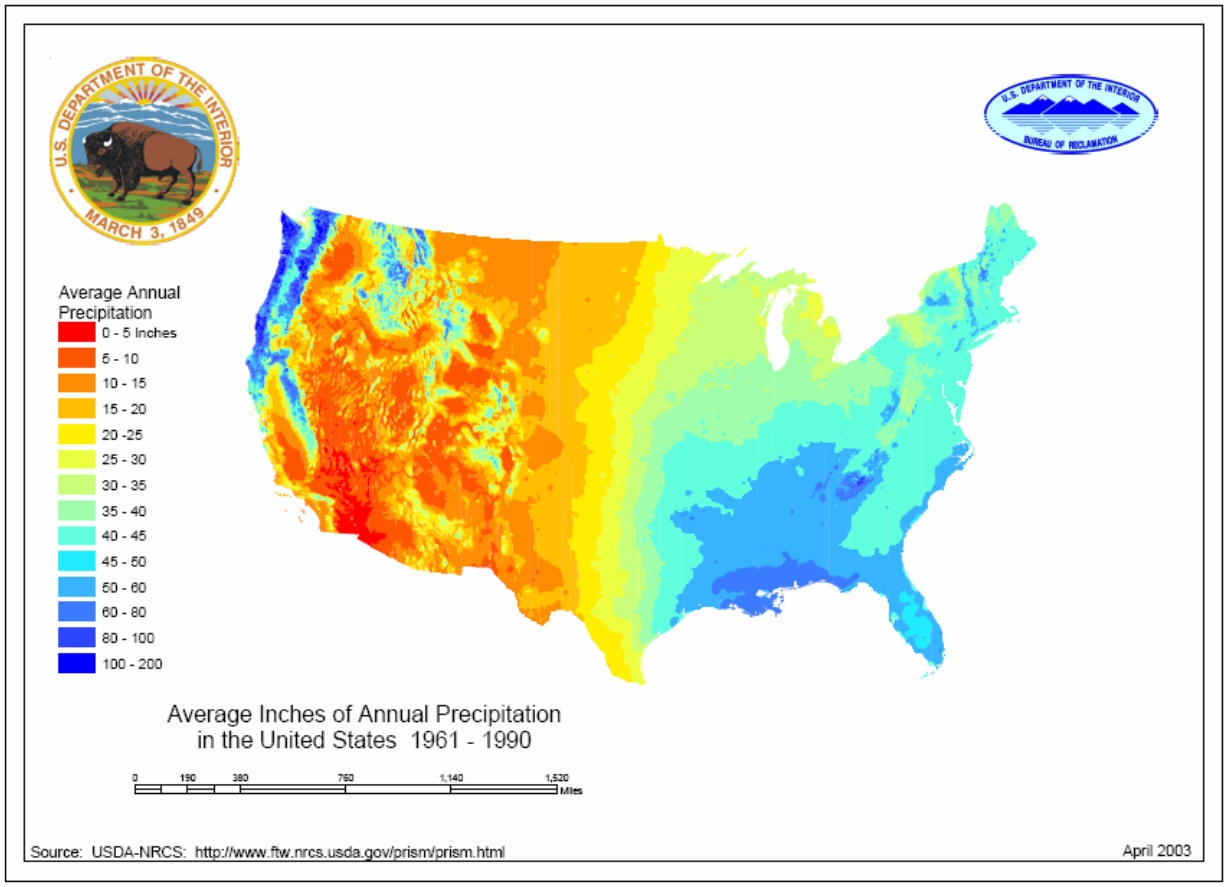


Figure 5. Average Annual Precipitation in the United States. Graphic courtesy of Bureau of Reclamation.

In Arizona, the legal difference between ground and surface water has contributed to conflict allowing ground water users pump from the recharge areas of gaining streams, leading to the drop in water tables and the loss of regular instream flow. This is because the state's water law does not always make a clear connection between ground and surface water resources. Instead, it is often open to interpretation in the courts. Presently, state court cases are determining if this legal difference can hold in the face of declining water tables and the loss of critical instream flows in the San Pedro and Gila rivers.

Another area of critical legal concern is to define whether water always is flowing just below the surface of the river unless the river is flowing on stainless steel or other impermeable material. Water is flowing just beneath the surface in what is termed the **subflow** or if it can be considered ground water. When water is pumped or drawn from these subflows, the court has determined that in some cases, it can be considered surface water, even though it has been drawn from beneath the ground. The key is to legally define these subflows and to differentiate them from ground water. At present, the court defines subflow as water found within the saturated **Holocene alluvium** along the channel of the stream. ADWR is currently evaluating the administration of the subflow zone.

Despite these clashing legal and hydrologic realities, water conflicts have been around and will continue to be here for Arizonans. We can also expect these conflicts to continue as long as water is scarce in western North America. Two things guarantee the perpetuity of water conflict as well as endless schemes to manage it—its scarcity and our thirst.

TAKING ACTION: WATER CONSERVATION

Arizona is the second fastest growing state in the U.S. after Nevada, and is a major region of the growth that the arid southwest has experienced in the last 50 years and Phoenix competes with Las Vegas for the fastest growing city in the country. At the same time, Arizona sits in the heart of the driest region in the country and depends upon over-allocated ground water and surface water (see Figure 5). Between climate variability, aridity, and endless demands, Arizonans find themselves in a bind (see Figure 4). It may seem like a hopeless situation, yet there is one thing we can do—**conserve water and teach others to conserve too**.

How? If you think about it, water conservation is relatively simple: it means paying attention to every water use we control and taking action to reduce any wasteful use.

Make an inventory of your water uses. Here are some of the most common ones:

- Water for drinking
- Water for cooking
- Water for cleaning our homes
- Water for washing dishes
- Water for landscaping or gardens
- Water for industrial processes like cooling or cleaning.

Then, take action! Here are some 98 suggestions for conserving water, courtesy of the "Water. Use It Wisely" campaign:

1. There are a number of ways to save water, and they all start with you.

2. When washing dishes by hand, don't let the water run while rinsing. Fill one sink with wash water and the other with rinse water.

3. Evaporative coolers require a seasonal maintenance checkup. Check your evaporative cooler annually and repair/maintain as appropriate.

4. Check your sprinkler system frequently and adjust sprinklers so only your lawn is watered and not the house, sidewalk, or street.

5. Run your washing machine and dishwasher only when they are full and you could save as much as 1,000 gallons a month.

6. Avoid planting turf in areas that are hard to water such as steep inclines and isolated strips along sidewalks and driveways.

7. Install covers on pools and spas to avoid water evaporation.

8. Use the garbage disposal less often.

9. Plant during the spring or fall when the watering requirements are lower.

10. Keep a pitcher of water in the refrigerator instead of running the tap for cold drinks.

11. Check your water meter and bill to track your water usage.

12. Always water during the early morning hours, when temperatures are cooler, to minimize evaporation.

13. Wash your produce in the sink or a pan that is partially filled with water instead of running water from the tap.

14. Use a layer of organic mulch around plants to reduce evaporation, promote plant growth, and reduce weeds.

15. Use a broom instead of a hose to clean your driveway and sidewalk and save up to 80 gallons of water every time.

16. If your shower head can fill a one-gallon bucket in less than 20 seconds, then replace it with a water-efficient shower head.

17. Reuse the water that you washed produce in for watering house plants or for cleaning.

18. Water your lawn in several short sessions rather than one long one. This will allow the water to be better absorbed.

19. We're more likely to notice leaky faucets indoors, but don't forget to check outdoor faucets, pipes, and hoses for leaks.

20. Periodically check your pool for leaks if you have an automatic refilling device.

21. Only water your lawn when needed. You can tell this by simply walking across your lawn. If you leave footprints, it's time to water.

22. When you shop for a new appliance, keep in mind that one offering several different cycles will be more water and energy-efficient.

23. Time your shower to keep it under 5 minutes. You'll save up to 1,000 gallons a month.

24. Install low-volume toilets.

25. Adjust your lawn mower to a higher setting. Longer grass will reduce the loss of water to evaporation.

26. When you clean your fish tank, use the water you've drained on your plants. The water is rich in nitrogen and phosphorus, providing you with a free and effective fertilizer.

27. Water small areas of grass by hand to avoid waste.

28. Put food coloring in your toilet tank. If it seeps into the bowl, you have a leak. It's easy to fix, and can save more than 600 gallons a month.

29. Plug the bathtub before turning the water on, then adjust the temperature as the tub fills up.

30. Use porous materials for walkways and patios to keep water in your yard and prevent wasteful runoff.

31. Collect and use rain water for watering your garden. (Check to make sure this is legal in your area.)

32. Designate one glass for your drinking water each day. This will cut down on the number of times you run your dishwasher.

33. Instead of using a hose or a sink to get rid of paints, motor oil, and pesticides, dispose of them properly by recycling or sending them to a hazardous waste site.

34. Install a rain shut-off device on your automatic sprinklers to eliminate unnecessary watering.

35. Don't use running water to thaw food.

36. Choose a water-efficient drip irrigation for your trees, shrubs, and flowers.

37. Grab a wrench and fix that leaky faucet. It's simple, inexpensive, and can save 140 gallons a week.

38. Cut back on the amount of grass in your yard by planting shrubs and ground cover or landscaping with rock.

39. When doing laundry, match the water level to the size of the load.

40. Teach your children to turn the faucets off tightly after each use.

41. Remember to check your sprinkler system valves periodically for leaks and keep the heads in good shape.

42. Before you lather up, install a low-flow showerhead. They're inexpensive, easy to install, and can save your family more than 500 gallons a week.

43. Soak your pots and pans instead of letting the water run while you scrape them clean.

44. Don't water your lawn on windy days.

45. Water deeply but less frequently to create healthier and stronger landscapes.

46. Make sure you know where your master water shut-off valve is located. This could save gallons of water and damage to your home if a pipe were to burst.

47. When watering grass on steep slopes, use a soaker hose to prevent wasteful runoff.

48. To get the most from your watering time, group your plants according to their water needs.

49. Remember to weed your lawn and garden regularly. Weeds compete with other plants for nutrients, light, and water.

50. While fertilizers promote plant growth, they also increase water consumption. Apply the minimum amount of fertilizer needed.

51. Avoid installing ornamental water features unless the water is being recycled.

52. Use a commercial car wash that recycles water.

53. Don't buy recreational water toys that require a constant flow of water.

54. Turn off the water while you brush your teeth and save 4 gallons a minute. That's 200 gallons each week for a family of four.

55. Buy a rain gauge to track how much rain or irrigation your yard receives.

56. Encourage your school system and local government to help develop and promote a water conservation ethic among children and adults. Visit the Project W.E.T. website for more information: http://www.ag.arizona.edu/AZWATER/wet/index.html

57. Teach your family how to shut off your automatic watering systems so anyone who is home can turn sprinklers off when a storm is approaching.

58. Set a kitchen timer when watering your lawn by sprinkler or hose.

59. Make sure your toilet flapper doesn't stick open after flushing.

60. Make sure there are aerators on all of your faucets.

61. Next time you add or replace a flower or shrub, choose a low water use plant and save up to 550 gallons each year.

62. Install an instant water heater on your kitchen sink so you don't have to let the water run while it heats up. This will also reduce heating costs for your household.

63. Use a grease pencil to mark the water level of your pool at the skimmer. Check the mark 24 hours later. Your pool should lose no more than 1/4 inch each day.

64. Spot spray or remove weeds as they appear.

65. Use a screwdriver as a soil probe to test soil moisture.

66. Install a drip irrigation system around your trees and shrubs to water more efficiently.

67. Mow your lawn as infrequently as possible. Mowing puts your lawn under additional stress, causing it to require more water.

68. Don't use the sprinklers just to cool off or for play. Running through water from a hose or sprinkler wastes gallons of water.

69. Make sure your swimming pools, fountains, and ponds are equipped with recirculating pumps.

70. Bathe your young children together.

71. Direct downspouts or gutters toward shrubs or trees.
72. Winterize outdoor spigots to avoid pipes from bursting or freezing.

73. Insulate hot water pipes so you don't have to run as much water to get hot water to the faucet.

74. Drop that tissue in the trash instead of flushing it and save gallons every time.

75. If you have an evaporative air conditioner, direct the water drain to a flower bed, tree, or your lawn.

76. Make suggestions to your employer to save water (and dollars) at work.

77. Use a hose nozzle and turn off the water while you wash your car to save more than 100 gallons.

78. Support projects that use reclaimed waste water for irrigation and other uses.

79. Encourage your friends and neighbors to be part of a water-conscious community.

80. Install a toilet dam or bottle filled with water in your toilet tank to cut down on the amount of water used for each flush (do not use clay bricks). Be sure these devices do not interfere with operating parts.

81. Install water softening systems only when necessary. Save water and salt by running the minimum number of regenerations necessary to maintain water softness.

82. Turn your water softeners off while you're on vacation.

83. Prune back heavy foliage. Reducing leaf area reduces water needs.

84. Report all significant water losses (broken pipes, open hydrants, errant sprinklers, abandoned free-flowing wells, etc.) to the property owner, local authorities, or your water management district.

85. If your grass is brown, it's not dead, it's just dormant. Dormant grass only needs to be watered every three weeks. When the rain begins, your grass will turn green again.

86. Start a compost pile. Using compost when you plant adds water-holding organic matter to the soil.

87. Listen for dripping faucets and toilets that flush themselves. Fixing a leak can save 500 gallons each month.

88. Use sprinklers that throw big drops of water close to the ground. Smaller drops of water and mist often evaporate before they hit the ground.

89. More plants die from over-watering than from under-watering. Be sure only to water plants when necessary.

90. Adjust your watering schedule to the season. Water your summer lawn every third day and your winter lawn every fifth day.

91. Cook food in as little water as possible. This will also retain more of the nutrients.

92. If it takes you more than a few minutes to shampoo and condition your hair, turn off the faucet while you work each in, then back on to rinse.

93. Bathe your pets outdoors in an area in need of water.

94. Choose new water-saving appliances, like washing machines that save up to 20 gallons per load.

95. Water only as rapidly as the soil can absorb the water.

96. Aerate your lawn. Punch holes in your lawn about six inches apart so water will reach the roots rather than run off the surface.

97. Select the proper size pans for cooking. Large pans require more cooking water than may be necessary.

98. Teach others about water conservation.

WORDS TO KNOW

Active Management Area (AMA) – Jurisdictional areas designated by the 1980 Ground water Management Act where ground water overdraft is most severe. In these areas, ADWR administers programs to reach aquifer safe yield, encourage conservation, and provide protection of ground water supplies.

Adjudication – Refers to a judicial process whereby water rights are determined or decreed by a court of law.

Aquifer – An underground bed or layer of earth, gravel, or porous stone that yields water.

Assured water supply – A permitting process whereby anyone who offers subdivided or unsubdivided land for sale or lease in an AMA must demonstrate an assured supply of water over 100 years to

ADWR before the land may be marketed to the public.

Beneficial use – A use of water that is deemed by Arizona to be beneficial to the health, safety and welfare of the people of the State. Beneficial uses include: domestic, irrigation, mining, stockwatering, municipal, and wildlife.

CAP – Central Arizona Project was designed to deliver 1.8 million acre feet of Colorado River water to cities, industries, agricultural users and Native American communities in Maricopa, Pima and Pinal counties.

Common pool resource – A resource that is held in common by a group of people and that cannot be easily divided due to expense, need or physical condition.

Doctrine of prior appropriation – A concept in water law under which the first person to take a quantity of water an put it to beneficial use has a higher priority than subsequent users. “First in time, first in right.”

Gaining stream – A stream or reach of a stream, the flow of which is being increased by the inflow of ground water seepage or from springs in, or alongside the channel.

Ground water overdraft – Removing more water from an aquifer than can be naturally or artificially recharged.

Holocene alluvium – Fluvial sediments deposited within the past 8,000 years in or adjacent to a stream channel. The geographic extent of Holocene alluvium is interpreted based on land form features, such as the flood plain, adjacent to the stream channel.

Instream flow rights – Water that is maintained in the stream and assigned a water right by permit from the ADWR, typically to meet riparian water needs or to address the water needs of threatened or endangered species.

Junior water right holder – A person or entity holding a water right that is of lower priority than previous right holders. In times of shortage, Senior water right holders may use their allocation prior to allowing diversion of water to the Junior rights, even to the extent that no water remains for the Junior right holders.

Municipal and Industrial (M and I) – Water used for distribution to households, community uses, and businesses by a municipal water provider.

Overdraft – A condition resulting from removing more water from a source than is being replenished back into that source.

Recharge – the process of storing water in depleted aquifers for future use.

Senior water right holder – A person or entity holding a water right that is of higher priority than subsequent right holders.

Subflow – See subsurface flow.

Subsidence – The sinking of the land surface due to extraction of ground water in clay-rich alluvial aquifers.

Subsurface flow – The saturated zone beneath the stream channel, in hydraulic communication with ground water. In Arizona streams, sub surface flow is as important as surface flow in maintaining base flow.

Water budget – An account of inflows to and outflows from, as well as storage of a hydrologic system.

Winters Doctrine – The result of a 1908 ruling by the U.S. Supreme Court that prohibits any non-Indians from interfering with Indian tribes’ use of their reserved water.

Water right – The legal right or permit to use a specific quantity of water, on a specific time schedule, at a specific place, and for a specific purpose.

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RESOURCES

Arizona Department of Water Resources: http://www.water.az.gov/adwr/

Arizona Department of Environmental Quality: http://www.azdeq.gov/

Arizona Water Resources Research Center: http://cals.arizona.edu/azwater/

Central Arizona Project: http://www.cap-az.com

Salt River Project: http://www.srpnet.com/menu/waterres.aspx

Bureau of Reclamation: http://www.usbr.gov/

Global Water News Watch: http://www.sahra.arizona.edu/newswatch/

Arizona Municipal Water Users Association: http://www.amwua.org/index.html