

WATERSHED BASICS

PART I: WATER RESOURCES

By Kim McReynolds, Susan Pater, & Kristine Uhlman

"We forget that the water cycle and the life cycle are one." –Jacques Cousteau

WHY IS WATER IMPORTANT?

The presence of liquid water makes our planet unique in the solar system. A water molecule is comprised of three atoms: two hydrogen (H) atoms and one oxygen (O) atom. The formula for water is H₂O. Water is essential to all forms of life.

Consumption of water is essential for humans, plants and animals. Water serves humans in many ways; the growing and preparation of food, cleansing, disposal of waste, transportation, power and recreation. It regulates the earth's temperature and the temperature of the human body.

Water, like all commodities, seems to have four descriptive attributes. Generally, these include:

- ☂ Quantity—the amount of water available for humans and the environment.
- ☂ Quality—the physical, biologically or chemically-influenced usefulness of water for different purposes.
- ☂ Timing—including floods and low flows.
- ☂ Location—moving water to where we need it or storing it in a strategic location.

In Arizona, where natural precipitation is generally scarce, water has influenced the distribution, types, and population of plants, animals and humans. As growth has increased, Arizonans have drilled wells to access ground water, built dams and reservoirs to store water, reduce flood damage, and to produce energy, and constructed canals to move water to fields and cities. For at least the last 4,000 years, people living in what is now Arizona have been actively manipulating the quantity, quality, timing and location of water.

In this section you will learn:

- ❖ About the properties of water and how it is cycled through the planet.
- ❖ How water is distributed globally and in Arizona.
- ❖ Why water quantity and quality are so important.
- ❖ How to define a watershed.
- ❖ Why watershed vegetation and soils are important to water quantity and quality.

UNIQUE PROPERTIES OF WATER

The temperatures and pressures found at the earth surface allow water to exist in its three states; solid, liquid, or gas. Examples of water in the solid state are ice caps and glaciers. Freshwater lakes, salt water lakes, rivers, oceans, soil moisture and ground water are in the liquid state. Water in the earth's atmosphere is in the gaseous state.

Water has some unique physical properties when compared to other substances. Some of these include:

- ☂ Water has the ability to remain liquid over a wide range of temperatures.
- ☂ Water is a universal solvent and can dissolve and transport many substances. This property enables plants to carry nutrients up through their roots.
- ☂ Water can absorb a large amount of heat before changing temperature or state. This property helps us maintain a constant body temperature and also gives many coastal areas moderate **climates**. Water also transports heat such as from land to air or from oceans to continents.
- ☂ Water is transparent. This allows

photosynthesis (a product of which is oxygen) to occur in surface water bodies. About one-sixth of all photosynthesis on earth occurs in the oceans.

☂ Water density is unique. Water is most dense at 4°C (39°F) and becomes less dense at temperatures both above and below 4°C. This is the reason ice floats on water and why lakes do not freeze from the bottom to the top in winter. It is also the reason why lakes in colder climates will often “turn over” during different seasons.

THE DISTRIBUTION OF WATER ON EARTH

Water covers 71 percent of the earth’s surface. It constitutes 50-70 percent of the weight of all plants and animals, including humans. Surface water makes up the vast majority of the earth’s water. Most of that however, is not available to us because it is salty.

The majority of the earth’s water supply (97.2%) is found in the oceans (Figure 1). Ice caps and glaciers store the next largest amount of water (2.15%). The ground water supply is 0.626%, while freshwater lakes and rivers hold 0.0091% of the earth’s water supply. The remaining amount of water is found in inland seas, salt lakes, soil moisture and atmospheric water (0.0149%). Ground water and fresh water make up the available usable supply. Although it is possible to desalinate ocean water, it is very costly. If the world’s water supply were represented by 1 gallon, then our usable supply of fresh water would be only one drop.

Most of the water on the earth is recycled. Essentially the same amount of water exists now as when the dinosaurs roamed the earth. However, the amount in usable liquid form is decreasing due to pollution and ground water “mining” in some areas.

ARIZONA’S REGIONAL WATER DISTRIBUTION

The distribution of the earth’s water is quite uneven. Some regions receive a great deal of precipitation each year, while other regions remain very dry. Location, elevation, proximity to major land forms (i.e. mountain ranges) and oceans or major lakes, climate (movement of air

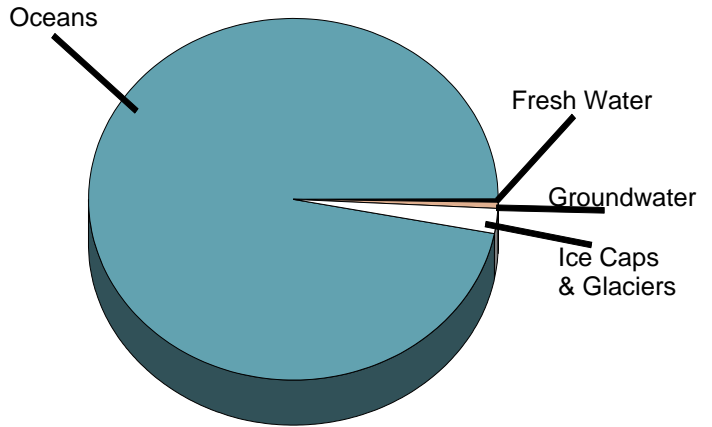


Figure 1. Distribution of Water on Earth.

masses and temperature), and other factors affect the amount of precipitation an area receives.

Geographic influences on climate can cause precipitation amounts to vary widely within relatively small distances. For example, the west slopes of the Sierra Nevada Mountain Range in California receive an estimated maximum of 80 inches of precipitation a year. To the east of the Sierra Nevada Mountain Range, the landscape turns into a desert, receiving less than 20 inches of rainfall on average. As clouds approach the mountains they begin to rise with increase in elevation of the mountains. As the air cools, the moisture in the clouds condenses into heavy drops or ice particles and falls as rain or snow on the western slopes of the mountains. After releasing the precipitation, the now dry storm continues east over the desert area. This phenomenon is called the **rain shadow** effect. The Rocky Mountains, Sierra Nevada mountains and most other north-south oriented mountain ranges provide a similar effect because of the rugged terrain. This effect is important for Arizona by blocking moist airflow over the region and keeping it relatively dry.

Much of the surface water in Arizona is generally distributed by rivers that bring water from the highlands on or above the Mogollon Rim, the Colorado Plateau, the Kaibab Plateau, and the White Mountains. The elevation of these highlands encourages greater rain and snowfall which then makes its way into streams and rivers that flow downhill into the deserts of

central and southern Arizona. All of these streams eventually make it into the Colorado River, the other major source of Arizona's water. The Colorado takes the majority of its water from rivers flowing down the slopes and foothills of the Rocky Mountains. In parts of southern Arizona, important streams also originate in isolated, "sky-island" mountain ranges.

More ancient waters are found in the underground deposits called **aquifers**. Many of the deepest of these are located in the deserts of the central and southern parts of the state. These aquifers hold waters that may have been deposited during or shortly after the last ice-age, and are dated to be thousands of years old.

Some of these underground deposits of water are replenished by surface streams.

THE WATER CYCLE

The cyclic movement of water from the surface reservoirs—primarily the oceans—to air, to the earth in the form of rain and snow, and finally back to the ocean reservoir via streams and rivers is called the **water cycle** or **hydrologic cycle** (Figure 2). It changes from solid to liquid to gas, over and over again. The water cycle is one of the largest physical processes occurring on earth. The water cycle is mainly driven by solar radiation and the rotation of the earth.

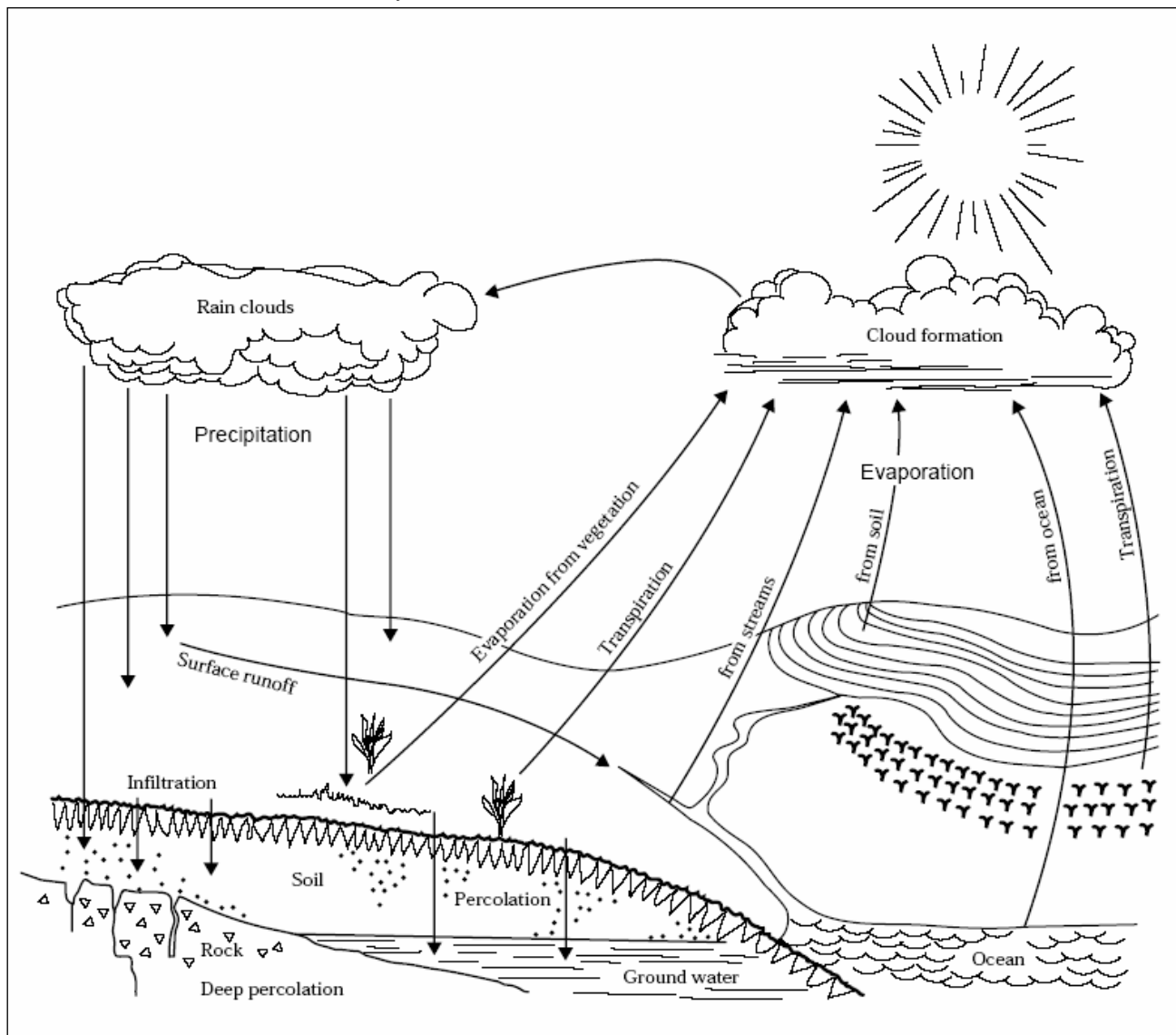


Figure 2. The water cycle. Graphic courtesy of the NRCS.

Water is seldom lost or added over time, however, the availability of the liquid form of water can vary greatly.

The basic steps in the water cycle are:

1. Solar energy (heat) transfers water from the earth's surface (oceans, lakes, rivers) to the atmosphere in the form of water **vapor** (gas).
2. Water vapor is created by **evaporation** (from bodies of water) and **transpiration** (from plants). Oceans create the most water vapor.
3. Water vapor, transported upwards by air masses, cools and condenses to form clouds. **Condensation** is the process by which water vapor is converted into precipitation.
4. Gravity causes **precipitation** to fall back to the earth in the form of rain, snow, sleet and hail.
5. Precipitation can follow several paths once it reaches the earth. It can be stored in ice, run off into streams and rivers, evaporate, or soak into the ground—the latter is a process called **infiltration**. Runoff occurs when precipitation flows toward a lower point on the earth's surface as a result of falling onto impermeable features such as parking lots or hard packed soils. Runoff also takes place when precipitation or snowmelt occurs faster than the ground can absorb it. Evaporation can take place before precipitation hits the ground or once it is on the surface. Some precipitation is absorbed by plants, stored, used, and transpired back into the atmosphere. Water that soaks into the ground and is not used by plants makes its way down to our aquifers, where **ground water** is stored. In Arizona's arid and semi-arid areas, only a small percentage of soil moisture reaches the aquifer.
6. **Runoff** makes its way toward the

oceans or inland basins (Great Salt Lake, the Great Basin, Willcox Playa) by way of rivers, streams, and washes.

7. Ground water moves slowly through the porous soil or cracks in bedrock. Ground water, like runoff, flows from a higher to lower elevation but geologic structure and formations also control its flow. Where the ground water table connects with the surface a stream or lake is formed, and evaporation can again take place. In streams, when ground water becomes surface water hydrologists call it **base flow**. Streams where ground water has been lowered below the level of the stream often lose this base flow. Unfortunately, Arizona is full of examples of this.
8. In addition to clouds, oceans, rivers, and valleys, living organisms are part of the water cycle. All living things need water to survive because it is essential to their bodily functions. Plants and animals take in water, use it to grow and reproduce, and return a large portion of it to the atmosphere as vapor by transpiring or breathing.

SURFACE WATER & GROUND WATER

In the coldest regions, water is stored for a long time as ice and hard-packed snow. But even ice and snow are in motion; the solid rivers of ice we call glaciers slowly melt as they move inch by inch. Icebergs break away from glaciers and float in the ocean, slowly melting as they float along the currents.

About 60 percent of all the water used in the United States in everyday life comes from surface water sources, such as rivers, streams, lakes, and reservoirs. The other 40 percent comes from ground water. It is only natural that we rely heavily on our surface water resources. After all, it is a lot easier and cheaper to get water out of a river than it is to drill a well and pump water out of the ground.

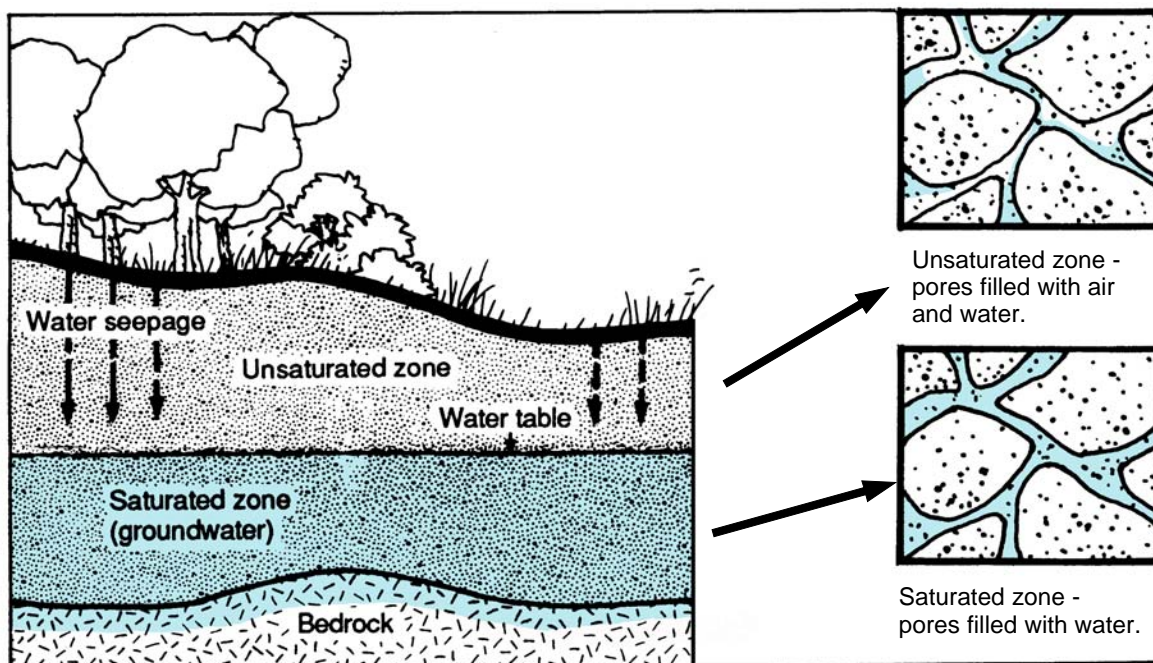


Figure 3. Ground water terminology. Graphic from Raymond 1992.

Ground water is an important water source for Arizona. It is often referred to as a stock resource—like coal, oil or minerals—because it cannot be quickly replaced. **Ground water** is water filled pores (spaces) or cracks in geological layers of sand, gravel and rock. This water-filled area is called the **saturated zone** (Figure 3). The largest source of the ground water supply is precipitation that has percolated down through the loose material at the base of mountains and in washes. The top of the saturated zone is called the **water table**. The water table rises and falls in depth depending on the amount of recharge received during the year and also seasonally (summer vs. winter precipitation).

The water table depth also responds to the amount of water used by people drawing on it and can be drawn down by excessive pumping. The zone between the water table and the land surface where the pores are only partially filled with water is called the **unsaturated** or **vadose zone**. This zone does not contain enough water to provide water for wells. The water-bearing soil or rock that is capable of yielding usable amounts of water is called an **aquifer**. Confined or artesian aquifers occur where ground water becomes trapped under impermeable (unable to transmit water) soil or rock and may be under pressure. Unconfined or water table aquifers

are not confined under pressure.

This trickle-down infiltration and recharge process for ground water takes time; deep ground water may require hundreds or thousands of years to be replenished. In many areas, the rate at which ground water is able to replenish itself cannot keep pace with the rate at which it is being used, a situation known as overdraft. Most of the ground water used in Arizona is not replenished, so it is generally not considered a renewable resource.

WATER QUANTITY & QUALITY

Whether our water supplies come from ground water (as does half of the drinking water in the United States) or from lakes, streams, reservoirs, or other surface water sources, using too much water too fast or contaminating water sources can cause problems for people and wildlife.

Water use can be either consumptive or non-consumptive. **Consumptive water use** means that the water used is no longer available because it has been evaporated, transpired by plants, incorporated into products or crops, consumed by people or animals, or otherwise removed from water supplies. **Non-consumptive water use** includes water

withdrawn for use that is not consumed, evaporated or transpired. For example, water withdrawn for the purpose of hydropower generation is a non-consumptive use although water used to cool power generating facilities is consumed because it is evaporated. Boating and fishing are also considered non-consumptive uses because water is still available for other uses at the same site.

Consumptive use of water is a growing concern in Arizona. The demand for potable water is increasing as supplies decrease. Conservation is one partial solution. For example, by installing a water-saving shower head, each person could save 5,000 gallons a year! Improved efficiency in irrigating crops can also result in saving large amounts of water, since over 80% of the state's consumptive use goes to agriculture.

Whether or not water is considered good quality, depends upon the use. For example, drinking water standards are more restrictive than standards for water used to cool nuclear reactor operations or for irrigation of golf courses.

Three major factors are considered when assessing water quality. They are: 1) Physical; 2) Chemical; and 3) Biological.

Physical factors include temperature, dissolved gases, density, turbidity and color, and mechanical properties such as viscosity, surface tension, and floating and suspended materials. Many of these factors are cross-influential, with temperature affecting almost all of them. For example, temperature affects density, dissolved gas capacity, viscosity, and pH, as well as chemical and biological factors.

Chemical factors include all of the dissolved chemicals that are in the water (metals leached from mining operations, volatile organic chemicals from nearby industry, or chemicals from animal and plant wastes). The chemical

characteristics of rocks surrounding water will influence it. Examples of this include alkaline springs, water high in calcium carbonate originating from limestone formations, and acidic waters from sulfide-rich soils.

Biological factors refer to the types of aquatic organisms found in the water. This includes whether or not harmful bacteria and other microorganisms are present and in what amounts, and which insects, plants and fish species are present (species diversity).

Pollution of water takes place from either point or non-point sources. A **point source pollutant** is one that can easily be traced to a single origin of the pollutant and is regulated by government agencies. An example is a factory dumping waste water into a river. Much of this kind of pollution has been regulated as a result of the Clean Water Act passed by Congress in 1972.

Much of today's major water pollution occurs because of runoff from **nonpoint sources** such as city streets, parking lots, farms, forests, abandoned mines, and rangelands. Pollutants in runoff can include sediment; pesticides from agriculture, lawns, parks, and golf courses; and oil, grease, salt and chemicals from urban sources. Non-point source pollution affects both surface and ground water and is far harder to control than point source pollution simply because the origin of the pollutants cannot be easily pinpointed and the responsible party cannot be found.

The key to water quality management is pollution prevention. The cost associated with cleaning up polluted water sources is extremely high. Disposing of used motor oil in a proper way instead of pouring it down the sewer or on the land is one example of prevention.

PART II: HYDROLOGY & WATERSHEDS



By Susan Pater, Kim McReynolds, & Robert Emanuel

WHAT IS A WATERSHED?

A watershed is the land that water flows across, through, or under on its way to a stream, river, lake or closed basin. It is usually defined by a topographical boundary around the elevational high points surrounding a common point where water collects into a channel. The movement of water is greatly influenced by the contour of land and geologic features such as mountains, valleys and hills. A watershed may consist of uplands, floodplains and a stream channel. Uplands often comprise more than 99% of the watershed's area, with the floodplain and stream channel making up the remaining 1%.

Watersheds exist at different scales or levels. Large watersheds like the ones for the Colorado River, Mississippi River, Columbia River, and Chesapeake Bay are made up of many smaller watersheds across several states. Watersheds come in many different shapes and sizes and have many different features. Watersheds can have hills or mountains or be nearly flat. They may include farmland, rangeland, small towns, and big cities. Watersheds exist at different scales, depending on the point of reference. If the Colorado River is that point of reference then almost the entire state of Arizona exists within a single watershed. This is because almost all of Arizona's land eventually drains to the Colorado River. The only exceptions in Arizona are certain areas draining through Mexico into the Gulf of California, and a few closed basins such as the Willcox Playa.

There are approximately 2 million miles of perennial rivers and streams in the United States, all of which contribute to one of seven major drainage systems (Figure 4).

The **Atlantic Ocean** receives water from New England and Mid-Atlantic states east of the Appalachian Mountains. The **Gulf of Mexico** is the ultimate drainage for more land mass in the United States than any other body of water. The

WATERSHEDS DEFINED

In 44 words

"The entire region drained by a waterway that drains into a lake or reservoir; total area above a given point on a stream that contributes water to the flow at that point; the topographic dividing line from which surface streams flow into two different directions."

-Congressional Research Service Report

In 22 words

"The line separating the waters flowing into different rivers or river basins; a narrow elevated tract of ground between two drainage areas."

-Oxford English Dictionary

In 20 words

"A geographic area of land bounded by topographic features and height of land that drains waters to a shared destination."

-Canada Department of Fisheries and Oceans

In 19 words

"The components of river basins that define drainage areas for these surface waters as they combine to one river."

-North Carolina Watershed Council

In 12 words

"A land area that when it rains it leaks into a creek"

-Allen Creek Elementary 4th grader

In 11 words

"A host of ecosystems in a wide array of developmental stages."

-California Watershed Information Technical Systems

In 9 words

"Everything dead or alive between two or more mountains."

-Forks Elementary 4th grader

In 8 words

"The whole gathering ground of a river system."

-Oxford English Dictionary

In 4 words

"A complete topographic unit."

-Taiwan Forestry Research Institute

(Adapted from Watersheds of Snohomish County, WA, 2003)

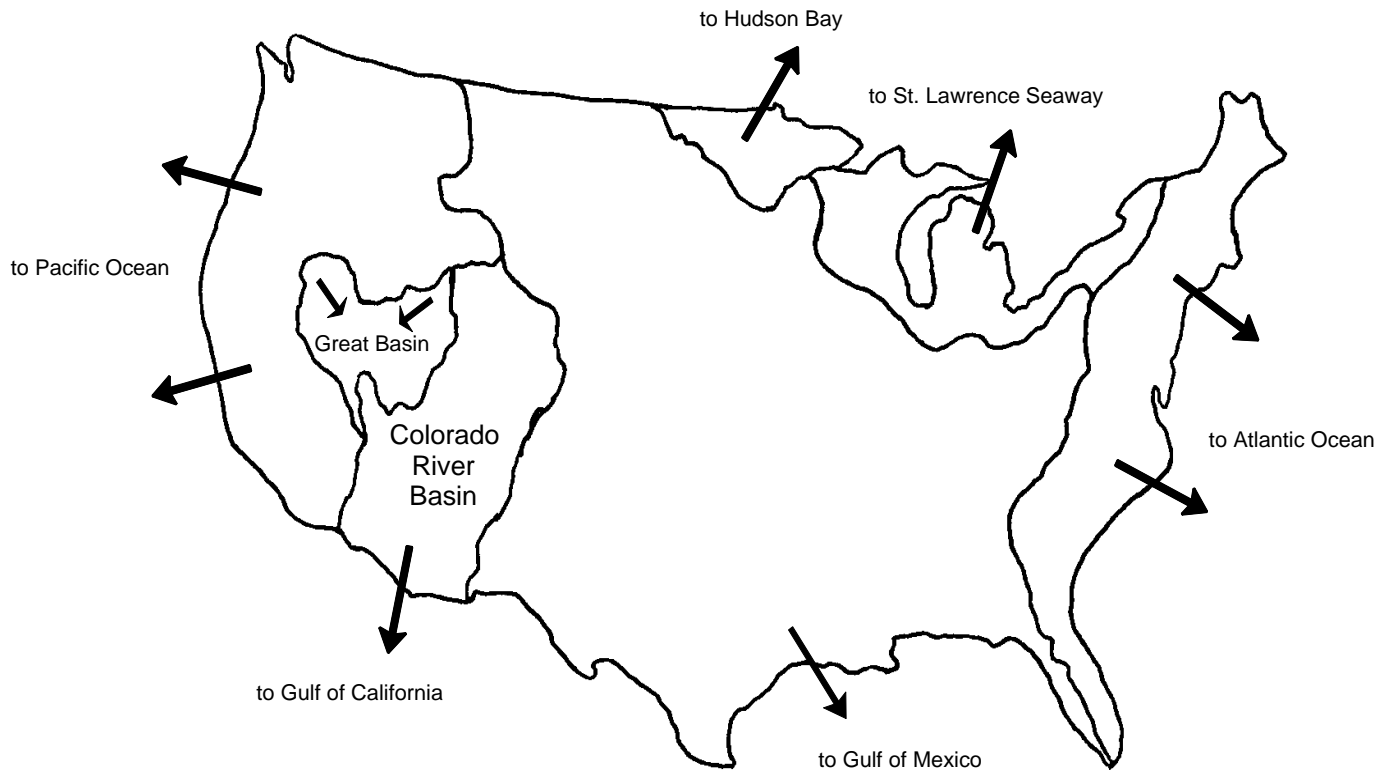


Figure 4. Major Drainage Systems of the United States.

Gulf receives water from the states west of the Appalachian Mountains to the Continental Divide, plus parts of Florida, the expansive watersheds of the Ohio River, the Tennessee River, the Upper and Lower Mississippi River, the Missouri River, and the Rio Grande. Of course, the waters of the Gulf of Mexico ultimately mix with those of the Atlantic Ocean.

The **St. Lawrence Seaway** is the outlet for the Great Lakes, which contain one-fifth of all the freshwater on earth and drain all of Michigan as well as northern portions of Minnesota, Illinois, Indiana, Ohio, Pennsylvania, and New York. The seaway flows into the Atlantic Ocean. **Hudson Bay** receives water from a portion of Minnesota and North Dakota.

The little water that exists in the arid lands of Nevada and western Utah flows to the **Great Basin**. The Great Basin is an example of a final destination of water in the United States that is not an ocean. Most of the water that flows into the Great Basin either evaporates or provides freshwater input to the Great Salt Lake in Utah. The Willcox Playa in Cochise County, Arizona is another example of a closed basin watershed.

Water that flows west of the Continental Divide created by the Rocky Mountains and that does

not first drain into the Gulf of California or the Great Basin ends its long journey in the **Pacific Ocean**. The Pacific Ocean drains most of the land in California west of the Sierra Nevada and all land that is in the Columbia River watershed in western Montana, Idaho, Oregon, and Washington.

Lastly, and most importantly for those of us in Arizona, is the drainage into the **Gulf of California**. Water from southwestern Wyoming, western Colorado, eastern Utah, western New Mexico and Arizona, flows to or is drained into the Gulf, largely by the Colorado River.

The United States is divided and sub-divided into successively smaller **hydrologic units**. Each hydrologic unit is identified by a unique hydrologic unit code (HUC) consisting of two to eight digits based on the four levels of classification in the hydrologic unit system. The first two digits signify the water resource region mapped in Figure 5. The second two digits signify the sub-regions (four digits), accounting units (six digits) and cataloging units (eight digits). Smaller subwatershed areas are then subdivided into ten or more digit HUCs.



Figure 5. Water Resource Regions. Adapted from Hydrologic Unit Map of the United States. Courtesy, United States Geologic Survey.

ARIZONA WATERSHEDS

Arizona shares the Colorado River watershed with six other states and Mexico (Figure 6). Dams have been built in many areas for flood control, power generation, water storage, and/or recreation purposes. The Central Arizona Project (CAP) is a system of reservoirs, canals, and pumps which brings water from the Colorado River through Phoenix and into Tucson.

On its way to the Colorado River, water in Arizona flows through various drainage systems that are in themselves watersheds. In other words, smaller watersheds—also called subwatersheds—are nested within larger ones (see Figure 7 below). Devised by the U.S. Geologic Survey (USGS), there are 18 - six digit watersheds (accounting units) and 84 - eight digit subwatersheds (cataloging units) within Arizona. Each cataloging unit is a geographic area representing part of or all of a surface drainage basin, a combination of drainage basins, or a distinct hydrologic feature. Numbers assigned to each act as a zip-code for that particular watershed.

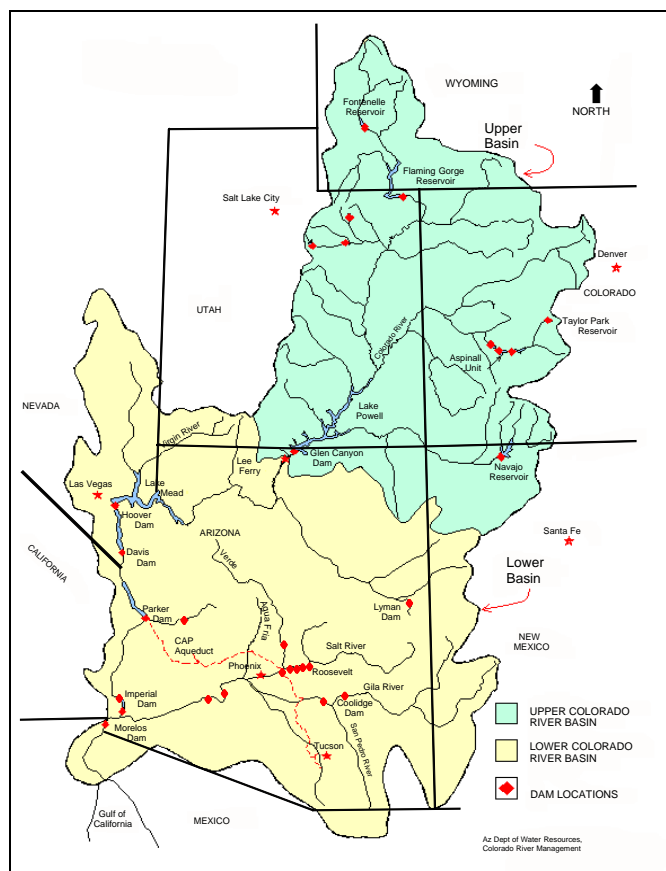


Figure 6. The Colorado River Basin.

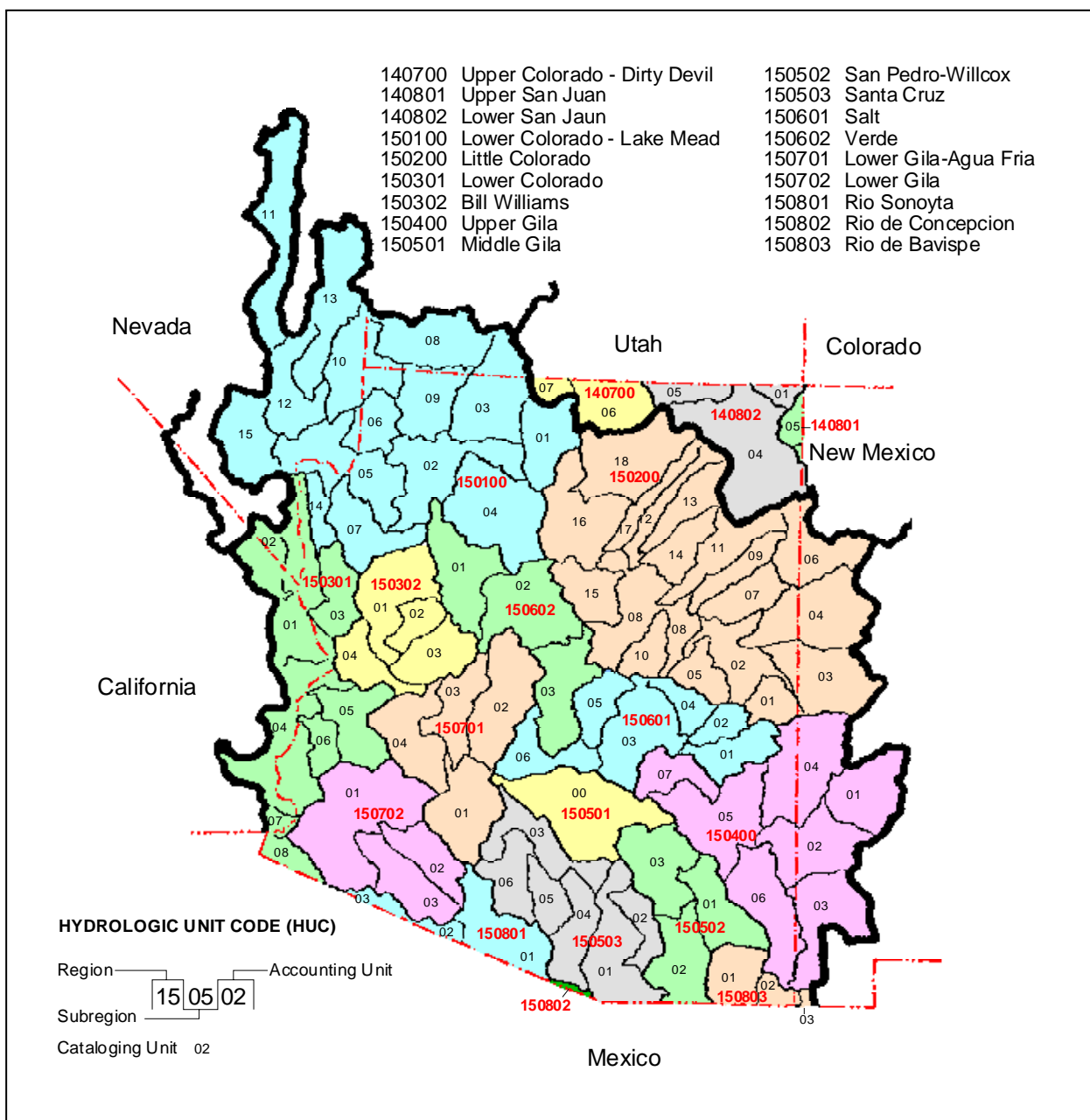


Figure 7. Lower Colorado River watersheds and subwatersheds. Note that many of these areas are contained in Arizona. Courtesy of the Arizona Department of Water Resources.

WATERSHED MANAGEMENT

Because watersheds are defined by natural topography and hydrology, they represent a logical basis for managing water resources. When watersheds become the focal point, managers, stakeholders and others are able to gain a more complete understanding of overall conditions in an area as well as the stressors that may affect those conditions. As you learned in the introduction, watersheds catch and store precipitation, releasing the stored water to stream channels and ground water. These functions are influenced by climate, geology, elevation, land uses, the type and condition of soil and vegetation, steepness of the slopes, their orientation to

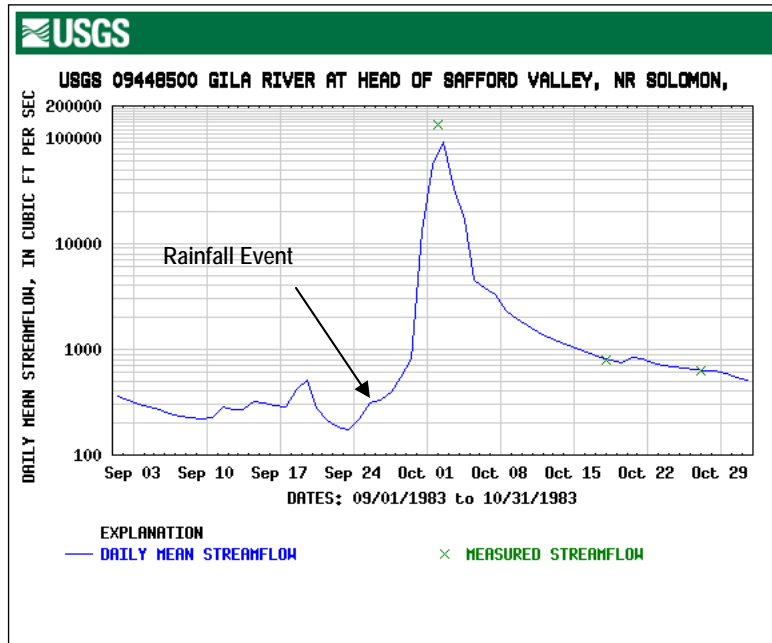


Figure 8. Streamflow curve (hydrograph) for the upper Gila River, near Solomon, Arizona.

watershed less sediment enters the stream to degrade water quality. More of the precipitation falling to the ground is available to vegetation, as well as to contributes to late season stream flow, and the reduction of high early season runoff. Figure 8 illustrates the streamflow curve (called a **hydrograph**) of the upper Gila River near Solomon, Arizona during a late monsoon season storm. With lower peak flow, energy and water are released into the channel over a longer period of time. While the peak on the graph appears high, the long slope after that peak indicates that energy is being dissipated slowly as flood waters recede.

Removing or altering vegetation in a watershed, such that areas of bare ground are exposed, increases the runoff and the potential for erosion. Water runs off the surface before it has an opportunity to soak into the soil. Its energy is concentrated, thereby accelerating erosion. In some cases, a process called downcutting within the stream channel may occur. Downcutting is the process of lowering the elevation of the stream channel bottom, while the old floodplain the stream remains high and dry. Sometimes lowered water tables result in downcutting. Runoff over bare ground carries more soil to the stream as erosion, degrading water quality by increasing sedimentation, but increasing water yield downstream. While more water downstream may seem like a good idea, in the long run, less water soaks into the soil so it is not available for use by vegetation.

the sun, and size of the watershed. While climate determines the amount and type of precipitation entering the watershed, people can significantly influence how these watersheds function. Land management activities, such as mining, forestry, recreation, grazing, fires, agriculture, and urbanization can impact the vegetation and soil that in turn affects the quantity and timing of water moving through the watershed.

Soil and vegetation within a watershed dissipates the energy of water, slowing the flow to the stream channel and allowing more water to enter the soil, to

grow plants and to percolate down into the aquifer. Less erosion occurs on well vegetated uplands. In a healthy

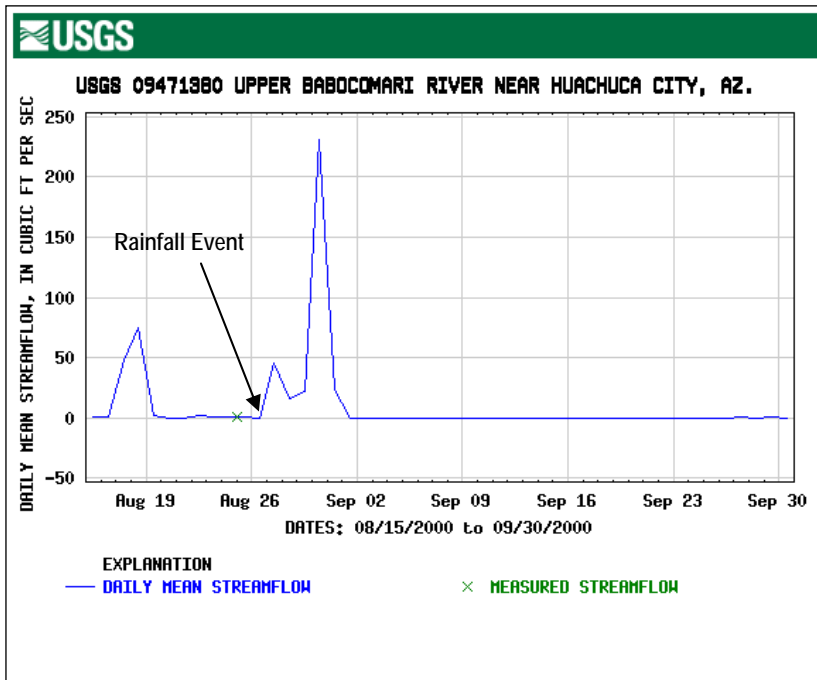


Figure 9. Streamflow curve (hydrograph) for the upper Babocomari River in Cochise County.

Figure 9 illustrates the streamflow curves of two watersheds where water runs more quickly out of the stream and less water is retained in the soil. With higher peak flow, energy is released into the channel in a shorter period of time than in the watershed illustrated by Figure 8. This is sometimes the case for watersheds that have been urbanized or somehow degraded by land use practices along the stream itself or in the surrounding uplands. Figure 8 shows the case of a largely rural watershed in Cochise County that exhibited perennial flows a century ago but is now largely dry except for “events” when runoff is sufficient.

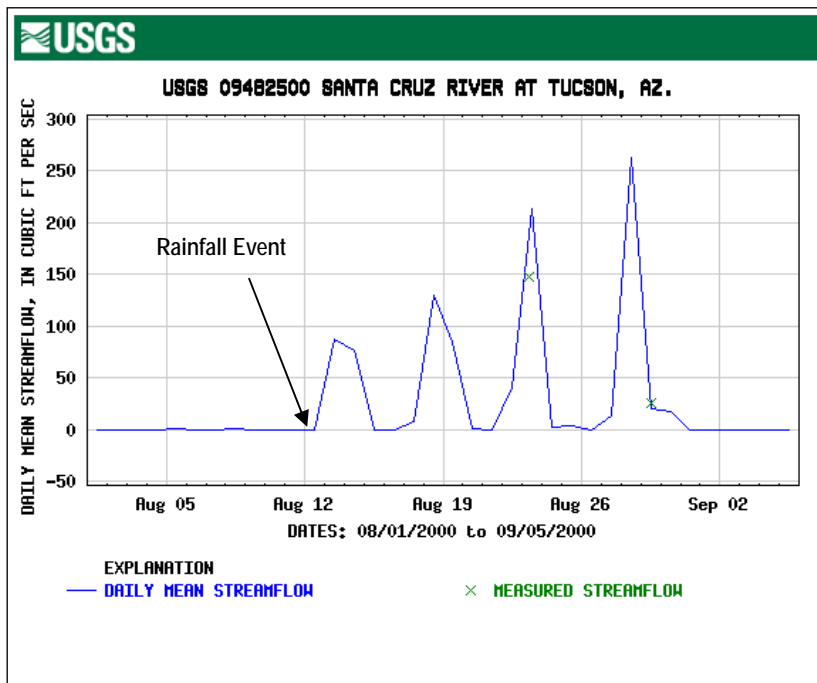


Figure 10. Streamflow curve (hydrograph) for the Santa Cruz River as it flows through Tucson.

Figure 10 illustrates the case of a largely urbanized watershed—the Santa Cruz as it flows through Tucson. Less than 65 years ago, this reach of the river was characterized by areas of perennial water base-flows sustained by groundwater and a marsh-like riparian habitat. Today, due to the ground water and flood-control demands of a major city, the river has been transformed. The river and its surrounding watershed can easily be characterized as “degraded.” Now flow north of the Ina Road Waste Water Treatment plant consists of treated effluent and the Santa Cruz is considered an ‘effluent’ dependent stream.

Before judging whether a watershed is degraded or healthy, however, there are many local factors to consider. Arizona’s geology is still actively changing, in places vegetation is naturally sparse, and rainstorms intense. Figures 9 and 10 may also illustrate normal desert streams.

The objective of watershed management is to maintain and enhance appropriate vegetative cover as well as healthy soil condition, so that water can infiltrate into the soil, be stored there, and then slowly released into the stream over an extended period of time. While this recharge, storage and slow release may not always be possible in arid regions, it is an important goal. Watershed management may involve a variety of tools such as dams, diversions, culverts, ponds, gabions, check-dams, vegetation, and natural riparian buffer zones. It also involves smart land use decisions that avoid erosion, channel degradation, and overuse of ground water. By understanding how water flows through a watershed, we can better predict how changes in land use will affect surface and ground water. Predictions such as these are used to help plan development that will be compatible with maintaining water resources.

Once individuals become invested in their watersheds, they often become more involved in decision-making as well as hands-on conservation and restoration efforts. Through such involvement, watershed approaches build a sense of community, help reduce conflicts, increase commitment to the actions necessary to meet environmental, and often, economic goals.

SOME FINAL THOUGHTS

Earth is unique because it is a planet dominated by water. Water moves through it in a complex cycle. That cycle distributes water across the globe. While there is plenty of water on the earth, the majority of that water is not potable (drinkable). What little potable water exists is not always where it is most needed by humans. Evidence of this in Arizona can be found in the need to construct large storage and transmission projects like the Central Arizona Project or the Salt River Project. Or it can be found in ancient Hohokam canal systems.

Water quality is equally important to water quantity. Polluting our freshwater sources

will seriously endanger our water supply by reducing the water that is relatively easy to access. Aside from big precipitation events, the water cycle moves very slowly for the most part, and much of our water is stored in places that we cannot access it without great cost. We must maintain the quality of what little we have access to at this moment.

Watersheds are a critical component of the water cycle. Proper management of the soil and vegetation in watersheds is essential to ensure a continuing supply of high quality and quantity water for plants, animals, and people, and to reduce flooding events.

In addition to proper watershed management, conservation of water resources and protection against water pollution are also important water management components. Wise water management can aid in ensuring an adequate water supply to meet our current and future needs.

WORDS TO KNOW

Aquifer - Any water-bearing soil or rock formation that is capable of yielding sufficient water to a well.

Base flow – The volume of flow in a stream that is not derived from surface run-off, hence, base flow is contributed by ground water discharging to a stream.

Climate - The general pattern of weather conditions, seasonal variations, and weather extremes over a long period.

Condensation - The process by which a vapor becomes liquid; the opposite of evaporation.

Consumptive (Water) Use - A use of water that renders it no longer available because it has been evaporated, transpired by plants, incorporated into products or crops, consumed by people or animals, or otherwise removed from water supplies.

Erosion - The detachment and movement of soil material from the land surface by wind or water.

Evaporation - A physical change of state in which a liquid is transformed into a vapor or gas.

Ground water - Water that infiltrates into the soil and is stored in slowly flowing and renewed underground reservoirs (aquifers).

Hydrograph – A graphic of changes in water flow or water level plotted against time. A hydrograph shows stage, flow, velocity, or other properties of water with respect to time.

Hydrologic Cycle - See Water Cycle.

Hydrologic Unit - Geographic area representing part or all of a surface drainage basin or distinct watershed.

Hydrology - the science of the waters of the earth, their occurrence, distribution, and circulation; their physical and chemical properties; and their reaction with the environment, and including living beings.

Infiltration - The entry of water into the soil, and recharge to groundwater.

Non-Consumptive (Water) Use - Non-consumptive water use includes water withdrawn for use that is not consumed, evaporated or transpired.

Nonpoint Source Pollution - Water pollution caused by diffuse sources with no discernable distinct point of source or responsible party, often referred to as runoff or polluted runoff from agriculture, urban areas, abandoned mine sites, construction sites and other sites.

Percolation - The downward movement of water in soil.

Point Source Pollution - Pollutants discharged from any identifiable point, including pipes, ditches, channels, sewers, tunnels, and containers of various types.

Precipitation - Water falling, in a liquid or solid state, from the atmosphere to the earth (e.g., rain, snow).

Rain shadow – A dry region on the lee side of a mountain range, where rainfall is noticeably less than the windward side.

Reach - Length of a river between two gaging stations or simply a specific length of river.

Runoff - Water that drains or flows from the surface of the land.

Sediment – Material carried and/or deposited by wind, water or glaciers.

Sedimentation - Insoluble particles of soil and other inorganic and organic materials that become suspended in water and eventually fall to the bottom.

Surface Water - Water found in rivers, streams, lakes and reservoirs.

Transpiration - The process by which water evaporates from plant tissue.

Vadose Zone – The subsurface zone between the water table and the land surface where some soil pores are filled with air.

Water Cycle - The paths water takes through its various states—gas, liquid and solid—as it moves through earth's systems (oceans, atmosphere, ground water, streams, etc.). Also known as the hydrologic cycle.

Watershed - The land area from which surface runoff drains into a stream channel, lake, reservoir, or other body of water.

Water Table - The top of the saturated zone when referring to ground water.

SOURCES

Arizona Department of Water Resources, Phoenix Active Management Area. 1992. *Hydrologic Cycle*.

Botsford, Manton L. *Dankworth Village Activity Guide*., U.S. Department of the Interior, Bureau of Land Management, 1993.

Raymond, Lyle S. 1992. *What is Groundwater?* Minnesota Extension Service.

Dickens, Betty. 1987. *Watershed* chapter, in *Draft Arizona Range Resource Manual*, M.S. thesis.

Fabritz, Sandy. 1997. *Some Unique Properties of Water*, from the Natural Resources Conservation Workshop for Arizona Youth.

Edelstein, Karen, Nancy Trautman, and Marianne Krasny. 1999. *Watershed Science for Educators*. Cornell Cooperative Extension.

Hassinger, Elaine. 1997. *Lakes & Water Quality*, from the Natural Resources Conservation Workshop for Arizona Youth.

Horton, Gary A. 1998. *Water Words Dictionary: Part 1 - A Compilation of Technical Water, Water Quality, Environmental, and Water-Related Terms*. Nevada Division of Water Planning, Department of Conservation and Natural Resources.

Minnesota Extension Service. 1992. *What is Ground water?* Publication Number AG-FO-5867-C.

The Oregon Watershed Improvement Coalition, *Watersheds: Their Importance and Functions*.

The University of Arizona. 1993. *Arizona WET*.

USDA Natural Resources Conservation Service. Undated. *What is a Watershed*, Program Aid Number 420.

USDA Natural Resources Conservation Service. 1996. *Water Quality*, NRCS/RCA Issue Brief 9. U.S. Geological Survey, <http://waterdata.usgs.gov/usa/nwis/rt>

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