

# WHEN IT RAINS IT RUNS OFF: RUNOFF AND URBANIZED AREAS IN ARIZONA

Summer Waters, Extension Agent, Water Resources, Maricopa County; Kitt Farrell-Poe, Ph.D., Water Quality Extension Specialist, Agricultural & Biosystems Engineering Department; Kristen Wagner, Program Coordinator, Sr., Urban Horticulture, Maricopa County; all with the University of Arizona Cooperative Extension.

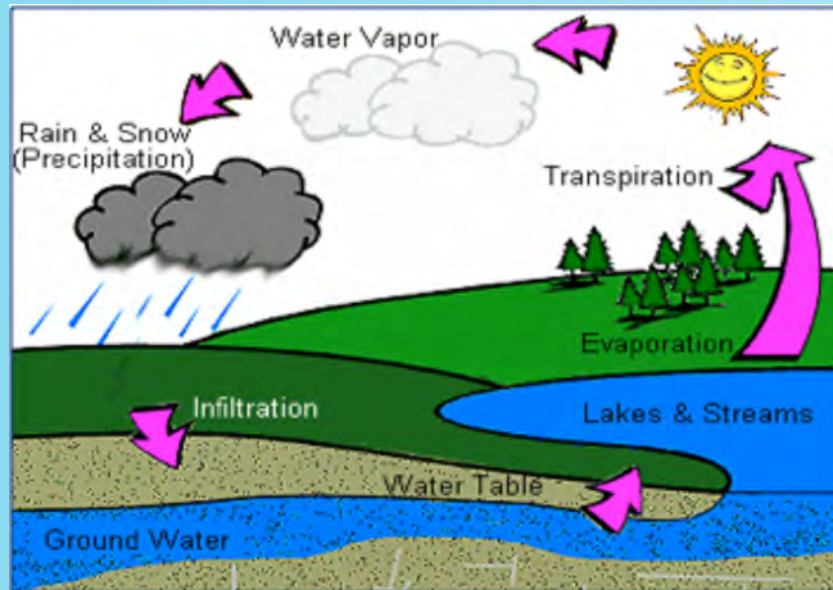


Figure 1. The Multiple Paths of Water in the Environment

## Introduction

This document is designed to introduce the concepts of urban runoff and nonpoint source pollution to the general public. It provides an overview of some of the stormwater issues in Arizona, background on regulations, and useful tips that you, as an individual, can implement. References and additional resources are provided at the end of the document to direct you to additional sources of local information.

## Understanding Stormwater and Runoff

When precipitation falls from the sky, it has multiple paths that it may take through the environment (figure 1). These paths include infiltration, evaporation, transpiration, and runoff. *Infiltration* occurs when water is absorbed into the soil profile. *Evaporation* occurs when the water in the ground becomes vapor and returns to the air. *Transpiration* is water that escapes from plants in the form of vapor. *Stormwater runoff* occurs when rain falls onto the ground and/or snow melts but is unable to infiltrate and therefore flows across the land. Runoff typically flows to a nearby water body or low-lying area.

## What is Urban Runoff?

In urban areas, water is often unable to infiltrate into the soil because buildings and paved surfaces (impermeable surfaces) are very common. As a result, urban runoff flows across rooftops, roadways, sidewalks, urban landscapes, and driveways. It eventually reaches a stormwater collection system. Stormwater collection systems can utilize existing natural features such as streambeds, or they can utilize human-made systems such as stormwater infiltration basins, collection channels, and underground pipes (figure 2).

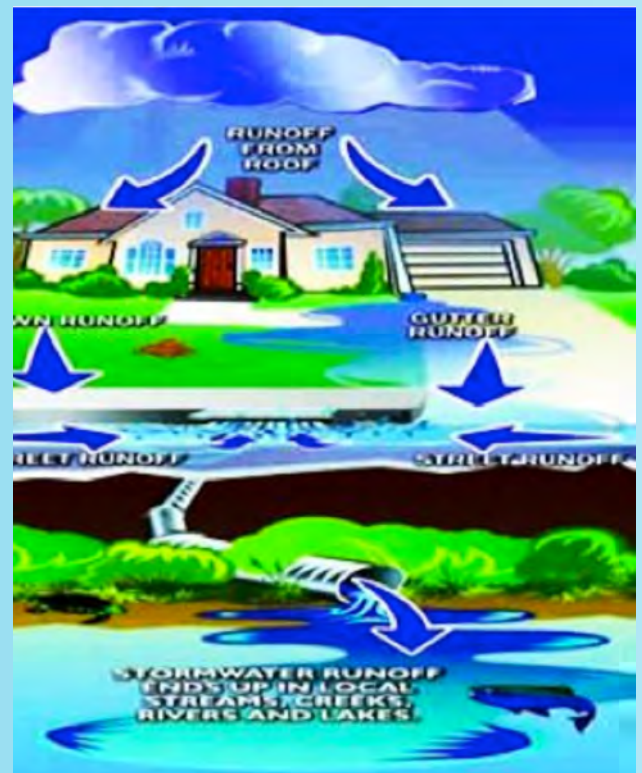


Figure 2. Stormwater Runoff Pathways

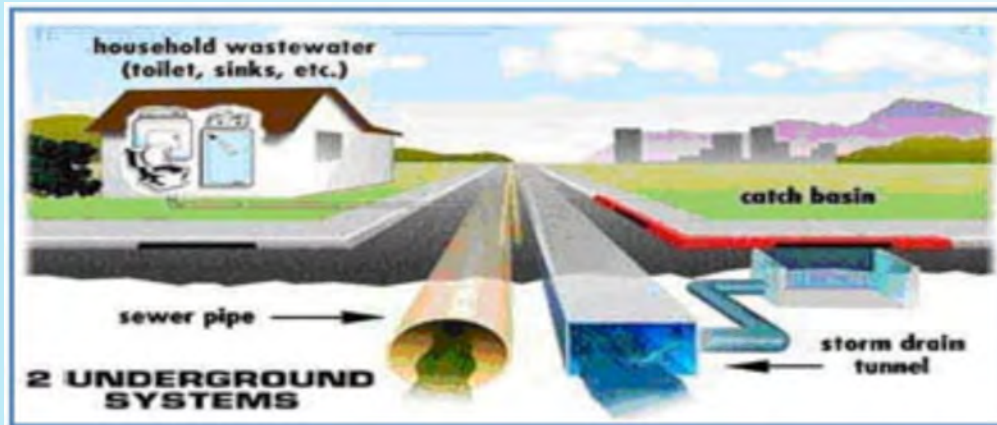


Figure 3. Arizona's Two Systems for Removing Stormwater and Wastewater



Figure 4. Stormwater Infiltration Basin in Yuma

In urban areas, stormwater collection systems convey water from natural storm events as well as the excess water that results from inappropriate or wasteful practices such as over-irrigating landscapes, overlooking irrigation system maintenance, or improperly disposing of pool filter backwash. It is important to remember that stormwater collection systems benefit us by quickly moving water from streets into waterways or drainage areas, which can prevent flooding.

Many people are not aware that in Arizona separate systems are utilized to collect stormwater and sewage. A stormwater system collects urban runoff and directs it, untreated, into rivers, infiltration basins, and parks. A sanitary sewer system is a separate system that collects household, industrial, and commercial wastewater from sinks, toilets, etc. and sends it to a wastewater treatment plant to be treated before being discharged into a river or other water body (figure 3).

Water enters a stormwater collection system through collector channels or storm drain inlets that can be seen on streets, parking lots, and curbs. This water flows directly from the streets into our washes, rivers, parks, and infiltration basins. Figure 4 shows a stormwater infiltration basin for a housing development in Yuma.

### How Does Urban Runoff Cause Water Pollution?

Urban runoff pollution is caused when the runoff, while traveling across the urban environment, acquires contaminants that affect water quality. The pollutants from urban runoff include plant material, fertilizers, pesticides, automotive and household chemicals, litter, and pet waste. These can be naturally occurring or human-caused. Urban runoff pollution is also called nonpoint source (NPS) pollution because it comes from many different sources and the original pollution source is not easily identified. NPS

pollution usually comes from a broad area. This contrasts with point source pollution, which can be attributed to a single, identifiable source (for example a factory discharge pipe).

While individual homes might contribute only small amounts of NPS pollution, the combined effects of neighborhoods and communities are serious and greatly impact our natural resources. NPS pollution accumulates as runoff and flows through neighborhoods, down roads, across parking lots, and into the stormwater system.

### What are the Sources & Effects of Urban Runoff Pollution?

Remember, urban runoff comes in contact with debris and pollutants as the water flows through the urban environment and into channels and storm drains. These may include fertilizers and pesticides from the lawn and garden, litter left in the street, oil from a leaky car, or pet waste in the park. Even washing a car can create nonpoint source pollution in the form of sediment and detergents. Urban runoff pollution can have negative effects on fish, people, and plants. Some pollutants can concentrate in fish and cause health concerns in people who eat them. The Arizona Game and Fish Department posts fish consumption advisories for rivers in Arizona. This is important information because fishing is a popular recreation in Arizona's urban areas as well as the more pristine streams.

Nationally, the Environmental Protection Agency lists sediment as the most common pollutant in rivers, streams, lakes, and reservoirs. In Arizona, the Arizona Department of Environmental Quality (ADEQ) has identified sediment as one of top three pollutants affecting Arizona's rivers and streams. It can come from natural sources, but is often exacerbated by human activity. Water polluted with sediment becomes murky or cloudy, which prevents animals from seeing food, prevents the growth of natural vegetation, clogs fish gills, and disrupts the food chain. Nutrients are often bound to sediment and are released when it is disturbed. Excessive nutrients used for lawns and landscaping can also become pollution when they wash down into the storm drains and cause increased plant growth, including algae. As plants die and decay, oxygen is removed from the water. Lowered oxygen levels can lead to the death of aquatic organisms and fish. Household cleaning products such as detergents and car wash soaps that leave the home and enter the urban environment can also negatively impact water bodies when they are concentrated in urban runoff.

Another household pollutant is pet waste. Pet waste left on the ground can harbor *E. coli* bacteria, as well as roundworm, tapeworm, and *toxoplasma gondii*. Not only are these parasites transmittable to humans, toxoplasmosis can cause serious health concerns in immune-compromised individuals and pregnant women. Many of these organisms persist in pet waste left on the ground, even in Arizona's desert environment.



Figure 5. Storm Drain Marker in Maricopa County



Figure 6. Storm Drain Marker in Tucson

Litter also contributes to NPS pollution. An estimated 75% or more of Arizona's wildlife relies on riparian areas (areas close to and along waterways), the same areas into which most storm drains empty. Litter from urban runoff can harm wildlife. For example, wildlife that ingests plastic can suffer internal injuries and death. Discarded fishing line and plastic six-pack holders can entrap birds, fish, and mammals. Lizards that crawl inside bottles or cans often become trapped and eventually die of overheating. Trash and litter can be harmful to humans when it clogs storm drains to the extent that it impacts surrounding properties. Storm drains clogged with trash cannot function properly and often result in local flooding. Trash such as food leftovers and diapers can carry bacteria. Improper disposal of trash or garbage and littering are the cause of this type of stormwater pollution.

### Regulating Urban Runoff

The Clean Water Act, passed in 1972, established a national commitment to addressing water pollution. Programs that address polluted runoff under this regulation are implemented at federal, state, and local levels. In Arizona, the Arizona Department of Environmental Quality (ADEQ) oversees the implementation of the Clean Water Act. Municipalities that are required to address nonpoint source pollution report to the ADEQ and receive an Arizona Pollution Discharge Elimination System (AZPDES) permit that outlines the requirements for complying with stormwater regulations. As a result, municipalities throughout the state of Arizona have made efforts to reduce the amount of runoff entering the stormwater conveyance systems, prevent stormwater pollution, and increase the awareness of urban runoff issues through a variety of programs. In the Phoenix metropolitan area, many cities have combined their efforts to reduce NPS pollution through an entity called STormwater Outreach for Regional Municipalities

(STORM). Similarly, the Pima Association of Governments (an organization of municipalities within Pima County) coordinates stormwater outreach efforts for member jurisdictions through its annual *Clean Water Starts With Me* campaign. The City of Flagstaff has implemented a Low Impact Development (LID) Ordinance to proactively address stormwater issues by minimizing runoff from impermeable surfaces. The City of Yuma has implemented its Stormwater Management Program since 2003.

An example of an educational program being implemented across the state is the marking of storm drains with stencils or markers. There are a number of different stencils, all of which are designed to draw attention to storm drains and remind the public not to put trash or other hazardous materials down these drains (figures 5 and 6). However, there remains much that an individual can do to understand and reduce urban runoff.

### What Can You Do?

Luckily, easy and often money-saving steps can be taken to improve the water quality of urban runoff. The most effective way to improve the quality of urban runoff is to first minimize the amount of runoff and pollutants being generated. This can be accomplished through pollution prevention and wise use of water outdoors.

#### Reduce Excess Outdoor Water Use!

Urban areas in Arizona use approximately one-half of their residential water outdoors! Some cities have focused their efforts on water conservation and use just under that amount whereas others still use well over it. Much of the water used outdoors in residential areas irrigates landscapes and lawns. The first step to reducing unnecessary runoff is to eliminate wasteful practices, such as over-irrigating plants and turf, by adjusting irrigation controllers seasonally and repairing leaky irrigation systems.

Next, rethink the path of water through the landscape and thoroughly assess the landscape's needs. Small changes in the physical characteristics of the landscape can allow stormwater to stay on the property and percolate into the soil. Utilizing berms and basins to collect water before it flows into the street and storm drain can help it infiltrate into the landscape and be used by the vegetation. This is often referred to as passive water harvesting. Passive rainwater harvesting includes practices that replace impermeable surfaces, such as sidewalks and driveways, with permeable surfaces that allow water to infiltrate into the soil. Alternatively, you can direct the flow of rainwater from an impervious area toward vegetation. These methods reduce runoff by allowing rainwater to be absorbed in the landscape and used for plants. In addition to reducing the volume of water leaving the landscape, another option to help improve the quality of urban runoff is to reduce the amount of water and chemicals applied to the landscape. Remember, excess irrigation water flows across landscapes and lawns into streets and sidewalks eventually becoming urban runoff.

Landscapes that employ the principles of Xeriscape utilize plant species that are native or well-adapted to the regional climate and limit the amount of turf. With proper design, installation, and maintenance, Xeriscape landscapes can help decrease a homeowner's outdoor water use. By selecting locally-adapted plants and watering properly, the use of water, fertilizers, and pesticides are reduced and therefore are not washed into the storm drains. Xeriscaping is required by some newer communities in Maricopa County and many of the homeowner associations in Pima County. Through local water providers, many cities offer rebates for homeowners that convert their high-water use landscapes to Xeriscape.

#### Manage Pet Waste!

Multiple studies have found that 40% of Americans do not pick up their pet's feces. To get an idea of the impact of improperly managed dog waste, Maricopa County alone has almost 300,000 licensed dogs. Simply disposing of pet waste properly could decrease the large amount of pet waste flowing into the storm drains each time it rains. The solution is easy: bring a bag with



Figure 7. Pet Waste Bag Dispenser



Figure 8. Storm Drain Clogged with Litter and Debris

you when walking your pet or make use of the dispensers available at local parks (figure 7). Be sure to properly dispose of the bag once the waste is collected.

### Wash Your Car Properly!

Water that runs off your car when it is washed can contain substances that cause water pollution. Washing vehicles at automated or self-serve commercial car washes prevents soaps, oils, sediment, and other chemicals on the vehicle from entering storm drains. Additionally, commercial car washes have water collection systems. Water collected through these systems can be re-used many times before it is sent to the treatment plant. Commercial car washes typically use less water than the average homeowner. If you do wash your car at home, use only water-based or phosphate-free biodegradable cleaners and minimize the amount of water you use.

### Don't be trashy!

After years of national advertising campaigns, litter is still a common source of pollution (figure 8). Communities that value their waterways and wildlife can join efforts to adopt highways and organize neighborhood clean-up events. Clean-up events are often organized around local riparian areas. These efforts are usually made possible through the hard work of volunteers. You can make a difference by putting trash in its place. In addition, securing lids on trash cans keep the contents from spilling out accidentally. Organic waste such as grass clippings and yard waste should be bagged when put out for collection in order to prevent it from washing into the storm drains.

## Summary

Urban runoff can pollute nearby water bodies with sediment, nutrients, toxic chemicals, and pathogens. There are many actions that communities, and you as an individual, can take to reduce the pollutants going into urban runoff. Many are easy (picking up after your pets), some require volunteers (storm drain stenciling), and some require city/county ordinances (Low Impact Development requirements). Do your part to protect our state's most precious natural resource ...water!

## References

- Arizona Department of Environmental Quality (2009). Arizona's 2009 Annual Nonpoint Source Annual Report: Nonpoint Source Program July 1, 2008 – June 30, 2009. Phoenix, AZ: State of Arizona. Retrieved from Arizona Department of Environmental Quality website: [http://www.azdeq.gov/environ/watershed/download/NSP\\_Annual\\_Report09-PA.pdf](http://www.azdeq.gov/environ/watershed/download/NSP_Annual_Report09-PA.pdf)
- Arizona Department of Environmental Quality (2009). Fact Sheet: Fish Consumption Advisories – April 2009. Phoenix, AZ: State of Arizona. Retrieved from Arizona Department of Environmental Quality website: <http://www.azdeq.gov/enviro/water/assessment/download/fish-0409.pdf>
- City of Clarksville, IN (2009). What is Stormwater? Clarksville, IN: City of Clarksville. Retrieved from [www.clarksvillesw.com/residents.html](http://www.clarksvillesw.com/residents.html)
- DeFrancesco, Donna and Robyn Baker (2008). Landscape Watering by the Numbers. N.p.: Park & Co.
- Environmental Protection Agency Nonpoint Source Control Branch (2010). USEPA Nonpoint Source Fact Sheets. Washington, DC: Government Printing Office. Retrieved from Environmental Protection Agency website: <http://www.epa.gov/owow/nps/facts/>
- Flood Control District of Maricopa County (2008). Metro Phoenix Area Drainage Master Plan. Phoenix, AZ: Maricopa County Government.
- Johnson, Carolyn (1999). Cleaning up Stormwater Runoff (GWQ016). Madison, WI: University of Wisconsin Cooperative Extension.
- Maricopa County Animal Care and Control (2008). Annual Report July 2007 – June 2008. Phoenix, AZ: Maricopa County Government.
- Miller, B.E, L.R Levick, L.J. Lane, and R.D Steger (2000). Organizing New Methods for Erosion and Sedimentation Monitoring and Control. Proc. of the Int'l Erosion Control Assoc. Conf. 31. Palm Springs, CA: Int'l Erosion Control Association. Retrieved from <http://www.tucson.ars.ag.gov/unit/Publications/PDFfiles/1271.pdf>
- Pitzer, Gary, Susanna Eden, and Joe Gelt (2007). Layperson's Guide to Arizona's Water." Tucson, AZ: Water Education Foundation and The University of Arizona.
- Stormwater Outreach for Regional Municipalities (2010). FAQs About the Storm Sewer System. Retrieved from <http://www.azstorm.org/storm-sewer-system/>.

## Additional Resources

- Coconino County Stormwater <http://www.coconino.az.gov/stormwater.aspx?id=1111> Coconino County, Arizona
- Flagstaff Stormwater Management <http://www.flagstaffstormwater.com/> Flagstaff, Arizona
- Clean Water Starts with Me <http://www.pagnet.org/Programs/EnvironmentalPlanning/Water/nbspnbspPAGStormCleanWaterStartswithMe/tabid/766/Default.aspx> Pima Association of Governments
- Stormwater Management Program. <http://www.co.yavapai.az.us/Content.aspx?id=15998> Yavapai County, Arizona
- Prescott Stormwater Management <http://www.cityofprescott.net/services/water/storm.php> Prescott, AZ
- Citizens Stormwater Pollution Prevention. <http://www.co.yuma.az.us/index.aspx?page=561> Yuma County, Arizona
- Stormwater Program: City of Yuma. <http://www.ci.yuma.az.us/13658.htm> Yuma, Arizona.