Arkansas Watershed Steward Handbook

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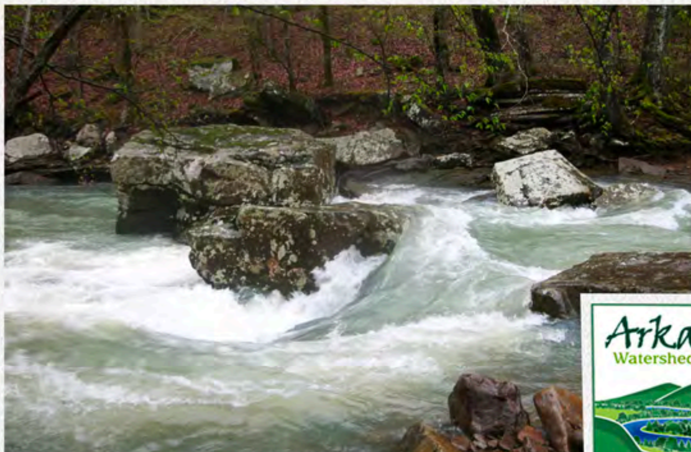

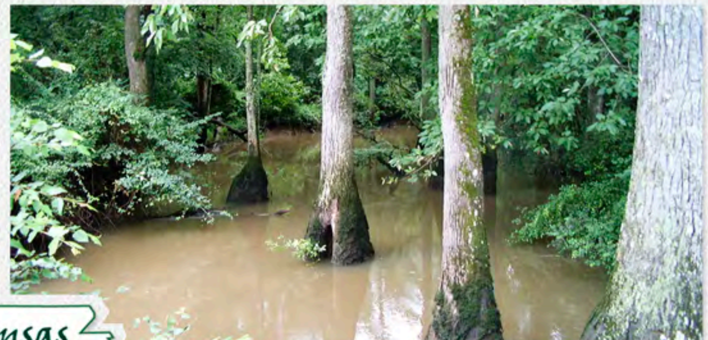

Arkansas Watershed Steward
"Citizens Caring for Water Resources"

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Arkansas Watershed Steward Handbook

A Water Resource Training Curriculum

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Executive Summary

The waters of Arkansas provide drinking water to over three million people in communities throughout the state, and fuel industrial, economic, and agricultural production, public recreation, and habitat for a wide variety of aquatic and terrestrial wildlife.

Consisting of over 600,000 acres of surface water, 91,000 miles of streams, and 282 identified aquifers, Arkansas is a water rich state.

However, the surface and groundwaters of Arkansas that so many rely on for so much, cannot protect the watersheds from activities that influence the quality of the water or the health of the land from which it flows.

The protection, improvement, and maintenance of water quality in Arkansas is up to all citizens, communities, businesses, and industries.

To accomplish the goal of voluntary water quality protection and improvement in our "Natural State", it is necessary for citizens of all ages to do their part.

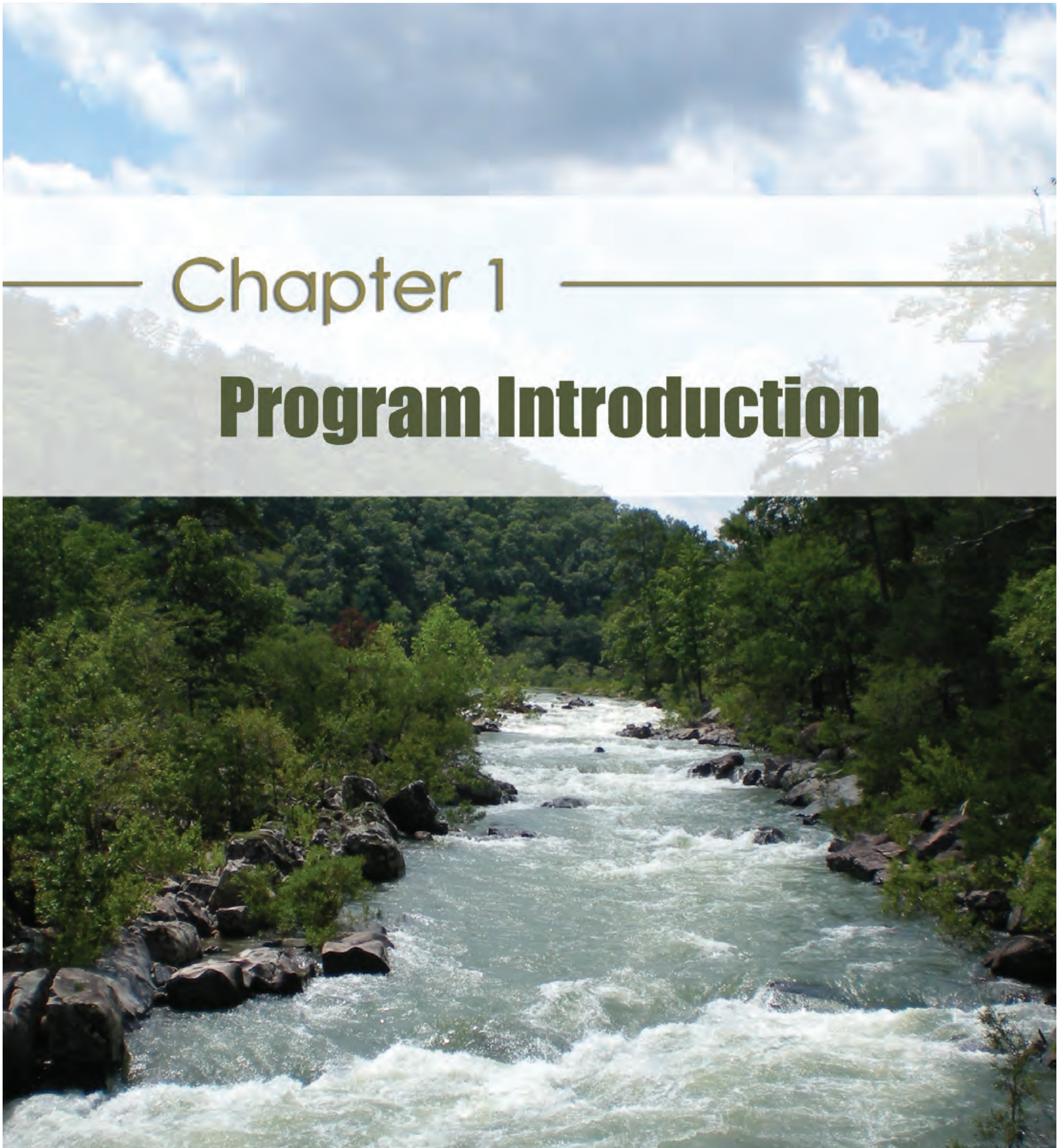
For these reasons the Arkansas Watershed Stewardship Handbook was created by a broad base of stakeholders, agencies, and organizations from across the state to help inspire, inform, and assist the citizens of Arkansas with the support and tools required to make a positive impact for the water quality of Arkansas and all that it provides for so many.

Within this guide the roadmap for understanding water quality and water quality issues within the watersheds of our state can be found, as well as the actions, approaches, and tools for making a positive impact on water quality and all that depends on the waters of our state.

The project team that helped put this guide together hope that it will encourage and assist countless individuals in the effort to steward or take care of watersheds throughout Arkansas.

Chapter 1

Program Introduction



Arkansas Watershed Steward Handbook

About This Handbook

The **Arkansas Watershed Steward Handbook: A Water Resource Training Curriculum** was written for residents of the state wanting to learn more about watershed stewardship and for participants in the Arkansas Watershed Steward Program (AWS). This handbook presents the background, principles and tools needed to become a "Watershed Steward" or to enhance existing stewardship skills and knowledge. It is designed to be an educational resource and training guide for potential Watershed Stewards throughout the state to use and share in the preservation, protection, and improvement of water resources in Arkansas.

The information in this handbook is for educational purposes only. Reference to commercial products and/or trade names is made with the understanding that no discrimination is intended and no endorsements by the University of Arkansas System Division of Agriculture Cooperative Extension Service are implied.

About the Arkansas Watershed Steward Program

The Arkansas Watershed Steward Program is an educational training offered by the University of Arkansas Cooperative Extension Service in cooperation with the Arkansas Department of Agriculture – Natural Resources Division and other partnering agencies and organizations. The purpose of this program is to promote healthy watersheds, increase understanding of the potential causes of water resource degradation and give people the knowledge and tools they need to identify, prevent and/or resolve water quality problems.

The broad goals of the Arkansas Watershed Steward Program are to:

- Make citizens more aware of and knowledgeable about water issues.
- Help individuals become community leaders in dealing with water issues.
- Facilitate local efforts and activities to improve water quality.
- Improve and protect the quality of local water resources.

Who Are Arkansas Watershed Stewards?

Arkansas Watershed Stewards are the folk with a willingness to learn about, a desire to improve and protect community, an ethic to become actively involved in protecting and improving water resources, and a willingness to share this information with their friends, family and community. This includes homeowners, agricultural producers, recreationists, decision makers and community leaders who all live, work or recreate in a watershed and depend on its valuable resources. The Arkansas Watershed Steward program is open to all people of all ages regardless of race, color, national origin, religion, gender, age, disability, or veteran status, or any other legally protected status and is an Affirmative Action/Equal Opportunity Employer.

The Importance of Watershed Stewardship

The word **stewardship** is defined as the responsible and careful management of something that is of value. The goal of stewardship is to maintain, and potentially enhance, the value and benefits of the resource being managed. Watershed stewardship means caring for the water, the air, the land, and the biodiversity in an entire watershed, while acknowledging that all resources are inter-connected and all are affected by both natural and human related activities. Limited clean water resources have significant impacts on or our livelihoods and way of life. The quality and quantity of water within our watersheds are greatly affected by the way we choose to live, work, and recreate on the land. And since each and every one of us lives in and benefits from a watershed, good watershed stewardship is crucial to ensuring the sustainability of our water resources for generations to come.

As we become more informed about our watersheds and understanding of how our activities affect them, our ability to preserve, protect, enhance, and benefit from these vital resources increases.

All of the Water in the World

The majority of the Earth's surface is composed of water. In fact, approximately three-fourths of the Earth's surface is covered by water. However, most of the water in the world is unavailable for use, as 97.5 percent is saltwater and 1.75 percent is stored frozen in ice caps and glaciers. This leaves us with less than 1 percent of liquid fresh water found in lakes, streams and underground aquifers available for use. To put these numbers into perspective, the available fresh water for our use is less than 0.01 percent of all of the water in the world. For this single reason, wise planning, use and conservation of our limited water resources is essential.

Knowing how little fresh water there is available, it is interesting to note how all that water is being used. Globally, about 70 percent of the world's fresh water is being used for agricultural production, 22 percent is being used for industrial purposes and 8 percent is being used for domestic uses (Fry, 2005).

If all of the water in the world was squeezed into a one liter bottle and what was not drinkable (too salty, frozen or polluted) was taken out, there would only be one drop left (Project Wet, 2003) and that might not pass the water quality standards of the United States.

DID YOU KNOW?

- **March 22nd has been celebrated as "World Water Day" since 1993.**
- **69% of global water use is for agricultural production, 19% is for industrial production and energy, and 12% is for drinking water.**
- **2.2 billion people do not have access to safely managed drinking water services.**
- **It is estimated that fewer than 20% of the worlds drainage basins exhibit nearly pristine water quality.**
- **Citizens of the United States use more water per capita than citizens of any other country.**
- **Water pollution is a main cause of water unavailability and can have serious impacts on the environment and human health.**
- **Ecosystems across the world, particularly wetlands and their ecosystem services are in decline. Between 4.2 and 20.2 Trillion per year worth of ecosystem services were lost between 1997-2011 due to land use change.**
- **Out of 191 nations in the world, six posses more than half of the worlds annual water resources.**
- **A little over $1 billion is spent on water treatment each day.**
- **The Great Lakes account for 20% of fresh water on Earth**

Water Facts of the United States

- The average American uses 88 gallons per day.
- Approximately 322 billion gallons of water are used in the United States each day.
- 86 percent of the U.S. population obtains its water from a privately or publicly owned water source; the remainder obtains water from domestic wells.
- Thermoelectric power generation is the largest water use in the U.S. each day accounting for nearly one half of all water uses.
- The United States has about 8 percent of the worlds freshwater holdings.
- Sediment is the number one pollutant of surface waters in the United States.
- Some waterways in California are listed as **impaired** from floatable trash.
- The average American residence uses more than 100,000 gallons annually.
- Americans use more water each day by flushing the toilet than they do by showering or any other activity.
- Surface water sources account for 80 percent of water withdrawals.
- California and Texas account for one-sixth of fresh water withdrawals in the United States.
- 90 percent of the fresh water in the United States is found within the Great Lakes.
- There are approximately 155,000 square miles of surface water in the U.S., which only accounts for 4 percent of the total area.
- 70 percent of all monitored surface waters nationwide are listed as impaired.

Arkansas Water Facts

- There are more than 600,000 acres of surface water in Arkansas.
- The Buffalo River is the first designated National River in the United States.
- Arkansas falls under the eastern or riparian water doctrine meaning that those who own or lease property adjacent to a waterway have a right to reasonably use that water.
- Metals, sediment, nutrients, and bacteria are the most prevalent pollutants.
- Approximately 4,500 stream miles in Arkansas have been listed as impaired on the 303(d) list over the past decade. Check DEQ for current information.
- Bayou Bartholomew is the worlds longest bayou, and contains the 2nd greatest diversity of aquatic wildlife in North America.
- Arkansas is working to reduce nutrient contributions to the Gulf of Mexico by 25%.
- The maximum recorded discharge of Mammoth Springs was 9 million gallons per hour.
- There are over 90,000 miles of streams in Arkansas.
- The state water plan was updated in 2014.
- Arkansas has over 92 million **acre-feet per year (AFY)** of water flowing through it annually.
- 19 lakes consisting of 35,533 surface acres in Arkansas are listed as impaired.
- The state is divided into six major river basins: Red River, Ouachita River, Arkansas River, White River, St. Francis River, and Mississippi River.
- In Arkansas, there is 4.8 Trillion gallons of water in lakes and 200 trillion gallons in the ground.
- 98% of Arkansans think that protecting drinking water is important.
- Groundwater furnishes 71 percent of the state's total consumption of water, and 95 percent of the groundwater comes from the Mississippi River Alluvial Aquifer.
- Turbidity is the number one pollutant to surface waters in Arkansas.
- Arkansans use 157 gallons of water a day.

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Notes

Chapter 2

Overview of Watershed Systems

Arkansas Watershed Steward Handbook

What Is a Watershed?

The United States Environmental Protection Agency (EPA) defines a **watershed** as "the area of land where all of the water that is under it or drains off of it goes into the same place." A watershed is sometimes called a catchment or drainage basin because it catches and drains precipitation that falls within its boundaries and directs it in to a particular creek, stream, river, lake, wetland or groundwater formation (Fig. 1).

The boundary between one watershed and another is known as a **watershed divide** (Fig. 2). Watershed divides are the highest points of elevation, such as the top of a mountain or hill that physically separate the surface flow of water down one side or the other. Just because a watershed divide separates surface water flow initially doesn't mean that the water will ultimately be separated, because all watersheds have **subwatersheds** nested within them and, in many cases, different sub-watersheds drain into a common and larger watershed system.

IN THIS CHAPTER, YOU WILL LEARN ABOUT:

- Watersheds
- Watershed Functions
- Watersheds Uses
- Watershed Features
- Arkansas Watersheds
- Hydrology and the Hydrologic Cycle

A subwatershed or **subbasin** is a smaller drainage unit that contributes to a larger watershed or basin. For example, the Arkansas River Watershed is a subwatershed of the Mississippi River Watershed because the Arkansas River flows into the Mississippi River.

Each watershed is unique in size, shape, land-use, land cover and geology. For example, a watershed in the Arkansas delta will have less elevation change and different soil types as compared to watersheds in the Ozark or Ouachita Mountains. Yet watersheds can have a great many similarities also. Similar

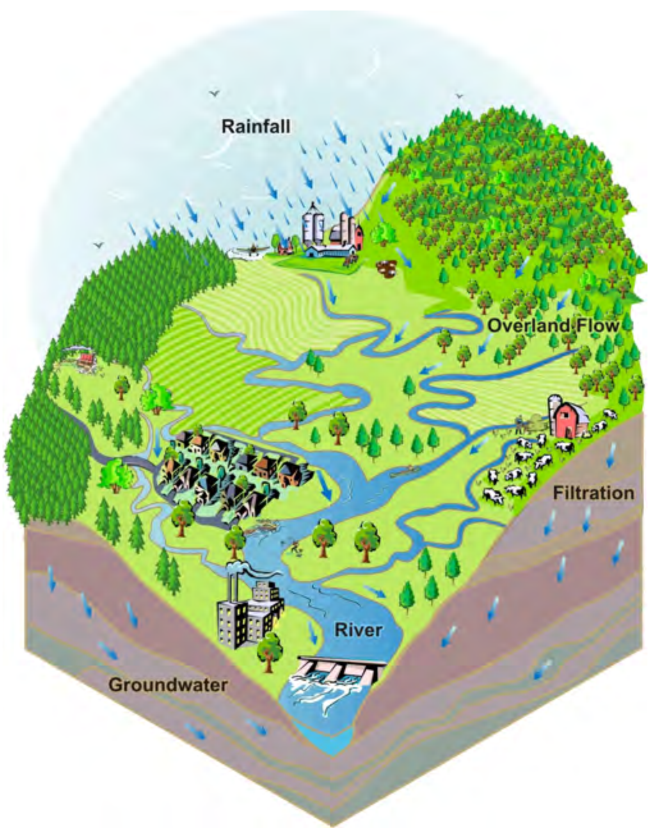


Fig. 1. Watershed cross section diagram
(Image courtesy of Arkansas Department of Environmental Quality)

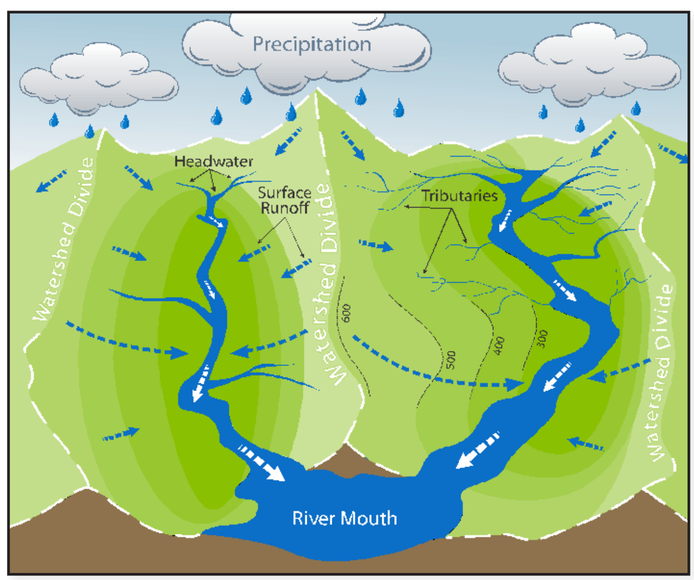


Fig. 2. Watershed divide
(Image courtesy of Arkansas Department of Environmental Quality)

features across watersheds include forested lands, agricultural lands, park lands, small towns and large cities.

A watershed can be large like the Mississippi River Watershed, which drains water from about 41 percent of the United States to the Gulf of Mexico, or as small as your yard or neighboring property, which drains to a storm drain, ditch or stream. Watersheds are everywhere, and everyone lives, works, or recreates within one each day.

Arkansas Watersheds

Arkansas has nearly 90,000 miles of streams that drain into 6 major **river basins** (Fig. 3). Each of these large river basins in Arkansas is composed of numerous watersheds and subwatersheds. For example, the Arkansas River Watershed contains the Mulberry River, Big Piney Creek, Lee Creek, Frog Bayou, Illinois Bayou, Shoal Creek, Petit Jean River, Illinois River, Fourche LaFave, Cadron Creek, Bayou Meto watersheds and so on. Similarly, each of the previously mentioned watersheds has many smaller watersheds than can be subdivided even further.

All or parts of four of the six large river basins in Arkansas originate outside of our state - Arkansas, St. Francis, Red, and Mississippi Rivers. The other two basins, the White and Ouachita, both originate in Arkansas but flow out of the state. The White River is the only large river in the state that flows out of the state and then back in again.

Since several streams and rivers have the same name across the United States, as well as in Arkansas, each watershed system has been given an identification number. This number is known as the **Hydrologic Unit Code (HUC)**. There are 21 major hydrologic regions in the United States and the Mississippi River Watershed includes about half of those. These 21 unique drainage regions are the basis of the HUC numbering system and are considered as two-digit HUCs. As each of those hydrologic unit codes are further subdivided into smaller and smaller units, the hydrologic unit code gets longer to specify a unique drainage.

In Arkansas, there are only two major hydrologic regions (two digit HUCs): the Lower Mississippi (08) and the Arkansas-Red-White Rivers (11) drainage systems. This means that all HUCs in Arkansas begin with either the digits 08 or 11. As these watersheds are further subdivided into smaller portions, the number of digits increases (Fig. 4). For example, the Buffalo River is an 8-digit sub-watershed (11010005) of the White River and Richland Creek is a 10-digit sub-watershed (110500503) of the White River that flows into the Buffalo River and Falling Water Creek is a 12-digit sub-watershed (11050050307) of the White River that flows into Richland Creek. In Arkansas there are 58 eight-digit watersheds, 308 ten-digit watersheds, and 1,557 twelve-digit Watersheds. Currently, watersheds of

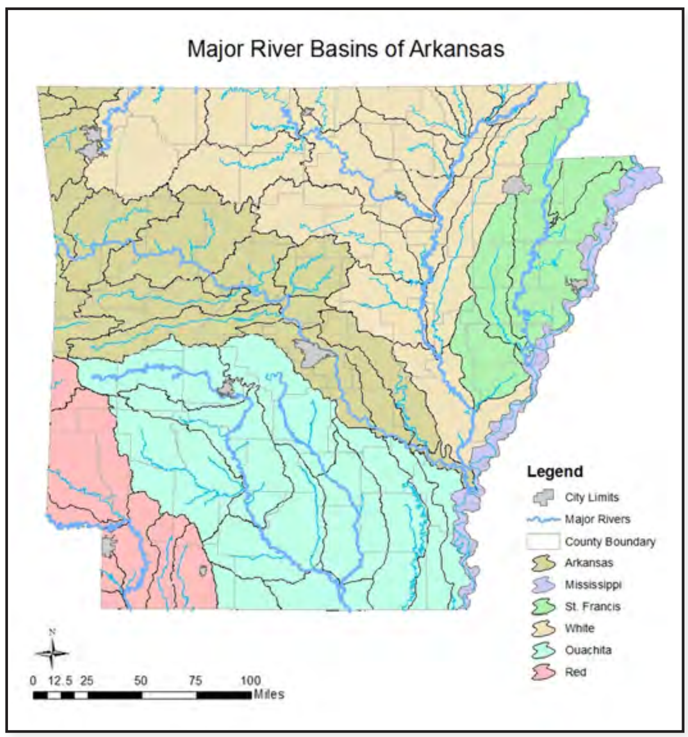


Fig. 3. The six major river basins of Arkansas
(Image courtesy of Arkansas Department of Environmental Quality)

Arkansas are only identified to the 12 digit level, although you could keep going. Additionally, the United States Geological Survey (USGS) spatially delineates and certifies HUC boundaries. The 8 and 12-digit HUCs are certified, thus their boundaries are the "standard" to be used in all planning, modeling, etc. The 10-digit HUCs have not been certified. Thus, their boundaries do not have a "standard" and their delineation is considered arbitrary and the boundaries are only defined by whomever is doing the delineation.

How Do Arkansans Use Watersheds?

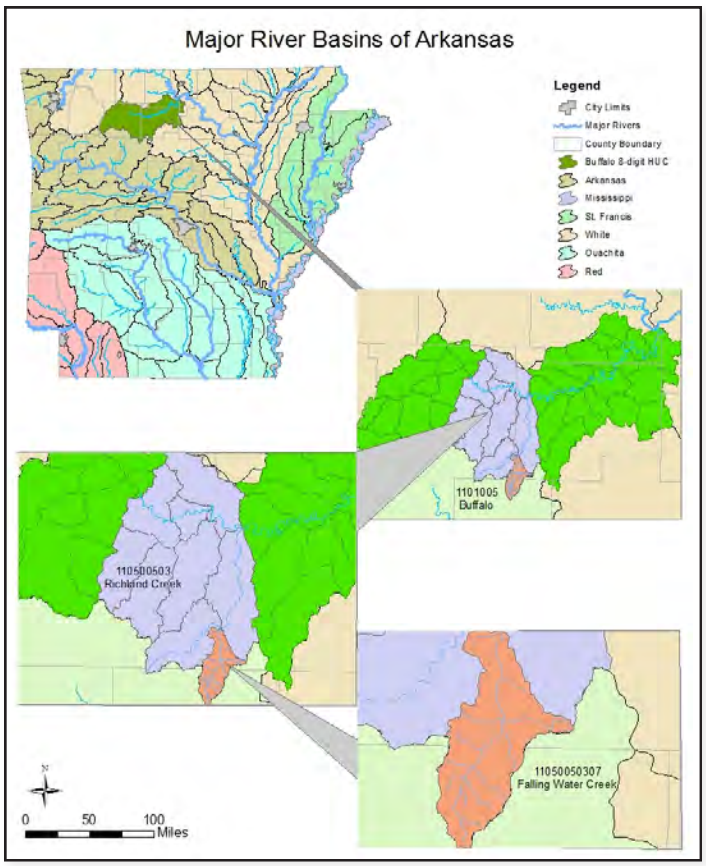


Fig. 4. Hydrologic unit code (HUC) graphic showing the nesting of smaller watersheds within larger watersheds *(Image courtesy of Arkansas Department of Environmental Quality)*

The uses of watersheds by Arkansans are varied and numerous, but domestic water, agriculture, fish and wildlife habitat, industry, transportation, natural resource extraction, recreation, living and residential and commercial development are some of the more general uses (Table 1).

On a typical day, Arkansans get 34 percent of their water from **surface water** sources and 66 percent from **groundwater** sources. The largest uses of water in Arkansas are for irrigation, thermoelectric power generation, industry and public supply (Holland, 2007).

Principles of Watershed Hydrology

The word "**hydrology**" literally means "the study of water," and **watershed hydrology** is defined as the study of water as it interacts with or flows across and through a watershed. The **hydrologic cycle** or water cycle is the most common principle of hydrology (Fig. 5). The water cycle is one of the, if not the largest, physical processes on earth. It connects the atmosphere, land masses and waters of the Earth. The water cycle is a

Table 1. Watershed Uses of Arkansas

Uses of a Watershed	Examples
Recreation	Boating, fishing, swimming, water skiing, hiking, camping, hunting
Water consumption	Drinking, irrigation, gardening and lawns, washing
Transportation	Bridges, shipping, roads, railroads, airports
Industrial	Thermal cooling, waste treatment, power production
Extraction of natural resources	Rock quarrying, natural gas extraction, mining
Agriculture	Crop and forage production, irrigation, logging
Commercial development	Buildings, retail stores, parking lots, sidewalks, roads
Living	Houses, apartments, driveways

continuous process that is driven by solar energy and gravity that migrates moisture from the atmosphere to the earth's surface then back to the atmosphere.

The components of the water cycle include evaporation, condensation, precipitation, **infiltration**, transpiration and **runoff**. **Evaporation** is the process of liquid water transforming into water vapor and returning to the atmosphere. **Transpiration** is the process of water evaporating from within plants to the atmosphere. **Condensation** is the process in which water vapor transforms into liquid. The process of condensation results in cloud formation, precipitation, dew, fog, frost and mist. **Precipitation** is the delivery of water from the atmosphere back to the Earth.

Once precipitation occurs, it can follow five different pathways associated with the water cycle.

1) Precipitation can evaporate from the air or from intercepting surfaces such as vegetation, structures, water bodies or even bare soil before returning to the atmosphere.

2) Precipitation can be absorbed into the soil through infiltration and recharge groundwater formations.

3) Water vapor can be released from plants to the atmosphere in the process of transpiration during plant photosynthesis or respiration.

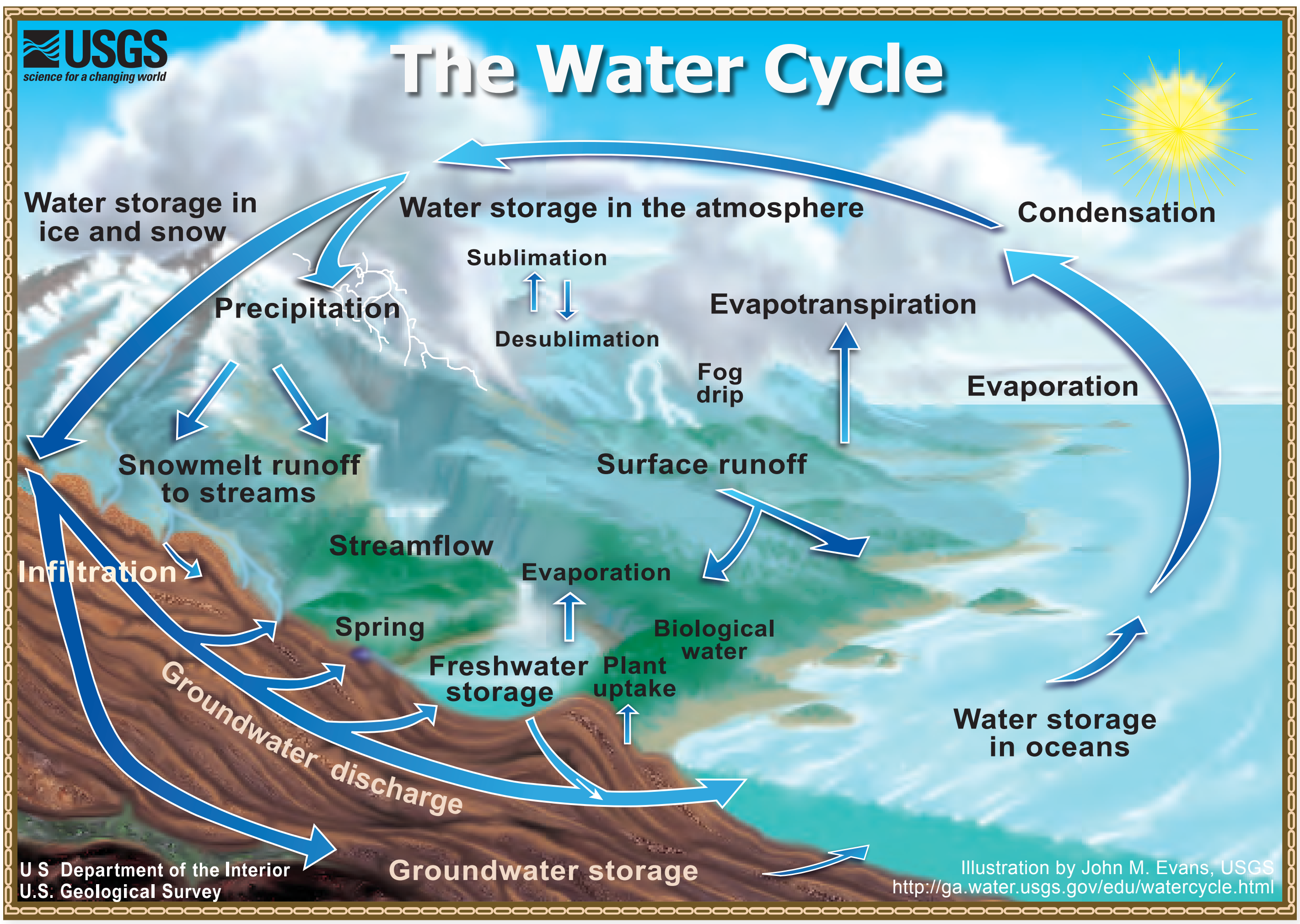


Fig. 5. Water cycle *(Image courtesy of U.S. Geological Survey)*

4) Precipitation can be stored for a period of time in ice caps, glaciers, lakes, oceans and deep groundwater.

5) Precipitation can run off from land surfaces into floodplains, streams, lakes, wetlands and oceans.

No matter which pathway precipitation takes, it will continue to cycle and recycle through the hydrologic cycle in all watersheds across the entire earth.

Natural Watershed Functions

Watersheds have developed over long periods of time in response to chemical, physical and biological factors such as **climate** changes, geologic processes and, more recently, humans. Additionally, watersheds are constantly adjusting in response to changes resulting from land use, geology, climate and their five hydrologic and ecologic functions. The five hydrologic and ecologic functions of watersheds include:

1) water catchment
2) water storage
3) water release
4) **biogeochemical** reactions
5) plant and animal habitat

Function 1: Water Catchment

Water catchment is the process in which water from the atmosphere is collected or absorbed within a watershed. When water is absorbed, it soaks or infiltrates into the soil profile or groundwater. Infiltration is the process in which water moves or drains into the soil. Many factors such as intensity of precipitation, the amount of vegetation, topography of land, soil type and structure and climate influence infiltration rates.

Function 2: Water Storage

When water is caught by the watershed, it can be stored within soil, **soil pores** or between rock formations to varying degrees, depending on the soil type, structure, depth and underlying geologic formations (Fig. 6). For example, sandy soils store much less water than soils with a higher percentage of silt or clay because sandy soils have less **porosity**. Soil porosity refers to the space between and within soil particles, which consists of various amounts of water and air. Porosity depends on both soil texture and structure. For example, a fine soil has smaller

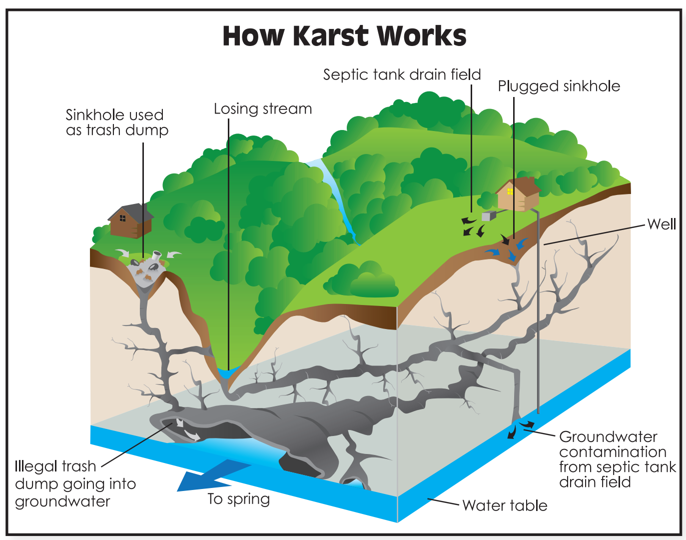


Fig. 6. Karst topography allows surface water to easily drain into groundwater and allows groundwater to become surface water quickly in some cases *(Image courtesy of University of Arkansas System Division of Agriculture)*

Fig. 7. A karst feature on Crooked Creek that allows surface flow to become subsurface flow *(Image courtesy to Tate Wentz from Arkansas Game and Fish Commission - Stream Team)*

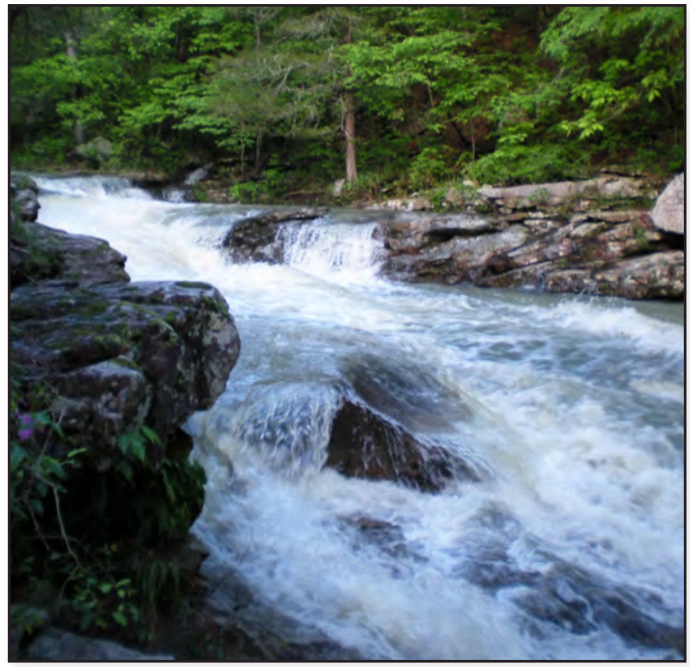


Fig. 8. Spirits Creek in Crawford County, Arkansas *(Image courtesy of Tate Wentz with the Arkansas Game and Fish Commission)*

but more numerous pores than a coarse soil. A coarse soil has bigger particles than a fine soil, but it has less porosity, or overall pore space. Water can be held tighter in small pores than in large ones, so fine soils can hold more water than coarse soils. Water stored in soil can be in the form of water vapor or liquid water saturating the soil such as at the **water table**.

Subsurface flow (Fig. 7) is the movement of water through soil pore spaces and rock crevices. As water moves underneath the land surface, it can collect in **aquifers**. The two major types of aquifers are **unconfined aquifers**, such as **alluvial aquifers** that store water in air spaces in-between alluvial sediment particles, and **confined aquifers**, such as **artesian aquifers**. Confined aquifers are often found within bedrock or certain geologic formations and landscapes, such as **Karst** landscapes, which confine the aquifer. The climate, type and amount of vegetation, land use and water use can also influence how much water is stored within a watershed.

Function 3: Water Release

Water release (Fig. 8) from a watershed occurs when water moves across the land's surface as runoff or when water from a groundwater formation surfaces at a spring or seeps into a stream, lake or other body of water. Water is also released from a watershed when it is pumped out of the ground to irrigate a crop or serve as a drinking water source. Water release can be modified by human actions such as land use changes or by natural occurrences such as climate change. Often, land use changes can cause environmental, social and economic problems for communities such as flooding.

Function 4: Biogeochemical Reactions

Biogeochemical refers to the interaction between living things, physical elements and chemical processes that occur between the three. In almost all cases, the details of these interactions are complex while the basic concepts can be easily grasped. For example, most of Arkansas was covered by ocean waters once upon a time. During that period, the calcium within exoskeletons of aquatic organisms would fall to the ocean floor when the organisms died leaving large deposits that influenced the geology. When the ocean receded, what used to be the ocean floor became the land surface. Since the new land surface was now exposed to the forces of wind, air, rainfall, terrestrial plants and organisms, and others, the shape, vegetation and wildlife of the Ozarks, as we know them today, began to form.

Function 5: Plant and Animal Habitat

Habitat is the place where living things can be found and is the place where they live, grow and reproduce (Fig. 9). Healthy habitat contains food, water and shelter. Our human habitat could be the town where we live, which has room for our house, workplace, exercise gym and grocery store. For plants and animals, habitat could be a forest, a wetland, a spring, a puddle, and so on. Because there are many living things that all need food, shelter and water, the type of habitats for each of these living creatures can be very specific and diverse. Healthy habitat is critical to all living things as well as the function of the watershed.

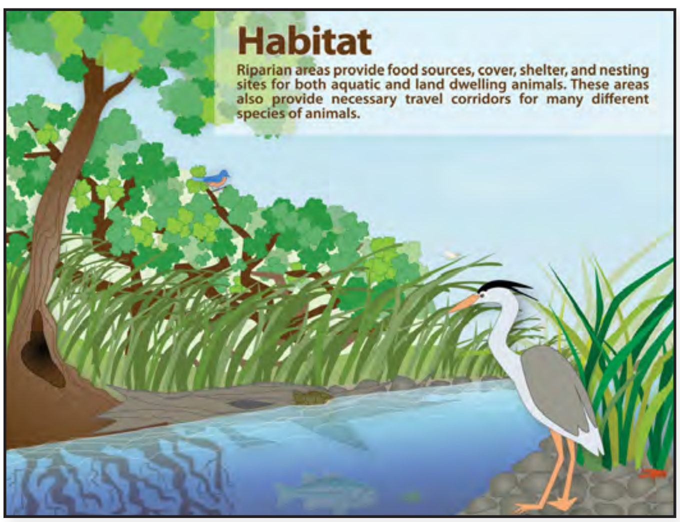


Fig. 9. Illustration of riparian habitat *(Image courtesy of University of Arkansas System Division of Agriculture)*

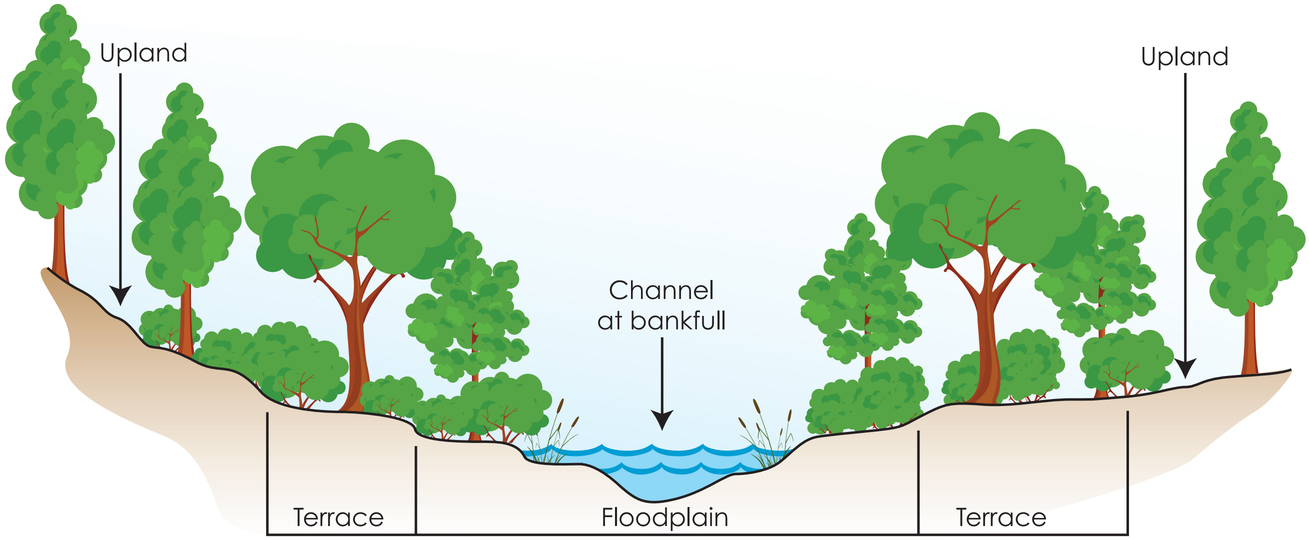
Natural Watershed Features

Natural features of healthy watersheds are also features of healthy communities of people, plants and animals. The natural features of watersheds are bodies of water, riparian areas, floodplains, valleys, uplands and open undeveloped spaces. Each of these landscape features is connected and performs critical natural functions known as **ecosystem services**. Ecosystem services are natural processes that provide social, economic or environmental benefits. For example, the natural features of the watershed capture, store and release water in a way that filters out pollutants, minimizes property loss, minimizes flooding and maximizes groundwater recharge in addition to providing habitat for our food sources and other living creatures.

Waterbody is a term that refers to streams, ponds, lakes/reservoirs, wetlands, estuaries, seas or oceans. Waterbodies can be classified as flowing (**lotic**) systems such as streams or rivers, or non-flowing (**lentic**) systems like lakes or ponds.

Uplands are the portions of watersheds (Fig. 9) located at higher elevations above waterbodies. Watershed divides are usually located beyond floodplains in uplands such as foothills, hills and mountains. Uplands are the highest part of the landscape and where water usually drains downhill into valleys, floodplains and waterbodies.

Valleys are elongated lowlands between ranges of mountains, hills or other uplands that often contain floodplains, wetlands, riparian areas, streams and lakes.



Riparian Ecosystem Cross Section
Steep to Gentle Terrain

Fig. 10. Riparian ecosystem cross section (*Image courtesy of University of Arkansas Division of Agriculture*)

Floodplains are the areas of land that surround streams and rivers and are prone to flooding. There are three types of flooding: **riverine**, **flash** and **drainage**. After big or intense precipitation events, water draining into streams may be more than a stream channel can contain. At this point, water leaves the **bankfull** stream channel and spills out onto the floodplain where it can spread out, slow down and soak into the soil or flow back into the waterway. Flooding is a natural and inevitable occurrence. Rivers, lakes and other waterbodies have always overflowed their banks periodically to inundate nearby land. A healthy stream and floodplain system increases groundwater recharge and ensures that this valuable underground water, often destined for agriculture and human consumption, will be both abundant and of high quality. The presence of natural floodplains helps to remove sediment from runoff water and reduces in-stream pressure on streambanks, which can in turn reduce streambank erosion. Undeveloped floodplains provide diverse wildlife habitat for aquatic and terrestrial species.

Riparian areas are the places where the water meets the land. The word **riparian** literally means "of or belonging to the river bank." Riparian areas naturally occur as non-cultivated areas of vegetation next to all water bodies and extend out into the floodplain of a particular body of water. Riparian areas physically separate a body of water from an upland habitat (Fig. 10). This area can include **wetlands** that are frequently covered with water and contain plants and animals adapted to living in those conditions. Riparian areas serve several functions such as:

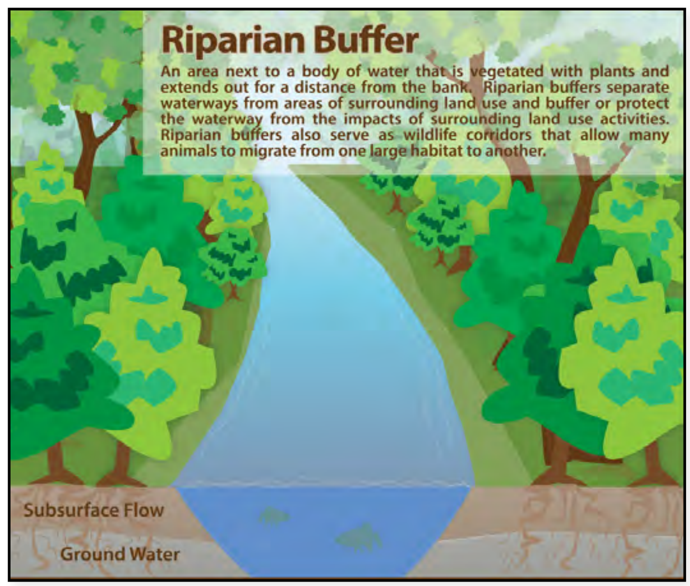


Fig. 11. Illustration of riparian buffer (*Image courtesy of University of Arkansas System Division of Agriculture*)

- ***Stabilizing streambanks***: Roots of plants hold soil in place, and leaves and stems provide friction and cover which decreases water velocity of runoff and floods and prevents erosion (Fig. 11).
- ***Pollutant filtration***: Plants trap sediment, nutrients, trash and other pollutants, which prevents them from making their way into waterbodies.
- ***Temperature regulation***: Plants provide shade to water, which decreases water temperature and increases the capacity of water to contain oxygen.
- ***Habitat***: Plants provide food sources, shelter and reproductive **substrate**.
- ***Flood mitigation***: Plants slow downstream water movement, while the wetlands and the floodplains allow places for water to pond, slow down, spread out, soak in and be absorbed by plants.

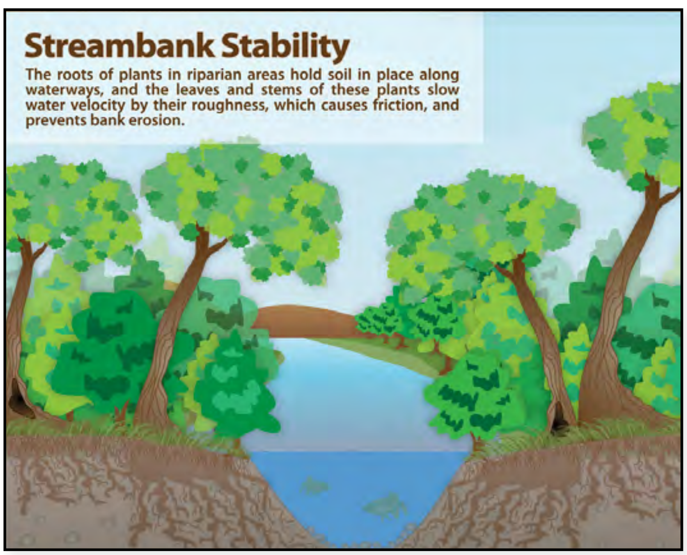


Fig. 12. Illustration of plant roots providing streambank stability *(Image courtesy of University of Arkansas System Division of Agriculture)*

As all watersheds are a little different, so are the many streams within them that drain the water away from the uplands and down into the river valleys. One distinct difference between different streams is their order.

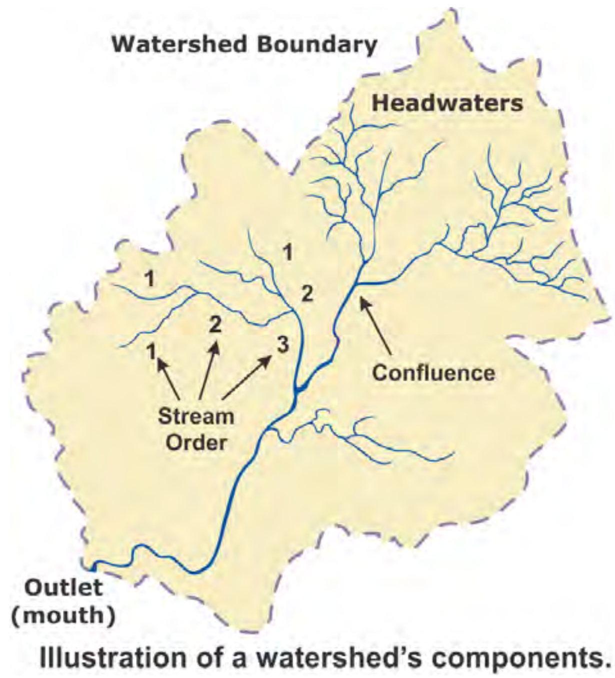


Fig.13. Illustration of headwaters, confluence, stream order and other watershed components *(Image courtesy of Arkansas Department of Environmental Quality)*

Stream order is the relative size, position, or rank of a stream channel segment in a drainage network. First-order streams have no tributaries, but are tributaries to larger, higher order streams.

When using stream order to classify a stream, the sizes range from a first order stream arising in the fold of a hillside all the way to the a twelfth-order stream such as the Amazon. A first-order stream is the smallest of the world's streams and consists of small tributaries. These are the streams that flow into and "feed" larger streams (Fig. 13) but do not normally have any water flowing into them. In addition, first - and second-order streams generally form on steep slopes and flow quickly until they slow down and meet the next order waterway.

First- through third-order streams often are headwater streams and constitute any waterways in the upper reaches of the watershed. It is estimated that over 80 percent of the world's waterways are these first- through third- order, or headwater, streams.

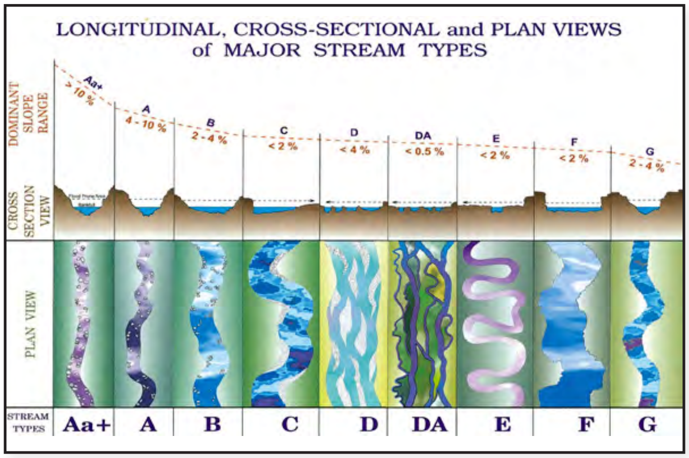


Fig. 14. Longitudinal, cross-sectional and plan views of major stream types *(Image courtesy of Wildland Hydrology)*

KEY POINTS TO REMEMBER:

- A watershed is an area of land that water flows across or under as it drains to a body of water.
- Watersheds are everywhere!
- Watersheds are used for many different purposes.
- Watersheds are a critical component of the water cycle, which is an endless process that cycles water and distributes it across the earth.
- Watersheds have hydrological and ecological functions.
- Watersheds have natural features that help them perform these hydrological and ecological functions.

Going up in size and strength, streams classified as fourth- through sixth-order are medium streams, while larger streams (up to 12th order) are considered rivers. For example, to compare the relative size of these different streams, the Ohio River in the United States is an eighth- order stream while the Mississippi River is a tenth-order stream. The world's largest river, the Amazon in South America, is considered a twelfth-order stream

There are three basic categories of streams based on the duration of water flow in the stream, channel definition and connectivity to groundwater.

- **Ephemeral streams** are streams that are dry most of the year, but in general will have flow for less than 30 days a year. Ephemeral streams flow only in immediate response to intense precipitation events.
- **Intermittent streams** are those that generally flow for 30 days or more a year. These streams are often referred to as seasonal streams as they usually flow in fall, winter or spring when the groundwater table is more likely raised.
- **Perennial streams** usually flow throughout the entire year and are connected by **riffles**. Sometimes the flow of these streams will not be visible and pools will not be connected by riffles. Instead the **pools** will endure from **groundwater inflow**, aquatic communities will persist and the water that can't be seen in-between pools may be moving below the streambed. The flow of water into and in these systems is greatly affected by the features of the watershed such as **topography**, vegetative density, land use, soils, geologic formations and climate.

These three main stream types can also be further subdivided (Fig. 13) into types based on their location in uplands and valleys (Fig. 14), their streambed composition and flow patterns (sometimes referred to as pattern, profile and dimension). Even though streams can be subdivided into different types, they all have similar characteristics such as **runs**, riffles, **glides** and pools. Additionally, all streams naturally **meander** and have **point bars** and **thalwegs**.

All features of the natural watershed have developed over time and perform necessary functions in relation to

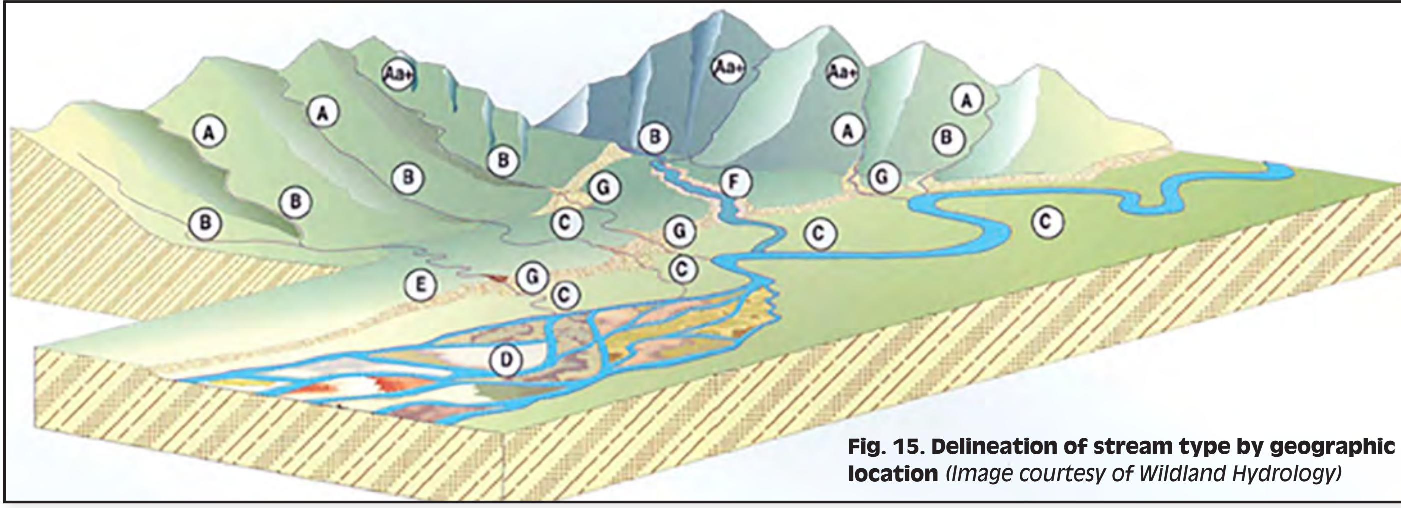


Fig. 15. Delineation of stream type by geographic location *(Image courtesy of Wildland Hydrology)*

water catchment, storage and release. Additionally, the natural features of watersheds provide wildlife habitat and allow room for necessary biogeochemical reactions to take place. All parts of the watershed are important and, much like with anything else, a change in one area will likely result in an equal and opposite change somewhere else. For example, if the catchment ability of the floodplain or upland areas is reduced by development and impervious surfaces, the storage of water in the soil and groundwater will be lessened and the release of water as runoff will increase. This in turn often results in increased bank erosion and flooding downstream.

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Notes

Chapter 3

Overview of Water Quality and Watershed Impairments

Arkansas Watershed Steward Handbook

Water Quality

The previous chapter presented the concepts of natural watershed functions and features. This chapter will address how water quality within a watershed is related to the natural and human made features and functions of the watershed as well as specific water quality laws and policies in Arkansas.

What Is Water Quality?

The term "**water quality**" describes a broad spectrum of items related to how we identify water concerns and how we collectively address them. The U.S. EPA Clean Water Act requires states to establish water quality standards and they must be comprised of three components: designated uses, water quality criteria, and an anti-degradation policy. Thus, the term "**water quality**" can be confusing and mean different things to different people. The U.S. EPA defines water quality as, "the chemical, physical and biological characteristics of water, usually in respect to its suitability for a **designated** use." Examples of designated uses (Fig. 16) in Arkansas are:

- Agricultural Water Supply
- Domestic Water Supply
- Ecologically Sensitive Waterbody
- Extraordinary Resource Waters
- Fisheries (Fishable)
- Industrial Water Supply
- Natural and Scenic Waterways
- Primary Contact (Swimmable)
- Secondary Contact (Wadable)
- Other Uses

Fig. 16. Kayakers on Lee Creek, a designated Extraordinary Resource Water *(Image courtesy of University of Arkansas System Division of Agriculture)*

IN THIS CHAPTER, YOU WILL LEARN ABOUT:

- Water quality
- Point and nonpoint sources of pollution
- Consequences of impaired water quality and quantity
- Watching water quality
- Water law and policy in Arkansas
- Water quality testing, monitoring and regulation
- Water quality assessments
- Water quality impairments

By examining the interaction of the surrounding land uses, environment, the organisms that live in a watershed, and water quality measurements, an overall assessment of the health, or integrity, of a waterbody watershed can be determined. Some of the key chemical, physical, and biologic parameters used in water quality assessments will now be presented in Table 2.

Table 2. Common Water Quality Parameters

Chemical Water Quality Parameters
Dissolved oxygen (DO) Nutrients (nitrogen, phosphorus) Total dissolved solids (TDS) Metals Conductivity pH
Physical Water Quality Measurements
Streamflow Total suspended solids (TSS) Turbidity Water temperature
Biological Water Quality Measurements
Benthic macroinvertebrates Biochemical oxygen demand (BOD) Fecal bacteria Submerged aquatic vegetation (SAV)

Chemical Water Quality Parameters

Chemical water quality measurements include evaluations of both dissolved and particulate substances like nutrients, metals, minerals, emerging contaminants and pesticides. Following is a discussion of several common chemical water quality parameters.

Dissolved oxygen (DO) is the measure of gaseous oxygen that is dissolved in water. Oxygen becomes dissolved into water through the process of diffusion. Diffusion usually occurs from the agitation or rapid movement of water in riffles, waterfalls or waves, which allows oxygen (O_2) from the atmosphere to enter the water or as a by-product of photosynthesis in aquatic plants. Dissolved oxygen is removed from the water through respiration by aquatic wildlife and the decomposition of organic matter like algae (Fig. 16).

Fig. 17. Sedimentation can enrich waterways with nutrients leading to excessive algae growth, low dissolved oxygen and decreased aquatic wildlife diversity *(Image courtesy of Tate Wentz, Arkansas Department of Environmental Quality)*

Warmer water holds less DO than colder water, and adequate DO is necessary for high- quality water that can support diverse and sensitive aquatic communities. Several factors can affect DO concentrations in water, such as:

- Riparian vegetation (canopy cover)
- Nutrient concentrations
- Dissolved or suspended solids
- Volume and velocity of water
- Climate and season
- Altitude
- Type and number of aquatic wildlife
- Groundwater inflow
- Decaying organic matter

Total dissolved solids (TDS) is a chemical measurement of the total amount of organic and inorganic solids in water that can pass through a two micrometer filter (human hair is about 90 micrometers!). Common inorganic solids in water include: calcium, magnesium, potassium, sodium, sulfate, and chloride. Common organic solids include decaying plants and animals, and fecal matter. The higher the level of TDS is, the higher the **conductivity** of the water. Conductivity is a measurement of the water's ability to conduct electrical current and is affected by the amount of TDS present in water. Groundwater often has a higher conductivity and TDS because of the water's interaction time with rock and soil, and usually contains higher amounts of dissolved metals and minerals.

Many **metals** are found in the waters of Arkansas. Metals present in waterbodies can be naturally occurring from geologic formations, deposited from the atmosphere, or they can be discharged as permitted point sources or as non-permitted and nonpoint sources of pollution. Metals concentrations in water can cause aquatic organisms to be unsafe for human consumption and kill aquatic organisms. Metal concentrations in water are greatly affected by **pH** of water.

pH is a measurement of how acidic or basic a solution is (Fig. 18). It is measured on a scale of 0 (very acidic) to 14 (very alkaline). A measurement of pH 7 is neutral and represents the pH of distilled water. While a pH range of 6.0 to 9.0 will generally support a wide range of freshwater fish and other aquatic organisms. In Arkansas, there are areas where water naturally has pH ranges above or below this average.

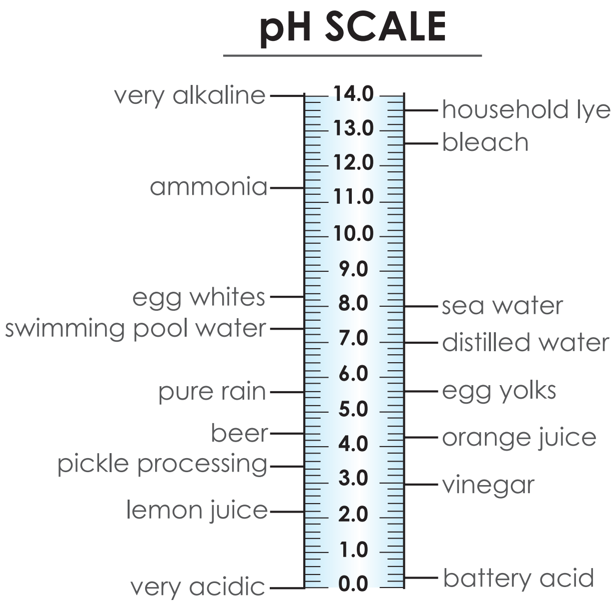


Fig. 18. pH scale

The pH of a waterbody can have a significant effect on aquatic life. Water that is either too acidic or too basic can kill aquatic plants and animals. In addition, pH can affect the solubility and toxicity of other substances found in water. Runoff from urban and industrial areas may contain cadmium, chromium, lead and other elements that, under normal conditions, are insoluble, meaning they do not dissolve in water and are less toxic to aquatic organisms. When the pH of water is too low (the water is too acidic), many of these substances become more soluble and may become toxic to aquatic plants and animals.

Nutrients are often included as a measure of water quality because, in excess, some can cause environmental concerns. The primary nutrients of concern in water are **nitrogen** (N) and **phosphorus** (P). Nitrogen is one of the most abundant and dynamic elements on earth. About 80 percent of the air we breathe is nitrogen. It is found in the cells of all living things and is a major part of proteins found in many different forms. A few common forms of nitrogen in the environment that frequently cycle from one form to another are **ammonia** (NH_3), **ammonium** (NH_4), **nitrate** (NO_3) and **nitrite** (NO_2).

As an essential nutrient, all life forms need nitrogen to survive. Optimum levels of nitrogen applied to land helps plants grow, and optimum amounts of proteins produced with nitrogen help animals grow. However, excessive amounts of nitrogen in water can harm water quality by causing excessive plant growth. Excessive plant growth can simply be a nuisance and asthetically unpleasing, or certain types of cyanobacteria or blue-green algae can be harmful. **Harmful algal blooms (HABs)** have become more prevelant in across in the United States in the last several decades due to excessive nutrients. The cyanobacteria responsible for HABs release cyanotoxins that can cause dermitatis, liver damage, or even death to livestock or pets. Arkansas has several sources of information regarding HABs, including the state's response plan and ways for you to identify HABs (Austin et al. 2018, DEQ 2019).

Similarly, phosphorus (P) is a nutrient that is required by all forms of life on earth, is a naturally occurring element and can harm water quality very quickly, just like nitrogen, when too much of it ends up in waterbodies.

Fig. 19. Eutrophication process at Lake Fayetteville
(Image courtesy of Lake Fayetteville Watershed Partnership)

The over-enrichment of water with nutrients is called eutrophication (Fig. 19). **Eutrophication** is a natural process that usually takes centuries to occur but can be accelerated by human activities and occur in much shorter time periods. Both nitrogen and phosphorus can cause rapid plant and algae growth (eutrophication). When plants and algae die, bacteria in the water begin to use up oxygen as they breakdown the plant material. This leads to low DO content of water or **hypoxia** such as found in the Gulf of Mexico, and can cause fish kills, and HABs. Common sources of both nitrogen and phosphorus in Arkansas are:

- Fertilizers
- Animal and human wastes
- Industrial discharges
- Wastewater treatment facilities
- Streambank erosion
- Low density development

Physical Water Quality Parameters

Physical water quality parameters can be measured to give an indication of water quality, just as chemical water quality parameters. However, physical measurements are direct measures of the physical attributes of a body of water. Following is a discussion of several common physical measurements of water quality.

Streamflow, or **discharge**, is the volume of water that moves past a fixed point during a certain period of time. Streamflow affects the concentrations of dissolved oxygen, natural substances, pollutants in the water as well as the temperature and turbidity. Therefore, streamflow should always be considered when measuring water quality.

Streamflow is a function of cross-sectional area multiplied by velocity *(feet × feet × feet/second = cubic feet per second)*. It is most often expressed as cubic feet per second (cfs). The flow of a stream is directly related to the amount of water moving through the watershed and into the steam or river channel. The discharge rate of a river or stream varies over time. For example, streamflow during the summer may be much lower than in the spring or after a heavy rain.

Total suspended solids (TSS) include solids that float in water or on its surface and are large enough to be trapped by a filter. Sediment, organic matter, decaying plant and animal matter, industrial wastes and sewage are all types of TSS. High levels of TSS can make water murky or **turbid**, harm wildlife and cause impairments.

If TSS in a water body are very high, it will alter the physical, chemical, and biological characteristics of water as compared to a body of water with low TSS. For example, water with high TSS which is murky because of the additional suspended solids can in turn do the following things: 1) increase water temperature, which causes oxygen levels to fall; 2) decrease photosynthesis, resulting in lower oxygen levels; and 3) alter the types of aquatic communities that can exist.

Water with a high TSS (Fig. 20) often has higher concentrations of bacteria, nutrients, pesticides, and metals. These pollutants may be attached to particles of sediment that are washed into a body of water during a storm. Once in the water the pollutants can be released from the sediment or travel farther downstream. Water with a high level of TSS can cause problems for industry using the water because the solids may clog or scour pipes and machinery.

Fig. 20. Turbid water has a high amount of total suspended solids *(Image courtesy of Nathan Wentz, Arkansas Department of Environmental Quality)*

Water temperature is a good indicator of rates that biological and chemical processes occur in bodies of water. Temperature affects the oxygen content of water, the rate of photosynthesis by aquatic plants, the metabolic rates of aquatic organisms and the sensitivity of organisms to toxic wastes, metals, parasites and diseases. Water temperature can be changed by weather, the removal of streambank vegetation that provides shade, the impoundment or release of water by a barrier such as a dam, the discharge of industrial cooling water, the runoff of urban stormwater or the inflow of groundwater.

Fig. 21. Biological water quality assessment by sampling for macroinvertebrates *(Image courtesy of University of Arkansas System Division of Agriculture)*

Biological Water Quality Measurements

The biological characteristics of water are a measure of the water's ability to support aquatic plant and animal life. Some of the common biological measurements (Fig. 21) are presented. **Benthic macroinvertebrates** are bottom-dwelling (benthic) organisms that are large enough to be seen with the naked eye (macro) and lack a backbone (invertebrate). Examples are aquatic insects (hellgrammites, mayflies, caddisflies and stoneflies), worms, crayfish and clams. Most benthic macroinvertebrates complete part of or all of their life cycles among submerged rocks, logs or vegetation.

Fig. 22. Benthic macroinvertebrates that were collected using kick nets as part of a biological water quality sampling activity *(Image courtesy of Arkansas Game and Fish Commission Stream Team)*

These organisms (Fig. 22) are biologically important because they play a vital role in the natural flow of energy and nutrients. Many invertebrates also feed on algae and bacteria. Benthic macroinvertebrates are excellent **indicators** of the health of a waterbody because many of them have very specific tolerances to pollutants and react to changes in water quality. Consequently, if a stream is inhabited only by macroinvertebrates, which have a high tolerance to pollution, while the more sensitive species are missing, there is likely to be a pollution problem.

Fecal bacteria are measured as colony-forming units per 100 milliliters of water. Fecal bacteria are naturally occurring microscopic organisms, such as E. coli and fecal coliform bacteria found in the feces of humans and other warm-blooded animals, and are commonly found in almost all streams and lakes. The amount of fecal bacteria will vary but can occasionally be found in high enough concentrations to impair or limit a designated water use such as swimming. When fecal bacteria are found in high concentrations in water, they serve as an indicator that other pathogenic organisms, such as viruses and parasites, might be present in high enough concentrations to cause some type of illness if primary contact were to occur. Fecal bacteria along with other pathogens can enter a body of water in the effluent from wastewater treatment plants and septic systems or directly from wildlife, domestic pets, livestock and humans. Fecal bacteria and other pathogens can also end up in water indirectly when stormwater runoff flowing over the land surface carries the organic and other nonpoint pollutants it encounters along its pathway to the nearest storm drain, creek, lake, or other waterway.

Biochemical oxygen demand (BOD) measures the potential amount of dissolved oxygen used by microorganisms when they decompose organic matter in water. Sources of organic matter are woody debris, dead plants and animals, animal manure, wildlife, effluents from industry, failing septic systems and urban stormwater runoff. As the amount of organic matter in water increases, the number of microorganisms and the amount of oxygen they use increase. The result of excessive BOD is the same as the result of inadequate dissolved oxygen – aquatic organisms become stressed and can suffocate and die.

Diatoms, Algae, Submergent and Emergent Aquatic Vegetation are plants that grow on sediment below the surface of the water, or grow from below the water surface and emerge. These plants may appear as slime, rooted or floating. This vegetation supplies food and shelter to fish and invertebrates, adds oxygen to the water, traps sediment, reduces turbidity, and absorbs nutrients such as nitrogen and phosphorus. When water contains a variety of plant species, the quality of the water is good. When the number and diversity of plant species start to decline, chances are that something has happened to degrade the water quality.

Point and Nonpoint Sources of Pollution

What causes the chemical, physical and biological quality of water to become impaired? The **United States Environmental Protection Agency (EPA**) has defined two sources of pollution known as "point source" and "nonpoint source" (NPS). **Point source pollution** is pollution that is discharged from a clearly defined, fixed point such as a pipe, ditch, channel or sewer (Fig. 21).

In Arkansas, one major source of point source pollution is the millions of gallons of wastewater **effluent** discharged by industrial facilities and municipal sewage plants into surface waters every day. Discharged wastewater, even when treated, can contain substances that are harmful to both wildlife and humans. The level of impact these discharges may have on water quality can vary from minimal to significant depending on a number of watershed and plant management factors

Fig. 23. Point source discharge from a municipal wastewater treatment facility *(Image courtesy of CH2M Hill)*

Nonpoint source pollution is pollution that does not originate from a clearly defined, fixed location. Instead, NPS pollution originates from many different places across the landscape, most of which may not be readily identified (Fig. 24). For this reason, NPS monitoring is extremely difficult because the contaminants are not easily traceable to an exact source or point of origin. NPS pollutants are generally carried off of the land by runoff from stormwater or excessive irrigation, or migration through groundwater. As the runoff moves over the land, it picks up and carries away natural and man-made pollutants, finally depositing them in surface water or even in underground sources of drinking water.

DID YOU KNOW?

There is an average 2,029 regulated point source discharges in Arkansas per year since 2012. Of those discharges, 735 are wastewater from sewer systems. **Source:** *DEQ, 2019*

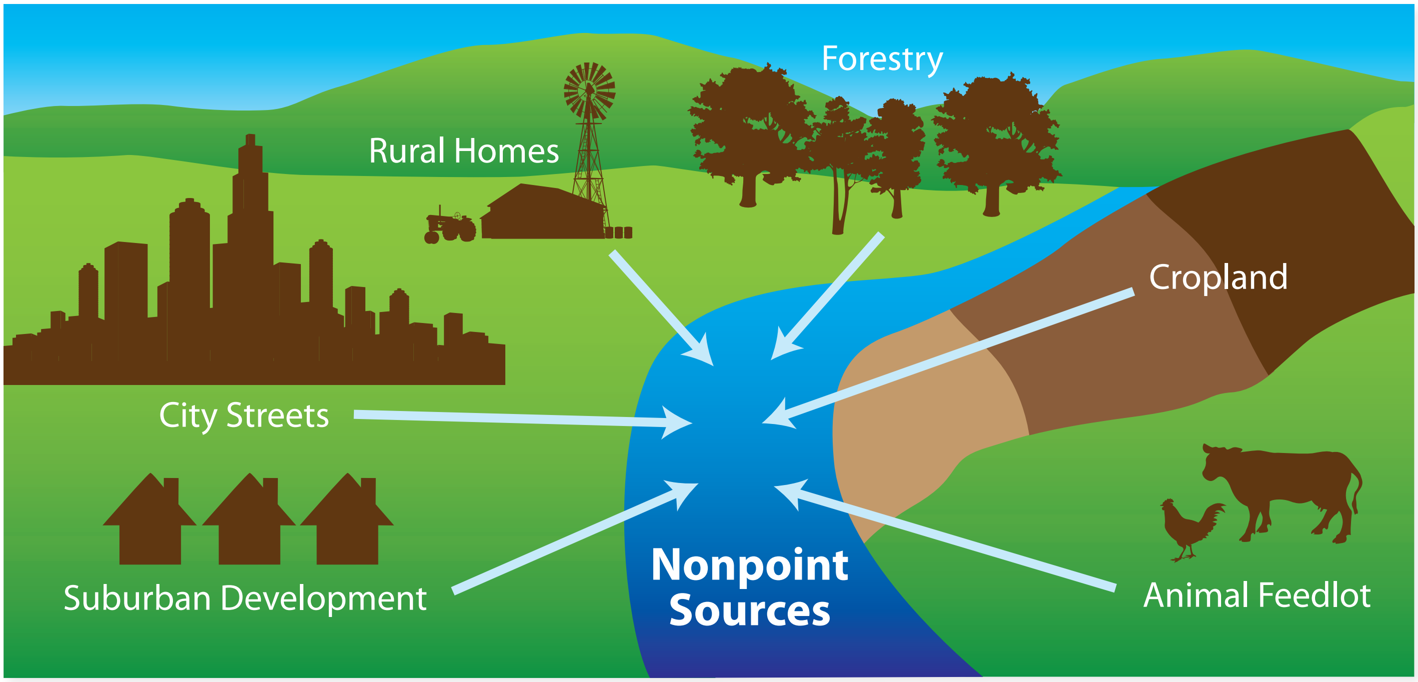


Fig. 24. Nonpoint sources of pollution across the landscape are numerous and varied *(Image courtesy of University of Arkansas System Division of Agriculture)*

DID YOU KNOW?

The EPA estimates that each American household generates 20 pounds of chemical waste each year, much of which is disposed of improperly and can end up in rivers, lakes and aquifers. In an effort to control this nonpoint source pollution, many communities have set up chemical waste collection programs to encourage the proper disposal of household hazardous wastes.

Source: *U.S. EPA*

Both point and nonpoint sources of pollution have impacted many of the waterways of Arkansas. However, NPS pollution is the leading cause of the nation's water quality problems. The EPA estimates that more than half of all water pollution in the U.S. originates from nonpoint sources. There are five main categories of nonpoint source pollutants (Table 3).

Bacteria

Most bacteria are harmless to healthy people, but some bacteria can be pathogenic or disease causing. Disease-causing bacteria and viruses that end up in water can come from many sources, including domestic pets, failed septic systems, boat discharges, wildlife and livestock. Whether these bacteria are directly deposited into water or are washed into waterways by stormwater runoff, they can pose severe health and environmental risks and can have major economic impacts. In Arkansas, 38 assessed waterways have been listed as impaired because of excessive bacteria levels (Arkansas Department of Environmental Quality, 2008).

DID YOU KNOW?

A single gram of dog feces contains 23 million fecal coliform, a type of bacteria that can be harmful to humans and can indicate the presence of pathogenic bacteria and viruses.

Source: *van der Wel, B. 1995*

Table 3. Main Categories of Nonpoint Source Pollutants

POLLUTANT	NONPOINT SOURCE	EFFECTS
Bacteria (coliform)	Pet waste, septic systems, livestock, boat discharge, wildlife	Introduces disease-causing organisms to surface water and groundwater, resulting in swimming restrictions and health advisories
Nutrients (phosphorous and nitrogen)	Fertilizers, livestock, pet, and animal waste, septic systems, sub-urban/urban development, soil erosion, yard waste	Promotes algae blooms and aquatic weed growth, which can deplete oxygen, increase turbidity and alter habitat and recreation conditions
Sediment (soil and rocks)	Construction, driveways, ditches, earth removal, dredging, mining, gravel operations, agriculture, road maintenance, forestry, dirt roads, streambank erosion, hydrologic modification	Increases surface water turbidity, which reduces plant growth and alters food supplies for aquatic organisms, decreases spawning habitat and cover for fish, interferes with navigation and recreation, and increases flooding
Toxic and hazardous substances	Landfills, junkyards, underground storage tanks, hazardous waste disposal, mining, pesticides, automobiles, household hazardous wastes	Accumulates in sediment, posing risks to bottom feeding organisms and their predators; contaminates ground and surface drinking water supplies; some contaminants may be carcinogenic, mutagenic and/or teratogenic and can bio-accumulate in tissues of fish and other organisms, including humans
Trash	Households, vehicles, people, construction sites, stores	Harmful to wildlife, bio-accumulates in human food supplies, degrades recreation and scenic beauty

Elevated levels of bacteria indicate that water quality may be impaired and the water is probably unsuitable for drinking and other domestic uses. Its suitability for recreation and its ability to sustain aquatic life also may be impaired by bacteria. Waterborne diseases such as cholera and salmonella can result from elevated bacteria levels and can pose severe risks to human health. Because bacteria can come from many sources, identifying the sources and controlling their levels can be extremely difficult and expensive.

Nutrients

Although nutrients are vital to plants and animals and are necessary to sustain life in general, when the levels of nutrients in water become too high, they are considered pollutants and can threaten the surrounding ecosystem. Two main nutrients of concern are nitrogen and phosphorus. Nitrogen is highly water soluble and dissolves into surface and groundwater easily. **Leaching** is the process by which substances including nutrients move through the soil profile into groundwater. Phosphorus is less mobile and soluble as compared to nitrogen. Nitrogen and phosphorus are components of plant/yard waste, animal manure, fertilizers, eroded soils and many cleaning products. When too much nitrogen or phosphorus is transported from the land into waterways during and after storms or via illicit discharges, it causes water quality problems. These nutrients stimulate aquatic plant growth and lead to oxygen depletion, fish kills and species shifts of aquatic life through a process known as eutrophication. This scenario makes water less suitable for beneficial uses such as swimming, fishing, drinking supply and other important uses.

It is estimated that about 12 million tons of nitrogen and 4 million tons of phosphate are applied each year as inorganic fertilizer in the United States.

Another 1.2 million tons of nitrogen and 0.72 million tons of phosphorus are applied annually as manure. If not applied properly and in the correct amounts, these important plant nutrients can become pollutants.

DID YOU KNOW?

In certain portions of Arkansas, known as Nutrient Surplus Areas, any fertilizer application made to 2.5 acres or more by homeowners, lawn care businesses, agricultural producers or other individuals must be made according to the protective rate and by a certified nutrient applicator who has been trained and participates in ongoing nutrient applicator continuing education courses.

Source: *UACES* (https://www.uaex.uada.edu/publications/PDF/FSA-9532.pdf.)

Nitrogen can also originate from the atmosphere. Scientists believe the combustion of fossil fuels such as oil and coal by power plants, large industries and automobiles is a major source of nutrients in the atmosphere that can be deposited on land and surface water through precipitation or dry deposition.

Sediment

One of the most important nonpoint source pollutants is sediment (Fig. 25). Sediment is loose particles of clay, silt, sand and gravel found in soil that can be carried off the land by wind and water erosion. Any bare soil is subject to erosion because there is a lack of vegetation to help keep soil in place and to block wind and water moving across the surface. Eventually, sediment finds its way into bodies of water. Sediment is always present in waterbodies, but in excessive amounts, it can create harmful conditions for plants and animals living in or near the water. Sediment can cloud the water and prevent light from penetrating to aquatic vegetation, which may increase water temperature and smother benthic macroinvertebrates and aquatic plants. Sediment can clog navigable waterways.

Fig. 25. Sediment carried into a storm drain that leads directly to a stream (*Image courtesy of Katie Teague, University of Arkansas System Division of Agriculture*)

Hazardous Substances

Hazardous substances include any material that can be harmful to humans and/or the environment. Pesticides and toxic chemicals are two common examples.

Pesticides – Any chemical such as insecticides, fungicides, herbicides or any other material used to eliminate or control pests is a **pesticide**. They are used extensively by farmers, homeowners, commercial exterminators, golf course managers, parks departments, schools, highway departments, utility companies and others to control any unwanted pests.

Pesticides can enter waterbodies through surface water runoff, wind and water erosion, leaching and spray drift. Once in a body of water, pesticides can decompose into more toxic compounds, deplete water oxygen content and kill wildlife. Furthermore, some pesticides last for a very long time in the environment and can bioaccumulate or build up in the food chain.

Over 1 billion pounds of pesticides are used in the United States each year at a cost of about $15 billion. Currently, the agricultural sector accounts for 76% of total pesticide use within the United States according to the EPA.

Toxic Chemicals – Toxic chemicals, such as spilled oils and fuels found on streets and parking lots (Fig 26), are examples of harmful substances that can runoff the land surface and be washed into surrounding waterbodies. Combustion of fuel from automobiles and factories can introduce hydrocarbons and metals into the atmosphere. These can eventually end up in water through atmospheric deposition or runoff. Industrial facilities without the proper means to control runoff also can contribute toxic chemicals to the environment. Various businesses and even homeowners may use chemicals such as solvents, paints, and cleaning solutions that can harm aquatic environments. The effects of toxic chemicals are usually greatest near urban areas where there is a lot of business, industry, and transportation.

Fig. 26. Oil on parking lot from leaky automobile
(Image courtesy of Karl Vandevender, University of Arkansas System Division of Agriculture)

Toxic chemicals can have detrimental effects on drinking water quality, water used for recreation, aquatic plant and animal life, and the pipes and pumps associated with industrial and other facilities. Cleanup of water contaminated by toxic chemicals can be very difficult and expensive.

DID YOU KNOW?

Toxic Chemicals in Arkansas

- 3.6 million lbs pounds of unwanted pesticides were recycled in from 2005 to 2018 in Arkansas.[1]
- A 1997 groundwater study in Arkansas, Kansas and Missouri found 20 of 88 pesticides, although none were above maximum contaminant levels set by EPA.[2]
- A 2004 surface water study in northwest Arkansas found 42 of 108 *targeted emerging contaminants.*[3]

Sources: [1]Arkansas State Plant Board, 2012
[2]Adenski, 1997
[3]Galloway, 2004

Trash

Improperly disposed refuse, product containers, packaging or materials are one of the most pervasive pollutants of surface water in Arkansas. Not only can trash degrade scenic beauty, wildlife habitat, and recreation potential but it can also degrade water quality. Urban areas often contribute high amounts of trash to waterways due to having large population densities of humans that don't properly dispose of trash.

Consequences of Impaired Water Quality

Water pollution is a serious problem that can have staggering consequences for the economy, human health and the environment. According to the EPA, more than 40 percent of the waters that have been assessed do not meet the water quality standards states, territories and authorized tribes have set for them. This includes more than 20,000 individual river segments, lakes and estuaries; approximately 300,000 miles of rivers and shorelines; and about 5 million acres of lakes (EPA, 2012). These waters are polluted mostly by sediments, excess nutrients and harmful microorganisms. An overwhelming majority of the U.S. population – 218 million people – live within 10 miles of these impaired waters (Fig. 27).

Economy – Millions of dollars are spent annually to control point and nonpoint source pollution and to reverse the harmful effects of poor water quality on the environment. Over the past century, the U.S has established a vast and complex system to provide clean water for drinking, agriculture and industry; to dispose of wastewater; to facilitate transportation; to generate electricity; to irrigate crops; and to reduce the risks of floods and droughts. Although this infrastructure has brought tremendous benefits, it also has come with major economic and environmental costs.

Fig. 27. Impaired water quality in this stream is caused by urban pollutants *(Image courtesy of University of Arkansas System Division of Agriculture)*

Economic impacts from impaired waterbodies are also of great concern as the Deepwater Horizon oil spill in 2010 caused an estimated 8.7 billion dollars in economic losses in the gulf region.

Environment – Degraded water quality can seriously limit the biodiversity of aquatic and terrestrial species and their habitats (Fig. 28). Harmful conditions such as hypoxia, eutrophication and algal blooms can destroy aquatic life. Increased sediment can clog the gills of aquatic organisms and cloud the water. Populations of benthic macroinvertebrates and other aquatic species that have low tolerances to contaminants can be reduced or eliminated from a system. Native shoreline vegetation that shades the water and prevents soil erosion can be removed or replaced by invasive weeds and plants that do not protect the waterbody and its functions.

Human Health – Perhaps the most important consequence of impaired water quality is the tremendous risk it poses to human health. In 2006, all 30 coastal states with beaches monitored in conjunction with the EPA's BEACH program were forced to issue health advisories or closures because of high levels of bacteria or other contaminants in the water. Contact with the contaminated water can cause rashes, earaches, pinkeye, respiratory infections, hepatitis, encephalitis, gastroenteritis, diarrhea, vomiting and stomach aches.

Fig. 28. Sediment can smother some aquatic wildlife species and impair a waterway for the aquatic life designated use *(Image courtesy of Nathan Wentz, Arkansas Department of Environmental Quality)*

Even more serious are the consequences of contact with toxic chemicals, which can include human birth defects, cancer, neurological disorders and kidney ailments.

DID YOU KNOW?

- Forty-four percent of the assessed river miles and 64 percent of assessed reservoirs in the U.S. are listed as impaired.
- The Mississippi-Atchafalaya river basin, which drains 41 percent of the continental U.S., carries about 3.2 billion pounds of nitrogen pollution into the Gulf of Mexico each year. The resulting hypoxic coastal dead zone in the Gulf each summer is about the size of Massachusetts.
- About 1.2 trillion gallons of untreated sewage, stormwater and industrial waste are discharged into U.S. waters annually.

Sources: *EPA, NOAA*
http://oceanservice.noaa.gov/products/hypox_final.pdf.
http://www.epa.gov/nrmrl/wswrd/wq/stormwater/cso.pdf.

How Land Use Affects Water Quality

The quality of water in Arkansas is affected by natural environmental factors and **anthropogenic** (human caused) factors. In this section some of the ways that humans can impair water quality are presented. In later sections, some of the ways that humans can improve water quality will be presented.

Water quality is closely linked to the way land is used and the type of land cover within a watershed (Fig. 29). Specific categories of land use include agricultural, industrial, recreational, residential, and urban. Most of the ways that people use land have

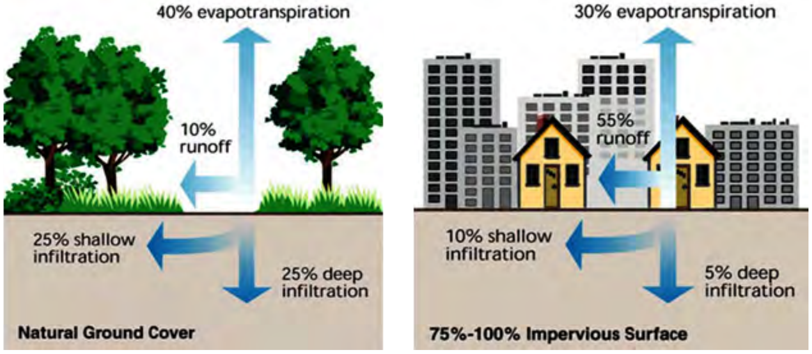


Fig. 29. Land use changes are capable of drastically altering or modifying natural drainage patterns *(Image courtesy of University of Arkansas Department of Agriculture)*

Fig. 30. Silt fence and rock wingdam BMP combination by Arkansas Highway and Transportation Department

the potential to generate pollutants that can impact and potentially impair or reduce water quality.

Land cover refers to the features of the Earth's surface. Types of land cover include forests, prairies, agricultural fields, urban areas, waterways, floodplains and even parking lots. When humans change the way that land is used in a watershed they most often alter the land cover (i.e., pasture to parking lot) and its natural features (such as water drainage) at the same time which causes **hydrologic modification** to occur. For example when new housing developments are built on forest or pasture land that intercepts, infiltrates and allows minimal runoff is cleared, runoff amounts and transport of pollutants are increased due to less water filtration by plants and soil because of the increases in impervious surfaces like rooftops, roads, driveways and sidewalks.

Here are a few occurrences that can impact both water quantity and quality (Fig. 30).

- Using fertilizers and pesticides
- Resource extraction
- Construction
- Wastewater disposal
- Land use change
- Littering
- Flooded buildings

Unless carried out in a thoughtful manner and with the use of **best management practices** (BMPs), the effects of the practices listed above can be severe. Such activities can alter natural hydrology of a watershed system including runoff volume, flood hazards and groundwater recharge. Additionally, these activities can increase erosion, sedimentation pollutant transport and loss of biodiversity and related ecosystem services. Urbanization has been shown to dramatically impact water quality and quantity. Wastewater, industrial discharges and solid wastes generated per unit area are much greater in urban areas compared to rural areas.

Urbanization can also significantly change the hydrology of an area because of increases in **impermeable** surfaces such as rooftops, parking lots, sidewalks, roads, and concrete lined waterways. This happens mostly because a permeable surface such as a forest or field that will allow water infiltration is replaced with impermeable or impervious surface that does not allow water to infiltrate, but instead sheds it rapidly downslope. This process of replacing permeable with impermeable surfaces increases runoff volumes, sedimentation rates, streambank erosion, flooding and decreases groundwater recharge – the movement of rain or stream water downward through the soil profile into groundwater sources. This is a two-fold concern because many urbanized communities are dealing with new flooding problems that require multi-million dollar solutions and also because 66 percent of all water used for domestic, agricultural, industrial, and other uses in Arkansas is from groundwater sources (Holland, 2007). Furthermore, as streambank erosion, sedimentation, and runoff volumes increase, so does the transport of pollutants into surface waters.

Adequate supplies of high-quality water are vital to the social, environmental and economic well-being of Arkansas, its residents and native inhabitants. However, there are places in Arkansas that are already facing the challenges presented by the presence of poor water quality. With a large potential for increased population growth and community and economic development in the future, we must take steps to ensure the presence of high-quality water resources for generations to come.

Water Quality Law and Policy in the United States

Clean water is of vital importance to sustaining public health, maintaining a strong economy and preserving a thriving ecosystem. The development and adoption of law and regulation have played a major role in protecting the country's environment. To better understand water quality and quantity legislation in Arkansas, it is important to examine the history of the federal government's role as well as the state's role in regulating this important resource (FSPPC102).

Table 4. Major Water Laws in the United States

FEDERAL LAW	DATE	PURPOSE
National Environmental Policy Act	1969	Established broad environmental goals for the nation and requires environmental assessments by agencies before taking major action.
Federal Water Pollution Control Act	1972	Strengthened water quality assessment and standard protocol, and established a regulatory structure for controlling discharges of pollution.
Clean Water Act	1977	Authorizes water quality programs, requires state water quality standards and permits for discharges of pollutants into navigable waters.
Clean Water Act Amendment	1987	Section 319 was added, requiring states to develop and implement programs to control and mitigate NPS pollution

Although federal and state water law dealing with quality dates back to the 19th century, until 1969 there was not a comprehensive water law in the United States (Table 4). Because of the development of water law in states prior to the federal law, water law differs from state to state and from the east to the west coast.

The **National Environmental Policy Act (NEPA)** of 1969 is considered the nation's first comprehensive environmental legislation that required environmental assessments be conducted on government lands before resource extraction or construction was to occur. A few years later new legislation known as the **Clean Water Act (CWA)** was developed. The legislation passed in response to the degradation of many of the nation's waterways, growing concern about disease epidemics related to waterborne pathogens and rivers on fire. The CWA was also created with the intent to restore and maintain the chemical, physical and biological condition of our nation's waters. The CWA authorizes water quality programs, requires state water quality standards and permits for discharges of pollutants and **fill** into navigable waters and authorizes funding for wastewater treatment works, construction grants and state revolving loan programs.

The CWA also identifies two sources of pollution:

1) *Point source* – pollution from clearly discernible discharge points such as pipes, wells, containers, concentrated feeding operations, boats or other watercraft
2) *Nonpoint source* – pollution coming from diffused points of discharge such as runoff from parking lots, agricultural fields, lawns, construction sites, mining and logging operations

The CWA amendments of 1987 began to address NPS pollution control, although in a non-regulatory way. Section 319 was added, which required states to develop and implement programs to control and mitigate NPS pollution. The 1987 amendments also directed the U.S. Department of Agriculture to develop programs to mitigate agricultural NPS pollution. But again, these mandates excluded any regulatory requirements. As such, most states developed their NPS programs around funding for voluntary, design-based approaches.

The CWA does not address water quantity issues or the quality of groundwater other than groundwater used as a public drinking water supply.

Water Quality Law and Policy in Arkansas

Under the CWA and Regulation 2 of the **Arkansas Pollution Control and Ecology Commission (APCEC)**, the Arkansas Department of Energy and Environment, Division of Environmental Quality (DEQ) has the responsibility to define and amend surface water quality standards for the state, or **Waters of the State of Arkansas**. Under the CWA Arkansas must define how waterbodies will be used and must develop and enforce a comprehensive set of water quality standards for each specific use. Every three years, Arkansas is required to evaluate its water quality standards in a process known as **triennial review**, and if necessary, revise them to keep in accordance with federal laws and guidelines. The EPA is required to review state water quality standards to ensure that they meet the goals outlined in the CWA. There are three Parts to the Arkansas Surface Water Quality Standards: (1) **designated uses**, (2) **narrative** or **numeric criteria** designed to prevent impairment of the designate uses, and (3) **an anti-degradation policy** to help prevent the deterioration of water quality.

Designated Uses

Several designated uses of water as defined by the Arkansas Pollution Control and Ecology Commission as previously listed in Chapter 3 are defined below:

- **Agricultural Water Supply** – This beneficial use designates waters that will be protected for irrigation of crops and/or consumption by livestock.
- **Domestic Water Supply** – This beneficial use designates water that will be protected for use in public and private water supplies. Conditioning or treatment may be necessary prior to use.
- **Ecologically Sensitive Waterbody** – This beneficial use identifies segments known to provide habitat within the existing range of threatened, endangered or endemic species of aquatic or semiaquatic life forms.
- **Extraordinary Resource Waters** – This beneficial use is a combination of the chemical, physical and biological characteristics of a waterbody and its watershed, which is characterized by scenic beauty, aesthetics, scientific values, broad scope recreation potential and intangible social values.
- **Aquatic Life (fishable)** – This beneficial use provides for the protection and propagation of fish, shellfish and other forms of aquatic life.
- **Industrial Water Supply** – This beneficial use designates water that will be protected for use as process or cooling water. Quality criteria may vary with the specific type of process involved, and the water supply may require prior treatment or conditioning.
- **Natural and Scenic Waterways** – This beneficial use identifies segments that have been legislatively adopted into a state or federal system.

Fig. 31. Ecoregions of Arkansas *(Image courtesy of Arkansas Department of Environmental Quality)*

- **Primary Contact (swimmable)** – This beneficial use designates waters where full body contact is involved. Any streams with watersheds of greater than 10 square miles of drainage are designated for full body contact. All streams with watersheds less than 10 square miles may be designated for primary contact recreation after site verification.
- **Secondary Contact (wadable)** – This beneficial use designates waters where partial or secondary contact with water in activities like boating, fishing or wading are involved.
- **Other Uses** – This category of beneficial use is generally used to designate uses not dependent upon water quality, such as hydroelectric power generation and navigation.

Narrative and Numeric Water Quality Standards

For each body of water where these designated uses are attainable, maximum and minimum limits for common biological, chemical and physical water quality parameters have been established. These include numeric and narrative standards for metals, dissolved oxygen, pH, nutrients, bacteria and so on.

Narrative criteria are written descriptions that define water quality standards for a particular body of water and are used because a numeric standard can't always be quantified for a designated use and does not always accurately reflect whether or not a body of water is impaired.

Numeric criteria are a range or set of specific numbers that can be directly measured and which relate directly to the condition of a body of water and it's quality of water. Many of the water quality parameters mentioned above are have numeric criteria protecting a designated use (e.g. dissolved oxygen criteria are protective of aquatic life designated uses).

Additionally, different standards for water quality are set for each of the six distinct **ecoregions** (Fig. 31) within Arkansas. Any waterbody that exceeds the accepted limits of any of these parameters is considered to be an impaired waterbody. An impaired waterbody is one that is currently not meeting one or more water quality standards.

Wastewater Effluent Standards

According to the CWA, all municipal and industrial facilities that discharge wastewater must obtain discharge permits from the EPA. These permits are known as **National Pollutant Discharge Elimination System (NPDES)** permits. Contrary to its name, the NPDES permit doesn't eliminate pollution. Instead, it controls point source pollution by setting limits on the physical or chemical water quality parameters within the wastewater that can be discharged from a facility to a receiving stream.

DEQ is responsible for issuing, enforcing, and renewing these discharge permits on a 5-year basis. The DEQ issues three types of NPDES wastewater permits:

1) Municipal
2) Industrial
3) Construction

Antidegradation (Surface Waters)

Under the CWA, Arkansas is responsible for developing an antidegradation policy for maintaining the quality of the state's waterbodies. In essence, this policy protects clean waters from becoming impaired and prohibits impaired waterbodies from getting worse.

The way Arkansas carries this out is through frequent monitoring of chemical constituents in the water and sediment of rivers, streams and lakes within the state and monitoring the biological communities and physical habitat within selected waters.

Section 305(b) of the CWA requires the states to perform a comprehensive water quality assessment every two years (biennial assessment) and submit an integrated water quality report (305(b) report) to the EPA. When waterbodies do not meet established standards for their designated uses, they are put onto a list known as the CWA "**Section 303 (d) List**" or "**Impaired Waterbody List**" and are scheduled for corrective action. The result of corrective action is intended to be the removal or "de-listing" of the impaired status to once again meet water quality standards. This includes identifying a source and cause of the pollution. Waters that do not meet water quality standards as a result of pollution are assigned **Total Maximum Daily Loads (TMDLs)** for particular pollutants. The development of TMDLs involves assessment of stream assimilation capacity of a pollutant, maximum pollutant loads and loads of pollutants that still allow for a margin of safety. The water quality standards must be reviewed and updated at least every three years (triennial review) where appropriate. The integrated report is an important management tool because it identifies the bodies of water that are a priority for restoration and those for which preventative measures are necessary to prevent further impairment.

Drinking Water Standards

Most Arkansans receive their drinking water from municipal water systems. Arkansans also obtain water from private water suppliers, private wells and public groundwater sources. Another significant water law in the U.S. is the **Safe Drinking Water Act (SDWA)** established in 1974 to regulate public drinking water standards in order to protect public health.

The SDWA authorizes the EPA to set national health-based standards for the presence of contaminants in drinking water.

The EPA sets drinking water standards based on three criteria: 1) Whether the contaminant harms human health; 2) Whether the contaminant can be detected in drinking water; 3) Whether the contaminant is known to occur in drinking water.

Drinking water supplied by public water supply systems is routinely tested for about 90 different contaminants to ensure compliance with state and federal standards (http://water.epa.gov/drink/contaminants/index.cfm).

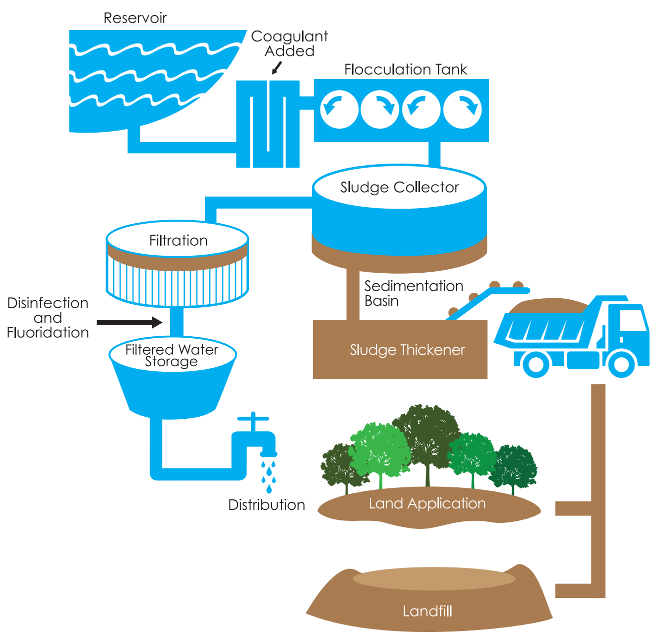


Fig. 32. Example of drinking water treatment process
(Image courtesy of University of Arkansas System Division of Agriculture)

There are two categories of drinking water standards:

1) Primary standards
2) Secondary Standards

Primary standards or **national primary drinking water regulations** protect against contaminants that are harmful to human health, including pathogens, radioactive elements and toxic chemicals. Primary standards set the maximum amount of each pollutant that can be in the drinking water supplied by a public water system. These limits are known as **maximum contaminant levels (MCL)**.

National primary drinking water regulations (NPDWRs) or primary standards are legally enforceable standards that apply to public water treatment systems (Fig. 32). Primary standards protect public health by limiting the levels of contaminants in drinking water. There are 87 specific MCLs established for microorganisms, disinfectants, **disinfection byproducts**, organic chemicals, inorganic chemicals and radionuclides.

Secondary standards protect against **secondary contaminants** that are not shown to be harmful to human health but pose a nuisance because they can cause unacceptable odor, taste, color, corrosion, foaming or staining. Maximum limits are also set for these contaminants and are known as **secondary maximum contaminant levels (SMCL)**.

Despite strict rules and standards protecting the quality of drinking water, a water supply system may still become contaminated and violate certain drinking water standards. When a violation occurs, the public water supply system must notify its customers about what the violation means to them and what steps are being taken to correct the situation. If consumption of the water poses a threat to human health, the water supply system is required to use mass media to reach the public as quickly as possible.

The quality of water in private wells is not regulated by the state. Regularly testing and monitoring the water quality in private wells is up to the owner.

The Arkansas Department of Health (ADH) is charged with the regulation and oversight of the state's public water systems. According to the ADH's Drinking Water Program Annual Report there were 1,058 public water systems in operation during 2019. Of those, 687 were **community water systems**, 35 were **non-transient non-community water systems** and 336 were **transient non-community systems**. Arkansas public water systems serve 95.7 percent of the population.

Water Quality Testing, Monitoring and Regulation

Water Quality Testing and Monitoring

How can we ensure that the state's surface waters, wastewater effluents and drinking water sources are meeting federal and state water quality standards? The answer is through water quality testing and monitoring. When the water is tested, the biological, chemical and physical characteristics of water are analyzed and the results determine the overall quality of a body of water related to its suitability for a specific use. Testing for water quality over a period of time (water quality monitoring) helps in understanding the dynamics of a particular body of water and whether the water quality is improving or declining.

Scientists, regulatory agencies, industries and municipalities use many different instruments to test the quality of surface water, groundwater and drinking water, including **Secchi disks**, probes, nets, **sondes**, gages and meters (Fig. 33).

Basic surface water quality assessment packages include tests for E. coli and Enterococcus spp. bacteria, nitrates, phosphorus, pH, sodium, chloride, fluoride, sulfate, iron, manganese, total dissolved solids and dissolved oxygen. Other tests may be appropriate if a particular contaminant is suspected. For example, some groundwater sources are tested for arsenic, selenium and uranium, while both surface water and groundwater sources used for drinking are often tested for harmful pesticides. Regular testing will show whether the water quality is changing and can help detect when some sort of activity is degrading water quality. Long-term monitoring programs are key to understanding changes in water quality and allow for better management of water resources.

Fig. 33. Sampling surface water quality parameters
(Image courtesy of Arkansas Water Resources Center)

Water quality monitoring is a fundamental tool in the management of Arkansas freshwater resources. Water quality is monitored to:

- Identify particular pollutants of concern
- Identify whether the quality of the water is appropriate
- Determine the quality of a particular body of water
- Detect trends in water quality
- Determine the effectiveness of watershed restoration and enhancement projects

Regular water quality testing and monitoring of both surface water and drinking water are required by the Clean Water Act (CWA) and the Safe Drinking Water Act (SDWA). In Arkansas, surface water quality monitoring falls under the DEQ's surface water quality monitoring program.

Water Quality Regulation (Arkansas Water Pollution Control Laws)

Since polluted water compromises the chemical, physical and biological integrity of Arkansas' waterbodies and poses a risk to public health and community economic development, the **Arkansas General Assembly** has enacted several laws that address water pollution.

The **Arkansas Water and Air Pollution Control Act** of 1949 makes it unlawful to "cause pollution…of any of the waters of this state" or to "place or cause to be placed any sewage, industrial waste or other wastes in a location where it is likely to cause pollution of any waters of this state."

The Arkansas Pollution Control and Ecology Commission is the environmental policy-making agency for the state. With guidance from the Governor, the General Assembly, the EPA and other stakeholders, the commission establishes environmental policies for the state, which the DEQ implements.

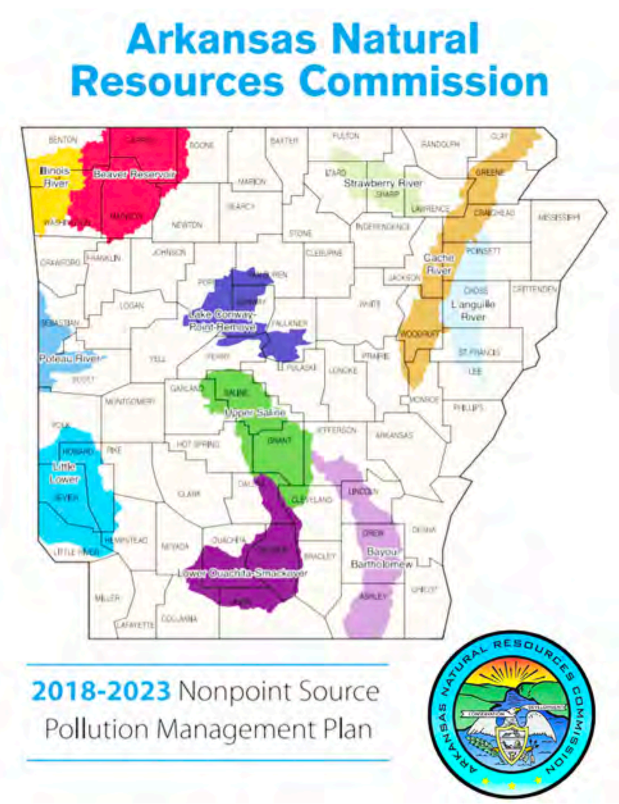
The commission is composed of seven members of the public who are appointed by the governor and six representatives from the following agencies:

- Arkansas Department of Agriculture – Natural Resources Division (ADA-NRD)
- Division of Environmental Quality (DEQ)
- Arkansas Department of Health (ADH)
- Arkansas Oil and Gas Commission (AOGC)
- Arkansas Game and Fish Commission (AGFC)
- Division of Forestry (DF)

Today, there are more than 20 entities with responsibility for ensuring Arkansas water quality, water quantity and public health.

Since 1990 the ADA-NRD, through a memorandum of agreement with DEQ and as dedicated by Governor Bill Clinton, has been charged responsible by the EPA to administer a **Nonpoint Source Pollution Program** for the State of Arkansas. The ultimate goal of this program is to reduce nonpoint source pollutant loads in Arkansas to a level that allows impaired or "listed" waters to be restored or "delisted" through watershed planning and restoration, voluntary best management practice adoption, and development of technologies that assist in pollution reductions (Fig. 33). The ADA-NRD receives funding from the EPA that can be utilized by state government agencies, academic institutions, municipalities, and non-governmental organizations.

The ADA-NRD also represents the State of Arkansas in the Gulf of Mexico Hypoxia Task Force. The task force was formed in 1997 in response to hypoxia in the Gulf and is working to reduce nutrient delivery to the Gulf of Mexico. The task force is composed of representatives from federal and state agencies and tribes within the Mississippi Atchafalaya River Basin. As the lead agency for Arkansas working to reduce nutrient delivery to the Gulf of Mexico, the ADA-NRD has developed a nutrient reduction strategy as recommended in the 2014 update of the Arkansas Water Plan for the State of Arkansas. This plan will be updated iteratively moving forward.



Finally, the ADA-NRD manages the Arkansas **Unpaved Roads Improvement Program** which was established in 2015 through Act 898 of the 90th General Assembly. The goals of the program are to assist with funding for safe, efficient, and environmentally sound projects for the maintenance and improvement of unpaved roads that have been identified as impacting water quality negatively.

The DEQ is charged by the EPA and Arkansas Pollution Control and Ecology Commission to improve and maintain the quality of the state's waterbodies. The Office of Water Quality the DEQ is divided into four branches: 1) The Permits Branch is responsible for issuing all National Pollution Discharge Elimination System discharge and no-discharge permits within the State; 2) The Water Quality Planning Branch coordinates the following programs associated with surface and ground water: Toxicity; Total Maximum Daily Load; Short Term Activity Authorizations; Integrated Assessment and Impaired Water Bodies List, Water Quality Standards; Water Quality Monitoring; and Biological Monitoring; 3) The Enforcement Branch is responsible for enforcing the compliance of water quality standards and water related permits; 4) The Compliance Branch is responsible for responding to citizen's complaints, and the inspection of permits and activities that affect water quality.

The **Arkansas Department of Health (ADH)** is responsible for the regulation and oversight of public water systems throughout the state. The ADH reviews plans of new water system facility construction, inspects water system facilities, troubleshoots water treatment and distribution problems, investigates complaints, and collects and analyzes samples to determine water quality. ADH also manages source water and wellhead protection programs mandated by the Safe Drinking Water Act both for surface intake watersheds and for groundwater wellhead protection areas. ADH geologists and specialists provide local governments, water system operators, and end users with delineations of drinking water source areas, 2) inventories of potential sources of contamination within all source water delineations 3) vulnerability assessments and 4) public outreach.

The **Arkansas Association of Conservation Districts (AACD)** are political subdivisions of the State of Arkansas. They are a creation of popular vote of resident landowners for the purpose of conserving our land and water resources as authorized by Act 197 of the Arkansas General Assembly in 1937; the Nation's first conservation district law.

Conservation districts are local governments at work and their specific responsibility is management of our soil and water resources. The idea behind their formation is to keep decision making on soil and water conservation matters at the local level. Each district is governed by a board of five directors who serve without pay. Two directors are appointed by the ANRC and three are elected by resident landowners.

The **Arkansas Game and Fish Commission** is the primary agency responsible for the protection and management of Arkansas' fish and wildlife resources, many of which are wholly or partially dependent upon waters of the U.S. The Environmental Coordination Division is responsible for the coordination of fish and wildlife resource review and comment on various water-related development activities and proposals, as well as developing opportunities to protect, enhance and restore fish and wildlife habitat in Arkansas.

The **Arkansas Department of Agriculture – Plant Industries Division (PID)** is responsible for enforcing regulations against water pollution from agricultural and other sources. The PID does this by enforcing the Arkansas Pesticide Control Act, which makes it unlawful for any person to "dispose of, discard, or store pesticides or pesticide containers in any manner as to pollute any water supply or waterway." The PID's Pesticide Division ensures the proper labeling, distribution, storage, transportation, use, application and disposal of the pesticides within the state. Before a pesticide can be sold in Arkansas it must first be registered by the PID. Additionally the PID issues regulations authorized by the Arkansas Pesticide Use and Application Act which allows the Plant Board to issue regulations relating to the conditions under which "pesticides may be applied and ….restrict or prohibit use of pesticides to prevent unreasonable adverse effects" to plants, wildlife, fish, humans or beneficial insects. The Pesticide Division also is involved in monitoring groundwater for contamination by pesticides and the impact of pesticides on endangered species within the state.

The **Arkansas Department of Agriculture - Natural Resources Division (ADA-NRD)** which serves as the state's water resource planning and management agency.

The **Arkansas Geological Survey** was established by Act 573 of 1923 and is charged with serving the people of Arkansas by providing geological information in order to develop and enable effective management of the State's mineral, fossil fuel and water resources while protecting the environment.

The **Arkansas Department of Agriculture –Division of Forestry** was established with the passage of Act 234 by the 1931 session of the Arkansas Legislature. The Division of Forestry works with agencies, organizations and residents to prevent and suppress wildfires, control forest insects and disease, grow and distribute trees, and gather and disseminate information concerning the growth, use and renewal of forests.

The **Arkansas Oil and Gas Commission** serves the public of Arkansas regarding oil and gas matters, prevention of waste, encouraging conservation, and protecting the correlative rights of ownership associated with the production of oil, natural gas and brine, while protecting the environment during the production process, through the regulation and enforcement of the laws of the State of Arkansas.

The **Arkansas Waterways Commission** is the sole state agency responsible for developing, promoting and protecting waterborne transportation in Arkansas. The Commission also promotes economic development for ports on the five commercially navigable rivers of the state: The Arkansas, Mississippi, Ouachita, Red, and White Rivers.

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Notes

Chapter 4

Overview of Water Quantity and Diminished Water

Arkansas Watershed Steward Handbook

Water Quantity

Now that water quality principles have been covered, it's time to look into the quantities of water in Arkansas and the factors that affect how much water we have. First of all, let's define water quantity as the volume of water that is present at any given time.

The water found in surface water sources such as rivers, streams, lakes, ponds, and wetlands in addition to all groundwater sources such as aquifers, perched water tables, and fractures in geologic formations are all included in the total water quantity of Arkansas.

Quantity of water in Arkansas is driven by precipitation and much of the precipitation that affects our surface and groundwater actually falls outside of the state. Surface waters in many large rivers, such as the Arkansas, often originate from rainfall or snow melt in other states such as Colorado, Kansas, and Oklahoma. Likewise groundwater found in some aquifers of Arkansas often percolate through the soil and other geologic formations in other states, in addition to those in Arkansas.

IN THIS CHAPTER, YOU WILL LEARN ABOUT:

- Water quantity
- Water quantity management
- Consequences of diminished water quantity
- Watching water quantity
- Water quantity law and policy in Arkansas

How do we know how much water is available in a water body in Arkansas at any given time? The primary method is through the direct measurement of streamflow and water levels, but we also use cross sectional measurements of lakes, streams, and aquifers in addition to using complex flow **models**.

Streamflow is directly measured with a flow meter or stream gage that measures how much water flows by per unit time. For the stream gage to be accurate, measurements of the stream channel's cross sectional width must be known and the gage must be calibrated accordingly. The information from the flow meter

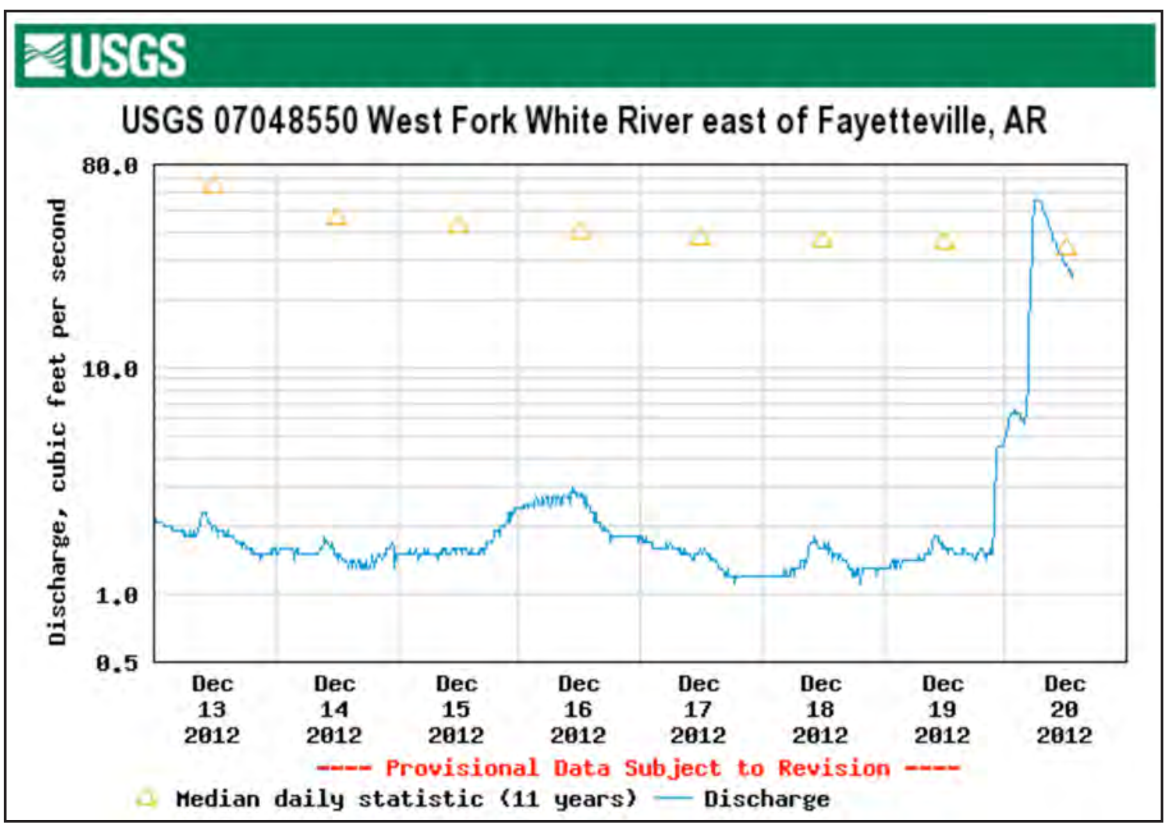


Fig. 34. USGS real-time streamflow depicted on a hydrograph from a stream gaging station
(Image courtesy of U.S. Geological Survey)

is then transmitted to a computer and displayed on a graph known as a stream hydrograph (Fig 34). As streamflow increases or decreases the stream hydrograph will reflect the increase or decrease in streamflow or discharge. A hydrograph provides a visual and valuable record of variations in streamflow. This information is helpful in understanding and managing a stream and the watershed it is in, especially when used in conjunction with additional information such as weather events and land use practices.

To determine how much water is in lakes, a similar method is used. First the cross sectional area of the lake is measured by survey crews before a lake is filled, or it can be measured with sonar. Either way, the relationship of the lake level, its correlating cross sectional capacity and total volume are determined.

Determining groundwater quantity is the hardest measurement to take, because there is so much variability in underlying soils and geologic formations in which water can be found. Complex flow models and underground mapping processes are used to quantify volume of underground storage and with simple depth measurements are used to correlate the quantity of water present.

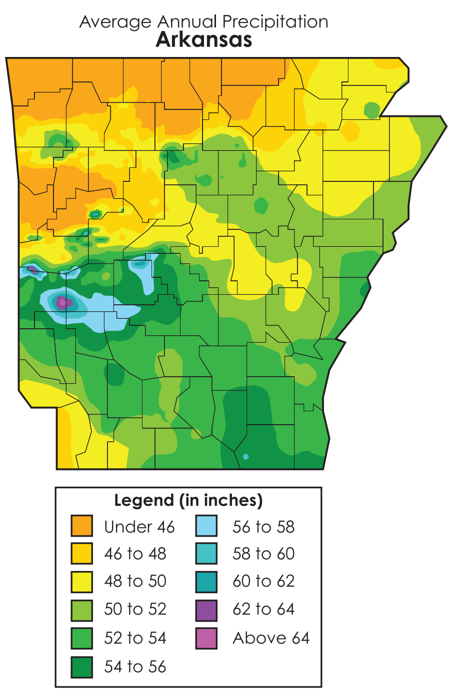


Fig. 35. Arkansas average annual precipitation map

The four factors that dominate the presence or absence of ground and surface water in Arkansas are: 1) Climate and associated variability, 2) Human use and watershed manipulation, 3) Topography, and 4) Geology.

The average weather conditions over a long period of time, or climate, greatly impacts the amount of surface and groundwater present at any point in time in a region. Weather events such as droughts, floods, and blizzards can alter how much water is present on a daily, monthly, or yearly basis. Precipitation is the single greatest indicator of water quantity in Arkansas. As precipitation increases, the amount of surface and groundwater also increases. The range of precipitation in Arkansas averages between 44 and 56 inches, with southern Arkansas having the higher average amount and northern Arkansas having the least (Fig. 35).

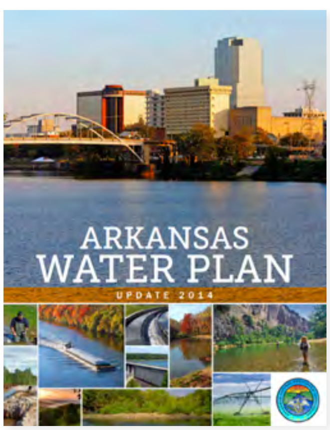
Human actions also influence water quantity. Examples of this are the building of dams, interbasin transfer, channelization of streams, and land use changes such as the replacing of pervious surfaces with impervious ones. Humans are also capable of wasting a lot of water daily.

So how much water is actually present in Arkansas? Arkansas receives an average of 49 inches of rainfall a year or approximately 124 billion gallons per day (bgd). Around 708, 480 acres of Arkansas is covered with water. Streams and rivers that flow into the state carry 40 bgd while 210 bgd flow in the Mississippi at Memphis as surface water. However, at least half of this total always returns to the atmosphere as vapor and some 48 percent becomes surface runoff, with most eventually going into the Mississippi River and to the Gulf of Mexico. About four percent or two inches out of the 49 inches of rain that falls on Arkansas finds its way into the ground to become groundwater. There is around 200 trillion gallons of water present as groundwater in Arkansas (Jackson and Mack, 1982).

How is Water Quantity Managed?

The management and stewardship of our water in Arkansas is headed up by the Arkansas Department of Agriculture – Natural Resources Division (ADA-NRD) which serves as the state's water resource planning and management agency.

The ADA-NRD manages the water quantity of Arkansas according to the **Arkansas Water Plan (AWP)** published originally in 1975. In 1985, the Arkansas General Assembly enacted Ark. Code Ann. Sec. 15-22-301 (Sec. 2 of Act 1051 of 1985), which broadened the ADA-NRD planning responsibilities to include: (1) an inventory of the state's water resources, including areas in which water use has or will become critical in the next 30 years; (2) the determination of the current needs and the projection of future needs of all water uses in the state; and (3) the determination of whether excess surface water exists that might be put to beneficial use. The plan was again updated in 1990, and again in 2014. The AWP 2014 Update (Fig. 36). is based on planning level projections of water demand and availability developed using consistent methodology on a statewide basis (ADA-NRD, 2014).



By examining the historic water availability and use trends, and projections for future water use demands, an overall assessment and plan for managing water quantity, such as the AWP can be developed to guide in the wise use and management of the waters of Arkansas.

DID YOU KNOW?

- Water demand for crop irrigation is about 80 percent of the total statewide water demand.
- Statewide municipal and self-supplied drinking water supply demand is projected to increase by about 25 percent from 462,500 AFY in 2010 to 578,000 AFY in 2050.
- The amount of surface water flow to support fish and wildlife is about 57 million AFY or 62 percent of the total Arkansas annual stream flow of 92 million AFY.
- Groundwater modeling of the Mississippi Embayment aquifers (primarily the East Arkansas Region) suggests that, under sustainable pumping conditions, only about 20 percent of the groundwater demand can be *met with groundwater in 2050.*

The AWP projects an increased water use demand of 14 percent from the current 12 million AFY (11 billion gallons per day [gpd]) up to about 14 million AFY (12.5 billion gpd) by 2050. Overall, about 71 percent of statewide water demand is supplied from groundwater sources and that is assumed for planning forecasts to remain the same through the 40 year planning horizon. Reduction of groundwater use depends on successful implementation of conservation, surface water use, and delivery of excess surface water (ADA-NRD, 2014).

The United States Corps of Engineers (USACE) plays a role in water quantity in Arkansas by managing the allocation, storage and release of water from the federal impoundments and navigation systems established in the state. Similarly, municipalities, industries, and citizens play a role in water quantity in Arkansas through their use and conservation of water resources.

Ground Water

Groundwater is an important water resource for the state and constitutes about 71 percent of the total water use in Arkansas. Differences in underlying rock type, geologic structure, and depositional history, which have produced aquifers having very different capabilities for storing and transporting underground water. These capabilities, combined with various land uses associated with both regions, have resulted in aquifers that have differing well yields and uses, water-quality conditions, and vulnerability to various land-use activities.

Surface Water

There are over 90,000 miles of rivers, streams, ditches, and canals and over 600,00 acres of surface water such as lakes, reservoirs, streams, and ponds in Arkansas. Major rivers in the state include the Arkansas River, Mississippi River, Ouachita River, Red River, St. Francis River, and White River. Approximately 33.6 million AFY (40 billion gallons per day) of water enters Arkansas from other states through the Arkansas River, White River, and St. Francis River and their tributaries. An average of 235.2 million AFY flows along the state border through the Mississippi River (ADEQ 2009; Howard, Colton, & Prior 1997). Streamflow based on gaged flow data in the state averages about 92 million AFY.

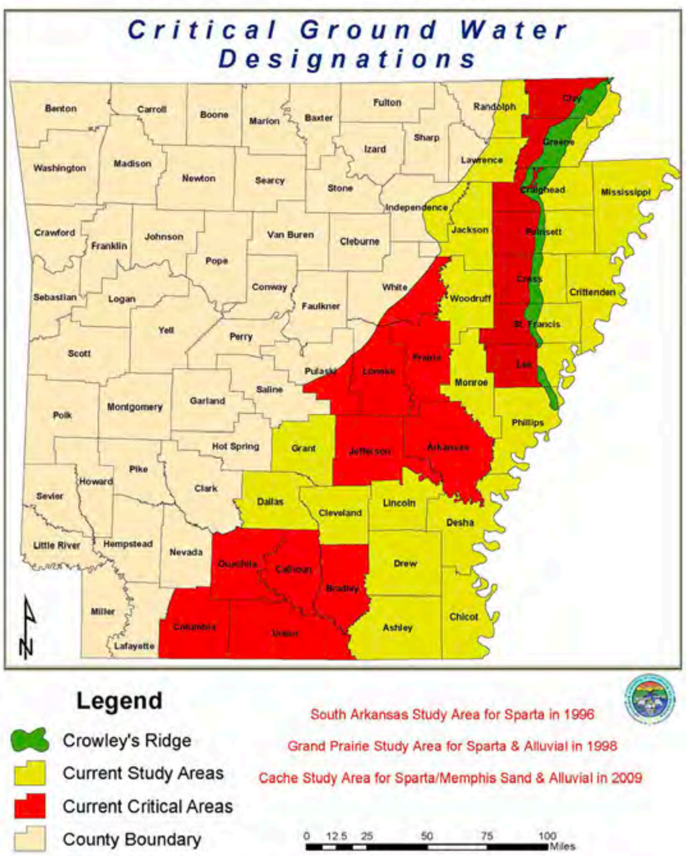


Fig. 36. Map of Arkansas Critical Groundwater Designations

On an average annual basis, there is estimated to be 8.7 million AFY of excess surface water available for all water uses in the state, however this water is not necessarily available for use when it is needed. Surface water sources such as rivers and lakes currently supply 34 percent for the state's water needs with 66 percent of this water being used for drinking water.

Consequences of Diminished Water Quantity

Diminished water quantity can cripple a community, region, or civilization much less have staggering consequences for the economy, human health, and the environment.

Economy – Millions of dollars are spent annually to develop infrastructure to manage water quantity. Much of these investments are to both increase availability and achieve conservation of the resource. Many sectors of the economy including recreation, tourism, energy extraction and production, industrial production (including foods and beverages) rely on adequate water supplies. Adequate water supplies are fundamental to the United States economy, and community development and economic growth.

Environment – Biodiversity of aquatic and terrestrial species and their habitats can also be affected by diminished water quantity. Populations of wildlife that depend on wetlands and other waterbodies can be reduced or eliminated from an ecosystem without enough water present. Ecosystem services produced by the environment are also impaired or lost without enough available water.

Human Health – Perhaps the most important consequence of diminished water quality is the tremendous risk it poses to human health. Diminished water quantity has been related to disease and death across the globe. Alternately, the presence of water has been linked to improved mental and physical health. Adequate supplies of high quality water are vital to the social, environmental, and economic well being of Arkansas, its residents, and native inhabitants. However, there are places in Arkansas that are already facing the challenges presented by the presence of poor water quality and/or limited quantity (Fig 36). Can you imagine a day without water?

Land Use Affects on Water Quantity

As mentioned in the previous chapter land use affects water quality, but it also affects water quantity. In this chapter some of the ways that humans can diminish water quantity are presented.

Water quantity is closely linked to the way land and water is used. (Fig. 37). Specific categories of land use include agricultural, industrial, recreational, residential, and urban. Most of the ways that people use land have the potential to affect water quantity in Arkansas.

When humans change the way that land is used in a watershed they most often alter the land cover and its natural features at the same time which causes hydrologic modification to occur and inhibits the lands ability to allow water to infiltrate. For example, often when development occurs and a forest or pasture land that intercepts, infiltrates, and allows runoff is cleared and mostly replaced with impervious surfaces which allows much less interception and infiltration and results in more flooding and runoff.

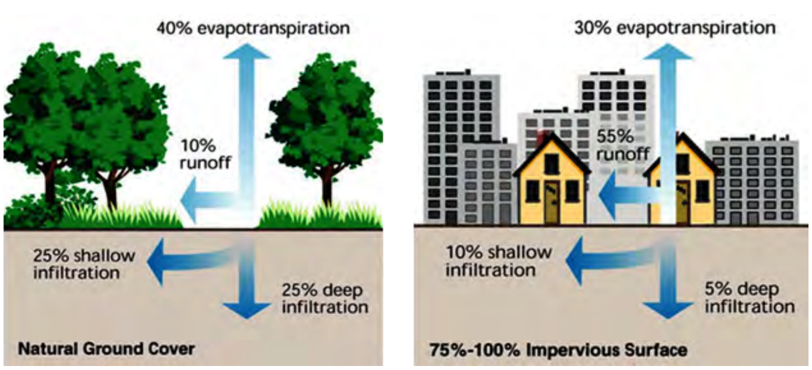


Fig. 37. Land use changes are capable of drastically altering or modifying natural drainage patterns *(Image courtesy of University of Arkansas Department of Agriculture)*

Fig. 38. An example of an effort to positively impact water quantity through wise management.

Here are a few occurrences that can impact water quantity (Figure 38).

- Population growth
- Resource extraction
- Wastewater disposal
- Land use change
- Water conservation practices
- Climate change
- Industrial production

Unless carried out in a thoughtful manner and with the use of water planning and conservation practices the impacts of diminished water quantity can be devastating. With a potential for increased population growth and community and economic development in the future, we must take steps to ensure the presence of water resources for generations to come.

Water Quantity Law and Policy in the United States

In Arkansas, as in much of the eastern United States, the legal concept or doctrine used in water management is **riparian doctrine**. Under riparian doctrine water that flows through or adjacent to your property, can be used in reasonable quantities (Fig. 39) as long as that use does not diminish a downstream riparian landowner's right to reasonable use. This differs from the doctrine of a priori also known as the **western doctrine**, where the first in line for water rights have the right of first use. This doctrine was generally developed and applied in the western U.S. where water can be scarce.

Fig. 39. Riparian water withdrawal is the right of riparian landowners in Arkansas *(Image courtesy of Ken Brazil, Arkansas Natural Resources Commission)*

Water Quantity Monitoring and Regulation

How can we ensure that the state's surface and groundwater quantity is improving or declining? The ADA-NRD was established in 1963 "to manage and protect our water and land resources for the health, safety and economic benefit of the State of Arkansas." It has the primary regulatory authority

Fig. 40. Flooding causes hundreds of millions of dollars in damage annually *(Image courtesy of University of Arkansas System Division of Agriculture)*

for many issues related to water rights, water conservation and water quantity. Arkansas Act 81 of 1957 mandates water users to register annually with DNR. This allows DNR to monitor and report the state's overall water usage and water needs. Act 629 of 1969 authorized ADA-NRD to administer a state Floodplain Management Program and delegates the responsibility to ADA-NRD and local municipalities to enact and enforce the minimum **National Flood Insurance Program (NFIP)** land use measures to reduce flood losses and ensure that federal flood insurance and disaster assistance is made available to Arkansas communities. Floodplain development regulations are simply a "good neighbor" policy designed to protect our citizens from future flood losses. Regulating floodplain development by using community **Flood Insurance Rate Maps (FIRMs)** helps keep flood liable structures out of Special Flood Hazard Areas (SFHA) and lessens potential flooding threats in urbanized communities (Fig. 40). For the purpose of protecting public safety, property rights and minimizing losses due to flood events, DNR provides technical assistance to municipalities and offers accreditation training and educational workshops for local floodplain administrators and **Certified Floodplain Managers (CFM)**. This program also provides flood preparedness outreach, risk mapping and post disaster mitigation assistance to the public.

Surface water laws established in Arkansas give the ADA-NRD authority to 1) Allocate surface water from streams during times of shortage based on the reasonable use concept 2) Determine preferential surface water allocations during times of shortage based on sustaining life, maintaining health and increasing wealth, in that order 3) Mandate registration of diversions of surface water from streams, lakes and ponds and 4) Issue dam construction permits.

The **Groundwater Protection Act** was established in Arkansas in 1991 and allows the ADA-NRD to first designate critical groundwater areas and then, if necessary, to initiate a regulatory program requiring that anyone who wants to withdraw groundwater from an existing well or construct a new well within the area obtain a water right.

A law specific to aquifers (Act 237) was passed in 1997 and gives the ADA-NRD authority to enter into negotiations with adjoining states that share the aquifer related to the use and protection of interstate waters. Additionally, Act 1406 was passed in 2001 and mandates that new groundwater withdrawals from sustaining aquifers must be metered. Domestic wells and pre-existing wells are excluded from that act unless alternative surface supplies are available.

Ground Water Protection Program

The basic responsibilities of the **Ground Water Protection Program** in Arkansas include budgeting and grant administration, groundwater planning and water quality monitoring, and addressing gaps in groundwater protection through development of regulations and guidelines. In general the groundwater in Arkansas is very good to exceptional throughout the state. Groundwater quantity is a serious issue in much of the agricultural eastern part of the state and in areas of heavy industrial use. Although the state does not have a formal set of groundwater standards, nor is groundwater formally protected by the Clean Water Act, the DEQ uses federal standards and health advisory limits to establish cleanup levels at contaminated sites.

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Notes

Chapter 5

Managing to Improve Watershed Function

Arkansas Watershed Steward Handbook

Using the Watershed Approach to Maintain and Enhance Water Quality

All Arkansans can help keep Arkansas "The Natural State" by being part of a team effort to help protect our water resources through positive management actions. Since watersheds and water quality issues and concerns often span across political boundaries of cities, counties, and states, it takes a watershed based management approach in which many **stakeholders** work together to improve and maintain water quality. Such an approach is known as the **watershed approach**.

The watershed approach is an engaging and decision making process that reflects a common strategy for information collection, analysis, and understanding of the roles, priorities and responsibilities of all stakeholders within a watershed. The watershed approach is based on the concept that many water quality problems are best addressed at the watershed level by all groups of stakeholders. In addition, this approach helps identify the most cost-effective and socially acceptable pollution control strategies to meet or maintain clean water goals.

Who is a Stakeholder?

The people who live in, work in, and have an interest in the watershed are called stakeholders. Examples of stakeholders are landowners, homeowners, and residents of a watershed. Businesses, industries, and city, county, state, and federal governments and agencies also have an impact within a watershed and they are also considered stakeholders. Realizing that we all are stakeholders and that we all impact the watersheds that we live, work, and play in, we must take steps to reduce the potential negative impacts that we all can leave behind. Without inclusive stakeholder involvement, the solutions to natural resource problems are much more difficult to accomplish. Besides providing a sizable workforce, inclusive stakeholder involvement or partnerships promote a team atmosphere. This team atmosphere is essential for all parties involved to better understand the problems, identify priorities, and buy into the methods used to improve water quality.

The goals of the watershed approach are to:

1) Identify and prioritize water quality/quantity problems in the watershed,
2) Develop increased public awareness, education, and involvement,
3) Coordinate efforts with other agencies, organizations, and stakeholders within the watershed and,
4) Measure success through monitoring and other data collection.

The watershed approach has proven to be an effective means of voluntarily protecting our water resources. Stakeholder-lead watershed organizations can play a vital, non-threatening role in protecting our water resources by empowering a diversity of stakeholders through partnerships to find common goals and joint solutions.

Water Quality Improvement Projects

Water quality improvement projects are often used to increase awareness and education of a water quality issue to the public. However, they are also used to directly address water quality issues or pollution sources directly either through the encouragement and implementation of voluntary best management practice use or with regulatory measures.

When a body of water is impaired or becoming degraded, stakeholder groups usually form to address whatever activity within the watershed that is causing the problem. In some cases though, stakeholders act to address potential watershed water quality problems before they even occur.

Either way, a watershed approach is often used in such efforts because it brings in key stakeholders that can help address water quality at the watershed scale.

Water quality improvement projects can be separated into five major categories:

1) Outreach and education activities,
2) BMP Implementation,
3) Planning and development of watershed management plans,
4) Dealing with established Total Daily Maximum Loads, and
5) Watershed water quality assessment.

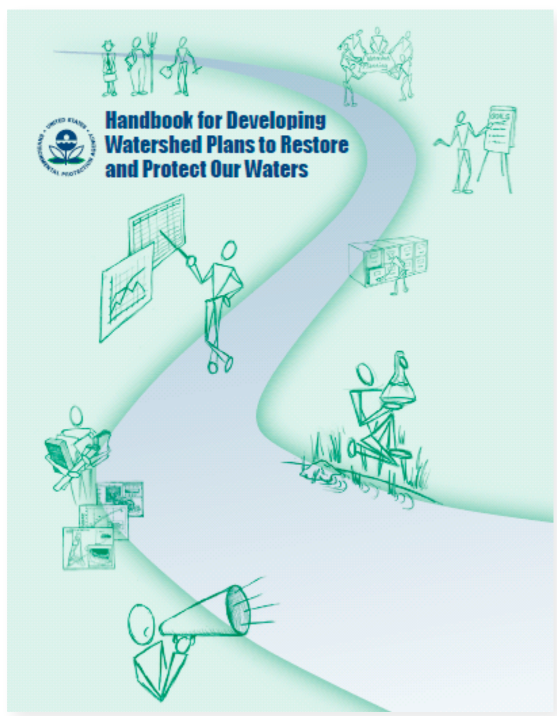
Watershed Management Plans

Watershed Management Plans (WMP) or protection strategies are community-driven management frameworks developed using a watershed approach to solve complex water quality problems within a watershed. Watershed Management Plans are often developed by communities, planning organizations, watershed partnerships and state and federal agencies.

The purpose of a WMP is to protect healthy bodies of water or to restore those that are impaired.

The EPA has guidelines for WMPs. See the "Handbook for Developing Watershed Plans to Restore and Protect Our Waters," available online at https://www.epa.gov/nps/handbook-developing-watershed-plans-restore-and-protect-our-waters. According to the EPA's guidelines, each WMP should contain the following nine elements.

1) Identification of the causes of impairment and pollutant sources that need to be controlled,
2) Estimation of the pollutant load reductions that need to be achieved through management,
3) Description of the point/nonpoint source management actions needed to achieve the reductions,
4) Estimation of the technical/financial assistance required to implement these management actions,
5) Information/education component to increase public understanding and awareness,
6) Schedule for implementing the management actions,
7) Measureable milestones for tracking the implementation of management actions,
8) Criteria for determining whether load reductions are being achieved,
9) Adaptive management to adjust efforts for the most effective plan.



In Arkansas, WMP's tend to be developed by a combination of non-governmental, non-profit, and governmental organizations. In most cases diverse stakeholder inclusion, public input, and technical service providers help to guide the development of such a plan. The DNR has a special role in the development of WMPs as they offer a funding mechanism provided by section 319(h) of the Clean Water Act. In Arkansas this is known as the Nonpoint Source Pollution Reduction Program. Through this program, the EPA allocates 319(h) funding to the DNR to carry out their nonpoint source management programs. These funds may be distributed to a variety of state, county, and city agencies in addition to local groups, non-profit and watershed organizations submitting work plans detailing activities to be accomplished and pollution reductions anticipated. Organizations and agencies that have developed or are using a nine element EPA accepted WMP are a higher priority for grant funding through the 319(h) program. Watershed's with EPA accepted 9 Element Plans in Arkansas are:

- Illinois River
- Upper White
- Beaver Lake Reservoir
- L'Anguille River
- Bayou Bartholomew
- Upper Saline River
- Buffalo River
- Lee Creek
- Upper Frog Bayou

Drinking water utilities are provided guidance by the American Water Works Association (AWWA) to help guide programs in development of a source water protection (SWP) programthat is protective of their drinking water sources. ANSI/AWWA Standard G300: Source Water Protection, provides the definitive standard for a drinkingwater utility to protect its drinking water supply source(s). AWWA G300 became effective on July 1, 2007, and outlines the six primary components of successful SWP programs and the requirements for meeting the standard (AWWA 2007).Watershed management plans are developed from community planning to address future growth and development needs, such as protection of a drinking water source, or to address existing impairments of a waterway as listed on the 303(d) list. If a community has a large water supply source, their economic growth and community development rely on a plentiful and quality water supply. Likewise, if a river has become impaired and water uses have either been lost or compromised then restoration action should be initiated at the local level. Either way, having a WMP can assist in obtaining funding to address prioritized water quality related issues.

Successful development of a WMP involves inclusion of diverse and committed individuals or groups willing to address watershed challenges. This often involves obtaining technical services and analysis from local, state, and regional consultants as well as a steering committee of all relevant stakeholders at the table. Watershed management plans usually take a year or two to create, but occasionally can take much longer. Historic and current conditions of the watershed have to be taken into consideration and compared, in addition to application of watershed modeling scenarios.

Once as much information as possible has been obtained, the best possible agreed upon approach to solving the water quality protection or management issue can be charted. This course should include the nine elements outlined by the EPA, and meet EPA approval in order to use the document for obtaining federal funds to help address the watershed challenges. Although EPA approval is not a necessary action for a watershed management plan to be implemented, it is a necessary action for the request for funding to implement the proposed management actions listed in the plan.

Awareness Outreach and Education Activities

A major portion of any WMP is targeted awareness and education outreach programming. This type of programming is designed to help:

1) Reach members of the public at large.
2) Increase awareness of water quality issues.
3) Educate members of the public how they can make a difference through their actions.
4) Collect measureable results and outcome indicators.
5) Analyze results.
6) Adjust programming appropriately.

Total Daily Maximum Loads

A Total Daily Maximum Load (TMDL) refers to "the amount, or load, of a specific pollutant that a water body can receive on a daily basis and still meet the water quality standards" (EPA 2005). The maximum pollutant load for a particular water body is established by conducting a detailed water quality assessment. During this assessment, pollutant loads are allocated among the various point and nonpoint pollutant sources that may be affecting the water body. A margin of safety and the effects of seasonal variations are figured into the maximum load calculation. The TMDL program and associated regulations are outlined in Section 303(d) of the Clean Water Act. The law calls for each state to give EPA a list of its impaired waterbodies and prioritize that list for TMDL development based on five categories of impairment.

Category 1: Attaining the water quality standard and no use is threatened; Designated Uses are supported WQ Criteria are attained.

Category 2: Attaining some of the designated uses; no use is threatened; and insufficient data are available to determine if the remaining uses are attained or threatened.

Category 3: Insufficient data to determine if any designated use is attained.

Category 4: The standard is not met or is threatened for one or more designated uses, but the development of a TMDL is not required because: A TMDL is required unless one or more (4A, B, C) is being met or implemented.

Category 4a: A TMDL has been completed and approved by the EPA.

Category 4b: Other pollution control requirements are reasonably expected to result in the attainment of the water quality standard in the near future.

Category 4c: Pollution is not the cause of the water quality standard not being met.

Category 5: The water body does not meet applicable water quality standards or is threatened for one or more designated uses by one or more pollutants.

Category 5a: A TMDL is under way or scheduled, or will be scheduled.

Category 5c: Additional information will be collected before a TMDL is scheduled.

Similar to WMPs, TMDLs also undergo various phases of approval, ending with a final approval from EPA. Once completed, the TMDL is initiated and discharge limits are placed on point source discharges and other pollutant reduction practices are recommended for nonpoint sources. In Arkansas, the DEQ is responsible for TMDL Development. Visit the DEQ website to learn more about TMDLs in Arkansas. https://www.adeq.state.ar.us/water/planning/integrated/tmdl/.

Best Management Practices

In any WMP, outreach and education activity, or TMDL - specific sources of pollution are targeted and remedies for preventing pollution are presented. Since point sources are easily identifiable and already regulated, a common approach to addressing the broad spectrum of nonpoint source pollution is through the use of **Best Management Practices (BMPs)**. The structural and managerial practices and actions that can prevent water pollution, have been scientifically proven, are practical, and help restore or de-list impaired waters are known as BMPs.

The EPA defines BMPs as "methods that have been determined to be the most effective, practical means of preventing or reducing pollution from non-point sources." The general approach of dealing with nonpoint source pollution throughout a watershed is through the use of BMPs by all stakeholders. The development of BMPs began with the recognition that potential pollutants can move from landscapes to surrounding streams and underlying groundwater if not managed. Not only can pollutants move from the landscape, but how we manage the land can impact our water quality in both an adverse and positive manner. Once this relationship was established, several different management options for best managing pollutants have been considered and scientifically evaluated. This has led to creative and effective ways of managing and preventing potential water quality problems.

Fig. 41. Soil testing before fertilizing is a common best management practice to protect water quality *(Image courtesy of University of Arkansas System Division of Agriculture)*

Best management practices can be used by homeowners (Fig. 41), municipalities, farmers, industries, and county, state, and federal governments and agencies or anyone who manages or owns land. While BMPs are tailored to a particular land management situation and geographical location, they are implemented for the same basic goal of protecting our water resources. A single or even multiple BMPs can be implemented by anyone, anywhere in a watershed, but the types of BMP used should depend on the specific sources, types, and transport pathways of pollutants responsible for water quality degradation.

For example, there are specific sets of BMPs for particular activities within a watershed such as agriculture, construction, municipal growth, lawn and garden activities and so on. The following sections provide information about the different types of BMPs.

Agricultural BMPs

Agricultural activities have long been associated with water quality issues, and the EPA lists agriculture as a source of pollution in 59 percent of the impaired river miles and 31 percent of lakes across the country. The primary nonpoint source pollutants are nutrients, sediment, animal wastes, salts and pesticides. Since agricultural activities such as fertilizer or pesticide applications, field and pasture conversions, grazing, removal of riparian vegetation, and manure and wastewater management actions can potentially generate non-point source pollutants that can enter water ways through runoff or seepage and contribute to water impairments, it is important BMPs be used in these settings.

The effects of agriculture on water quality are summarized in Table 5. Additionally, this obvious potential for pollution in the agricultural setting is partly responsible for the vast funding, scientific study, and development of agricultural BMPs over the past four decades. Since many BMPs are managerial in nature, there are many non-structural measures that can be taken to improve water quality in addition to structural and vegetative management practices. Managerial practices include planning and management activities or behaviors that indicate soil and water conservation knowledge and understanding such as soil testing, nutrient management, fertilizer application timing and placement, and irrigation water management. Structural practices most often include some kind of construction, installation, and maintenance. Examples of structural practices include fencing, litter stacking sheds, vegetative buffer strips. Table 6 lists the effectiveness of selected agricultural BMPs for protecting water quality. For more information on agricultural BMPs and agricultural initiatives to help protect water quality visit the Arkansas NRCS website http://www.ar.nrcs.usda.gov/programs/.

Managerial Best Management Practices

Nutrient management is a practice that allows farmers to efficiently manage fertilizer storage, application rate, placement, and timing (Fig. 42). Often this practice is accomplished with the use of **Nutrient Management Plan (NMP)**. A typical NMP will have a pasture by pasture or field by field inventory of soil fertility and a corresponding fertilization time, rate, and placement for each pasture, and will also contain a place for fertilizer application records and fertilizer application buffer areas. All the features associated with NMPs make them effective tools for protecting water quality because they provide a whole-farm, systematic means of identifying water quality concerns and evaluating the need of BMPs on each individual field. These plans are normally developed by trained professionals in your local Conservation District office.

Fig. 42. Fertilizer calibration *(Image courtesy of University of Arkansas System Division of Agriculture)*

Floodplain management sustains the wise use of floodprone areas by regulating the placement of pollutants or hazardous materials, ensuring the anchoring, elevation and flood-proofing of pumps and other electrical utilities and use of flood-resistant building materials.

Integrated pest management (IPM) is a pest management strategy developed to keep pest populations below crop

Table 5. Potential Agricultural Impacts on Water Quality

AGRICULTURAL ACTIVITY	POTENTIAL NEGATIVE IMPACTS	
	Surface Water	Groundwater
Tillage/plowing	Sediment can be carried by wind and runoff into streams, ponds and reservoirs contributing to nutrient loading of waters, siltation of riverbeds and loss of wildlife habitat.	diminished infiltration in the plowing row
Commercial fertilization	Nutrients such as nitrogen and phosphorus can be washed into streams, rivers, lakes and eventually the Gulf of Mexico. This can lead to eutrophication, taste and odor problems with drinking water, declines in recreation potential, excess algae growth and hypoxia.	Leaching of nitrate into groundwater. Excessive levels of nitrate in drinking water are a threat to public health.
Manure fertilization	Potential impacts are very similar to commercial fertilizer because manure is a fertilizer. Manure fertilizers contain bacteria and a few more heavy metals, unlike commercial fertilizers. Bacteria can prevent safe recreational contact with water and cause infectious disease.	Nutrients and bacteria from manure fertilizers can potentially leach into groundwater resulting in contamination, a threat to public health.
Pesticides	Pesticides can drift or be carried in runoff to surface waters. This can endanger wildlife and affect public health when fish to be consumed or drinking water has trace residues.	Pesticides can potentially leach into groundwater resulting in contamination.
Heavy use areas	Heavy use areas by definition have limited to no vegetation due to the amount of animal or equipment traffic. Therefore, any manure, feed, chemicals, etc., in these areas is subject to movement in runoff water, raising various concerns based on the makeup of the runoff water.	Heavy use areas tend to have low to no infiltration, so direct impact to groundwater is not usually a significant concern.
Irrigation	Overwatering can cause runoff carrying sediment, nutrients and pesticides to surface waters. These inputs can negatively affect wildlife, drinking water, recreation potential and hypoxia in the Gulf of Mexico.	Overwatering can cause pollutants to leach into groundwater and can contribute to declines in groundwater levels.
Forestry practices	Harvesting timber can increase erosion of land, siltation of streambeds and turbidity of rivers. Also, modification of the hydrologic regime and contribution of nutrients can endanger wildlife and degrade recreation and drinking water.	Alteration of hydrology can decrease groundwater recharge and, as a result, lessen surface flow of water in streams in summer.

damage thresholds. The first step in IPM is simply scouting or monitoring for the presence of pests. When pest populations grow too high in numbers, taking appropriate action with mechanical, chemical, or biological control is necessary. The integration of chemical, mechanical, cultural, and biological pest management strategies used in IPM is known to reduce the use of or reliance on pesticides.

Irrigation water management promotes the efficient use of water to produce profitable yields, conserve water, and minimize the leaching of nutrients into groundwater. The timing and amount of irrigation water applied to agricultural lands are critical decisions for each operator because they affect profits and crop yields. Applying too much water increases pumping costs, reduces water efficiency, and increases the potential for nitrates and pesticides to leach into groundwater. On the other hand, delaying irrigation until plants are water stressed can reduce yield and make fertilizers and pesticides less effective. And irrigation water management plans should use soil moisture monitoring techniques to determine when irrigation is necessary. Irrigating only when a crop needs it is an effective BMP for reducing non-point pollutants and conserving water.

Utilization of warm and cool season forages can not only reduce sediment and nutrient runoff from pastures, but can increase the length of the grazing season on a farm.

Table 6. Table of Agricultural BMPs Impact on Potential Pollutants

BEST MANAGEMENT PRACTICE	EFFECTIVENESS IN CONTROLLING NONPOINT SOURCE POLLUTANTS			
	Sediment	Nutrients	Pesticides	Pathogens
Managerial BMPs				
Nutrient management	–	+	–	+
Irrigation water management	+	+	+	+
Integrated pest management	–	–	+	–
Manure amendments	–	+	–	–
Feed management	–	+	–	–
Vegetative BMPs				
Controlled grazing	+	+	+	+
Riparian buffer	+	+	+	+
Vegetative filter strip	+	+	+	+
Conservation tillage				
Cover crop	+	+		
Critical area planting	+	+		
Filter border	+	+	+	+
Wetland restoration	+	+	+	+
Structural BMPs				
Stream crossing	+	+	–	+
Farm pond	+	+	+	+
Grade stabilizaton structure	+	+		
Off-stream watering	+	+	–	+
Pasture fencing	+	+		
Stream fencing	+	+		+
Water control structure	+	+		
Heavy use area	+	+	–	+
Mortality composting	–	+	–	+
Manure composting	–	+	–	+
Manure storage facility	–	+	–	+

Legume establishment in pastures allows nitrogen to be fixed in the soil and can reduce your nitrogen fertilization needs. In addition to reducing nitrogen inputs in your pasture legumes also increase the forage quality of your pasture-forage mix.

Vegetative filter strips are strips of herbaceous vegetation that are placed between pasture or cropland and environmentally sensitive areas such as streams and lakes. These strips of vegetation reduce the amount of sediment, nutrients, and pesticides transported to surface waters in storm runoff.

Buffer strips are areas that do not receive fertilizer or pesticide applications. Buffer strips are most often implemented adjacent to or surrounding a ditch, stream, pond, or a wetland area. The use of buffer strips limits the amount of nutrients, sediments, and pesticides transported from agricultural production areas in storm runoff.

Riparian buffers are zones of grasses, forbs, trees and shrubs that are located next to streams, lakes, ponds, and wetlands. Riparian buffers reduce sediment, nutrient, and pesticide loss from the surrounding land area. Riparian buffers also maintain streambank integrity which prevents streambank erosion and property loss.

Structural Best Management Practices

Fencing is the practice of excluding livestock from certain pastures or parts of pastures and streamside areas (Fig. 43). As more pasture is divided into smaller paddocks the utilization of forages by grazing livestock can increase. As utilization of forages is increased and cattle are moved more frequently the ungrazed paddocks will have fresh forages available for grazing and the previously grazed paddocks will have time to rest. Rest periods from grazing will allow forage to grow back and prevents overgrazing which can lead to increased storm water runoff and unnecessary sediment and nutrient loss. Stream fencing prevents livestock from degrading stream bank integrity. Protecting stream banks leads to decreased stream bank erosion, loss of pastureland and nutrient and sediment loss from pastures.

Fig. 43. Pasture fencing enables rotational grazing, which can increase forage utilization, animal weight gain, forage yield and protect water quality

Alternative watering is a way of providing water for livestock that are fenced out of streams and ponds. Alternative watering is also designed to deliver water to livestock at multiple places on a farm which enhances a rotational grazing system. The use of alternative watering enhances pasture nutrient distribution by grazing animals and prevents stream bank erosion (Fig. 44).

Fig. 44. Alternative watering provides water to livestock away from environmentally sensitive areas such as streams *(Image courtesy of Natural Resources Conservation Service)*

Litter stacking sheds provide a structure where dry manure can be stored until it is time to be land applied or hauled off the farm. Dry storage of manure prevents loss of manure nutrient content and potentially negative environmental impacts by protecting the fertilizer source from rain and nutrient transport in storm runoff.

Irrigation tailwater recovery helps to conserve farm irrigation water supplies and improve water quality by collecting the water that runs off the field surface for reuse on the farm.

Heavy use area management in addition to reducing animal and equipment traffic problems due to excessively muddy conditions, are designed to reduce and treat runoff water from high animal an equipment traffic areas that can't maintain vegetation.

Streambank stabilization is a process that prevents an already eroding stream bank from further deterioration. Streambank erosion can cause property loss, damage to structures near the stream bank, and sedimentation and nutrient loading of rivers and lakes.

Urban Best Management Practices

The Census Bureau estimates that the amount of land in the U.S. covered by urban areas has increased from roughly 15 million acres in 1945 to over 98 million acres in 2007. During this same period, the population of the U.S. more than doubled. According to the annual USDA National Resources Inventory report the amount of developed land increased by 36 percent between 1982 and 2007.

Urbanization means that more and more land is being covered by impervious surfaces such as parking lots, roads, rooftops (Fig. 45). These types of surfaces increase rainfall runoff because water cannot infiltrate into the soil. Instead, water is channeled into storm drains and emptied into neighboring creeks and streams. This can cause flooding, property loss and damage, erosion, stream channel alteration, increased pollution and ecological damage, all of which pose serious threats to watersheds (Table 7).

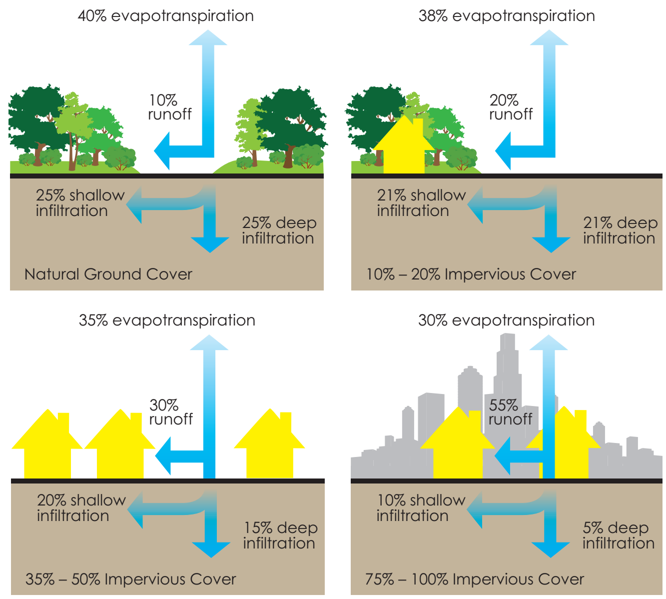


Fig. 45. Hydromodification image showing runoff and infiltration differences before and after development (*Image courtesy of University of Arkansas System Division of Agriculture*)

Best management practices for urban environments generally focus on managing water flow and reducing the amounts of nonpoint source pollutants that enter bodies of water. Pollutant loads can be especially high in urban areas. Major nonpoint source pollutants in urban areas include pathogens (from dogs and cats and failed centralized waste collection systems), toxic substances (from spilled oil, grease and toxic chemicals from cars), nutrients (from excess fertilizer applied to lawns, sports fields and landscaped areas), sediment (from construction sites and development), and floatable trash (Table 8).

Table 7. Impacts of Hydrologic Modification in Watersheds to Streams

IMPERVIOUS SURFACES LEAD TO:	EFFECTS				
	Flooding	Habitat Loss	Erosion	Channel Widening	Streambed Alteration
Increased volume	X	X	X	X	X
Increased peak flow	X	X	X	X	X
Decreased peak flow duration	X	X	X	X	X
Increased stream temperature		X			
Decreased base flow		X			
Changes in sediment loading	X	X	X	X	X

Table 8. Potential Pollution Problems Associated With Urban Areas

Urban Activity of Land Use	Potential Pollutants
Paved areas	Asphalt and concrete particles, polyaromatic hydrocarbons, road paints, coal tar, salts, sand, automotive fluids, dirt and other spills.
Motor vehicles	Leaked oil, gas, antifreeze, tire, clutch and brake lining parts.
Industrial/commercial/municipal	Heavy metals, hazardous chemicals, hazardous waste, grease, overflowing trash and seepage from dumpsters, sediment.
Leaves and gardens	Lawn clippings, leaves, prunings, pesticides, fertilizers, pet waste.
Construction and demolition areas	Sediment, construction materials and solid wastes, concrete washout, trash.
Littering	Trash that is not properly disposed of – such as in streets, stormdrains, trails, parks and other areas.
Wastewater treatment and septic tanks	Faulty or failing septic systems and sanitary sewers contribute hazardous waste, heavy metals, nutrients, bacteria and emerging contaminants.

Table 9. Relative Effectiveness of BMPs for Reducing Potential Pollutants in Urban Settings

BEST MANAGEMENT PRACTICE	EFFECTIVENESS IN CONTROLLING NONPOINT SOURCE POLLUTANTS				
	Sediment	Nutrients	Pesticides and toxic chemicals	Pathogens	Trash
Managerial BMPs					
Nutrient management	-	+	-	-	-
Irrigation management	+	+	+	+	+
Integrated pest management	-	-	+	-	-
Pet waste management	-	+	-	+	-
Trash management	-	+	+	+	+
Good housekeeping	+	+	+	-	+
Ordinances	+	+	+	+	+
Illicit discharge abatement	+	+	+	+	-
Smart growth	+	+	+	-	-
Yard waste management	+	+	-	-	-
Outreach and education	+	+	+	+	+
Septic system management	-	+	+	+	-
Vegetative BMPs					
Grassed or bioswales	+	+	+	+	+
Riparian buffer	+	+	+	+	+
Vegetative filter strip	+	+	+	+	+
Rain gardens	+	+	+	+	-
Conservation of green space	+	+	+	-	-
Green infrastructure	+	+	+	+	-
Structural BMPs					
Detention basins	+	+	+	+	+
Retention ponds	+	+	+	+	+
Constructed wetlands	+	+	+	+	+
Rainwater harvesting	+	+	-	-	-
Permeable pavement	+	+	-	-	-
Green roofs	+	+	-	-	-

As with BMPs developed for agriculture, urban BMPs can also be non-structural or structural in nature. Table 9 contains BMPs for urban settings. For a more complete listing of BMPs for the urban setting visit Pennsylvania's Stormwater Management Manual. http://www.depgreenport.state.pa.us/elibrary/GetFolder?FolderID=4673.

Structural Practices

Infiltration systems are designed to capture and store stormwater runoff so that it can infiltrate into the soil profile. Infiltration practices may include porous pavement, infiltration trenches, and infiltration basins. Infiltration systems have numerous benefits. By allowing rain fall to percolate and by capturing surface runoff, they reduce the impacts of hydrologic modification by lessening volume of water generated by impervious surfaces. This reduces excess runoff volumes and pollutant loads entering streams, rivers, and lakes. These practices also allow for groundwater recharge and help maintain base flow levels in streams in addition to filtering pollutants from water.

Fig. 46. Cisterns can be used to capture rooftop runoff for later reuse *(Image courtesy of University of Arkansas System Division of Agriculture)*

Detention systems collect and temporarily hold stormwater runoff for gradual release into a receiving body of water. Their main function is to regulate the flow of stormwater generated by impervious surfaces, but they also catch sediment and other pollutants. These systems not only minimize downstream flooding, but also help protect receiving streams from scour and bank erosion.

Retention systems include retention ponds and a variety of underground cisterns, pipes, and tanks that

Fig. 47. Constructed wetlands can absorb and process stormwater runoff in addition to providing other benefits *(Image courtesy of University of Arkansas System Division of Agriculture)*

intercept, store, and treat or reuse urban stormwater runoff (Fig. 46). In retention systems water is held indefinitely. Properly designed and maintained retention systems can be extremely effective because they regulate both water quantity and water quality. Diverting water to a retention system decreases peak stormwater discharge and flow rates which reduces downstream flooding, stream channel scour and streambank erosion. Retention systems filter out sediment and suspended solids, improve infiltration and the biological uptake of nutrients by aquatic plants, increase volatilization and breakdown of organic compounds. Retention systems also promote plant uptake of metals and the biological conversion of organic compounds.

Constructed wetland systems are designed to mimic the functions of natural wetlands by removing pollutants from urban stormwater (Fig.47). In a constructed wetland system, the water, plants, animals, microorganisms and natural elements (sun, soil, water and air) work together to improve water quality. These systems are efficient in removing pollutants such as nitrogen, suspended solids, hydrocarbons, and other pollutants such as metals. Constructed wetlands regulate stormwater runoff quantity for a period of time. Wetlands make excellent wildlife habitat and are aesthetic areas in a community.

Vegetative BMPs are often used in several categories of water quality protection, but their function to absorb, filter, and uptake stormwater runoff and associated pollutants as they flow through the vegetation is always the same. The use of native vegetation is common in bio-swales, rain gardens, open space, riparian buffers, green infrastructure, low impact development, and grassed waterways is very effective to reduce pollutant transport from land surfaces to waterbodies.

Low impact development (LID) practices and **green infrastructure** are being adopted in many communities to balance urban growth with environmental integrity through good land use planning in combination with other best management practices such as **preservation of natural landscape features**. Aquatic resources, water quality and natural watershed hydrology can all be maintained in the development process with LID and

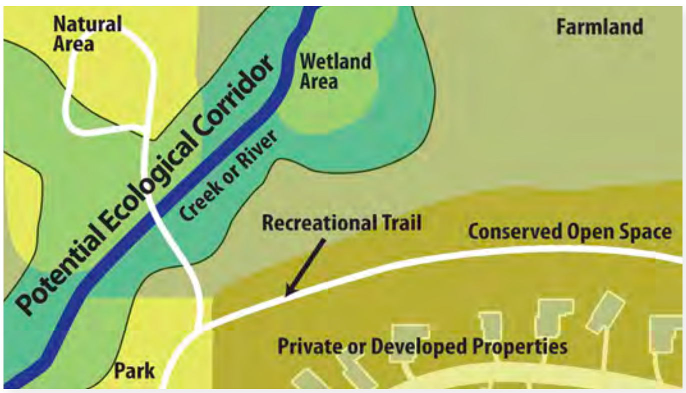


Fig. 48. Green infrastructure or LID planning can protect water quality and add value to communites *(Image courtesy of University of Arkansas System Division of Agriculture)*

green infrastructure (Fig. 48) development techniques. Some of the most common practices include strategic **conservation easements**, using pervious rather than impervious surfaces, placing restrictions on land use/ development, protecting sensitive areas, preserving open space, restricting development in **Special Flood Hazard Areas (SFHAs)**, and minimizing disturbance to soil and vegetation. Other LID practices include the use of **green roofs, bioswales, rain gardens**, and native landscaping (Fig. 49). Together, these practices help reduce the amount and quality of stormwater runoff that is generated which results in improvements to water quality, water quantity, through the preservation of natural watershed hydrology.

Low impact development practices can provide benefits to property owners, developers, municipalities, the general public and environment. With LID there is less need to

Fig. 49. Green roofs like this one at the University of Arkansas in Fayetteville can help reduce stormwater runoff *(Image courtesy of University of Arkansas System Division of Agriculture)*

build expensive grey infrastructure like roads and drainage systems, because of better planning and utilization of naturally occurring green infrastructure. Additionally, there is less burden on existing infrastructure systems and developments and the costs associated with repair and replacement are minimized. Communities that preserve their water quality and natural watershed hydrology do not face the need for expensive restoration measures due to a lack of planning and preventative actions.

Fig. 50. Painted storm drain inlets in public places with lots of visiblity, such as near trails and libraries, can draw a lot of attention and create a lot of awareness *(Image courtesy of University of Arkansas System Division of Agriculture)*

Non-Structural BMPs

Education and **outreach** is one of the most important non-structural BMPs. The general public, including decision makers, are often unaware of the hazards of nonpoint source pollutants, living or developing in or near floodprone areas, and the ways in which their individual actions may be contributing to problems in their watershed. Many people aren't aware of the steps that they and their communities can take to minimize nonpoint source pollution and reduce community flood hazard risks. Educational programs can take many forms (Fig. 51):

- Using television, newspaper, radio, social media and other forms to present information.
- Enlisting community organizations such as neighborhood associations and public recreation groups to encourage good stewardship and the adoption of BMPs by individuals and families.
- Youth education in schools and clubs (boys and girls clubs, 4-H, boy and girl scouts).
- Training public employees such as city and county staff in planning, engineering, parks and recreation, and road maintenance about floodplain management, nonpoint source pollution, and BMPs to use in park, building, and fleet maintenance, new construction, and stormwater maintenance.
- Training employees of business and industry to incorporate pollution prevention and good housekeeping techniques into their operations.
- Enacting disclosure laws to inform potential buyers of the risks of flood-prone property before the "final closing" meeting. Review or develop a flood disaster emergency plan and flood mitigation plan for your community.

Best Management Practice Maintenance programs are very important in reducing urban pollution, mitigating flood risks, and ensuring that measures adopted to deal with stormwater are functioning as designed. Important maintenance activities include checking on the status of previously implemented BMPs, maintaining infrastructure such as roads, ditches and flood control structures in repetitive flood loss areas. For example, street and parking lot sweeping can make a difference as more than 50 to 80 percent of the runoff from typical residential and commercial areas comes directly from streets and parking lots. While vegetated drainages, filter strips, and swales may need occasional re-seeding or planting in order to perform at an optimal level.

Policy development is a tool that is often used in municipal settings to manage water quality. In some instances, policy development is required of largely populated municipalities known as **MS4's (Municipal Separate Storm Sewer Systems)** that meet the definition of an urbanized area by the EPA and must then meet the **Six Minimum Measures** to reduce pollution to the extent practicable. Such policies often come in the form of ordinances, procedures, and land use planning. Ordinances can range from mandatory to voluntary (Fig 51). For example, in Fayetteville Arkansas, a mandatory "streamside protection ordinance" was established to help protect water quality, and a voluntary ordinance was created to allow a developer to be able to use LID practices in creation of new developments if they desired.

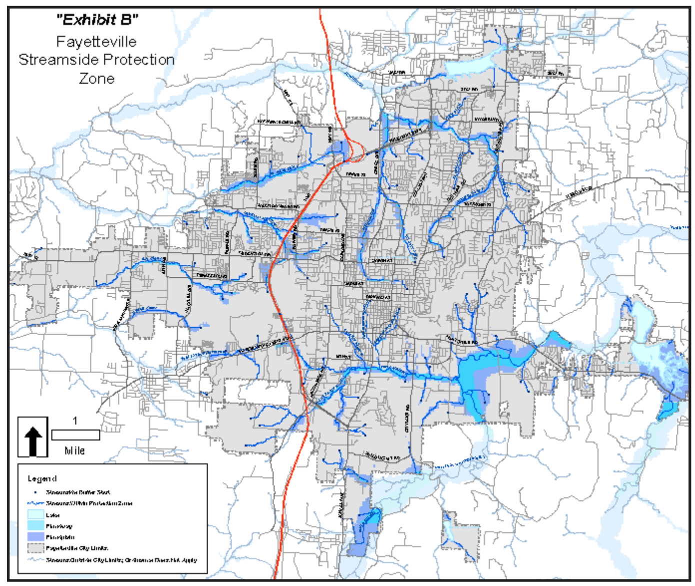


Fig. 51. Fayetteville Streamside Protection map

In other instances policy development is not mandated, but simply and option. One such option is community enrollment into the voluntary **Community Rating System (CRS)** program provides incentives to communities that enforce stricter land use regulations and implement programs that exceed the minimum requirements of the NFIP by reducing premiums up to 45% to residents in those communities. To earn CRS credit, your community can do things like preserve open space in the floodplain, enforce higher standards for safer new development, maintain drainage systems, and inform people about flood hazards, flood insurance, and how to reduce flood damage.

Forestry Best Management Practices

Over eighteen million acres of forests occur within Arkansas and between 2007 and 2011 3,335,200 acres were harvested (Rosson, 2012). **Silvicultural** practices can cause soil to move into streams. Implementing BMPs is an effective way to protect forest water quality and the water quality of downstream waterways within the state. As such, the Division of Forestry has developed a Forestry Best Management Practices Manual specific to Arkansas from which most of the following information was obtained.

Non-Structural Practices

Pre-harvest planning involves ensuring that forestry activities, including timber harvesting, site preparation, regeneration, and associated road construction, are planned with water quality considerations in mind and conducted without significant nonpoint source pollutant delivery to streams or other surface waters. Professionals at the Division of Forestry are available to the public and can provide free assistance for this process and the Arkansas Timber Producers Association maintains a list of trained loggers help select a contractor that has been trained in Silviculture BMPs. Stream identification and road location/planning are an essential element in protecting water quality during forest management activities because forest roads and stream crossings are one of the largest potential sources of sediment. Careful planning can aid in recognizing sensitive areas to avoid and help limit stream crossings by identifying practical alternatives and minimizing, the overall area disturbed by the operation. Topographic maps, aerial photographs, and soil surveys are helpful tools commonly used in conjunction with site reconnaissance to plan forestry activities (Fig. 53).

Timber harvesting BMPs include practices such as **locating log decks**, roads, and **skid trails** away from streams and on firm ground; capturing and properly disposing equipment fluids and trash; and preventing logging debris from entering stream channels. The goal of these practices is to conduct harvesting in a way that prevents nonpoint source pollution and minimize the impact to water quality.

In order to protect jurisdictional wetlands, **Section 404 of the Clean Water Act** regulates all soil disturbing activities within jurisdictional wetland areas by requiring a 404 Permit prior to disturbance. However, certain natural resource activities including silviculture have been granted an exemption from this permitting requirement for the construction of access roads, skid trails, etc. as long as fifteen conditions are met in the course of constructing these roads. These BMPs ensure that the flow and circulation patterns and chemical and biological characteristics of the wetland are not impaired, that the size is not reduced, and that any adverse effect on the aquatic environment will be minimized.

Practices that protect water resources during and after prescribed burning and wildfires include minimizing or excluding fire in SMZs or riparian areas, refraining from prescribed burning on steep terrain with erodible soils, and ensuring that exposed fire breaks are only as wide and deep as needed and stabilized and well drained to prevent erosion. The goal of these practices is to minimize nonpoint source pollution and erosion resulting from prescribed fire and activities associated with wildfire control or suppression.

Ensuring that pesticide application equipment is in good working order, applying chemicals away from surface water bodies and riparian areas, following the directions on the pesticide label, and disposing residues and containers in accordance with state and federal laws are all practices that prevent the direct or indirect application of forestry chemicals such as pesticides and fertilizers to open water sources.

Recreational usage, such as ATV traffic, can cause damage to forest vegetation and result in a reduced ability to conserve water quality. Careful planning, evaluation, and maintenance procedures can help guard against damage from recreational forest usage. Planning for ATV usage should involve properly locating new trails. Soil surveys, topographic maps, or site visits can aid in determining proper locations for ATV trails. For instance, trails should be located so that the number of stream crossings are minimized or avoided completely.

If streams must be crossed, the trail should cross at a right angle. Trails should be placed along topographic contours away from streamside management zones.

Fig. 52. Delineation between SMZ and managed uplands; hardwoods were not harvested in the SMZ and are now surrounded by pines *(Image courtesy of University of Arkansas at Monticello Forest Resources Center)*

Structural Practices

Streamside management zones, or SMZs, are forested riparian buffers intentionally left in place along streams in order to help protect water quality (Fig. 52). These SMZs allow the riparian buffer to reduce runoff velocity, filter sediment, provide streambank stability, regulate water temperature and provide wildlife habitat. SMZs minimize impacts to water quality, but vary in size with slope and stream type.

Stream crossings enable equipment to traverse streams when necessary and protect water quality. Typical crossings consist of bridges, culverts, and fords (Fig. 55). Selecting the most appropriate type of crossing for the site and properly installing in the best location and maintaining the structure can help prevent excessive sediment transport in runoff and help maintain natural stream flow.

Revegetation by natural regeneration, hand planting or direct seeding is used to stabilize exposed or disturbed soils, especially on steep slopes with erodible soils (Fig. 53). Vegetation can restabilize the soil by protecting it from rain drop impact, holding it in place with roots, reducing the velocity of runoff, and increasing organic matter which allows increased infiltration rates.

Road Construction and Maintenance Practices

Crowning and outsloping are road surface shaping techniques that enable quick and effective drainage to prevent erosion of the road surface. These practices also prevent water from accumulating on the road surface which can lead to rutting and erosion from vehicle traffic. Armoring road surfaces with rock or other forms of aggregate also protects against degradation from traffic (Fig. 53). Road surfaces are constructed to drain into roadside ditches that move water alongside a road to a point where it can safely be diverted into areas away from lakes, wetlands, and streams. This prevents runoff, which might be polluted with soil and other pollutants, from entering waterbodies.

Fig. 53. Revegetation after forest road construction or maintenance prevents erosion *(Image courtesy of University of Arkansas at Monticello Forest Resources Center)*

Waterbars are compacted earthen berms angled across the road surface, similar to speed bumps, the diversion devices intercept, divert, and drain runoff water off of inactive dirt roads. Constructing a series of water bars at regular intervals along a steep road helps to prevent erosion by reducing the volume of water carried down the road and decreasing the erosive velocity of that water by limiting the distance it can travel. The spacing of waterbars depends on the type of soils present and the slope of the road. **Wing ditches** are used on active and crowned roads, collect the runoff and disperse it into

Fig. 54. Wing ditches are common forestry BMPs used along dirt roads *(Image courtesy of Hal Liechty, University of Arkansas at Monticello)*

areas of stable vegetation away from water bodies (Fig. 54). **Cross drains** help to minimize erosion of road surfaces and roadside ditches while also maintaining the natural drainage patterns of the landscape by providing a stable way of transferring water across roads. **Culverts** transfer water under the road (Fig. 55) while broad based dips and rolling dips transfer water over the road surface.

Household and Back Yard Best Management Practices

Everyday household activities and practices can impact water quality within a given watershed. Residential stormwater is generated when precipitation runs off roofs, over paved roads, driveways, and parking lots, and into storm drains that empty into waterbodies. Stormwater runoff from residential property may contain urban pollutants such as fertilizer, pesticides, hazardous wastes and litter that negatively impact water quality. While the amount of pollutants coming from one property might be a small amount similar amounts coming from many different property's can have a harmful effect on water quality. Household BMPs are practices and actions that residents all over Arkansas can implement in their own homes and on their own property to help maintain and even improve water quality.

Property Drainage Assessments can be helpful in familiarizing property owners or tenants with the stormwater pathways on their property such as impervious surfaces, downspouts, slopes, natural

Fig. 55. Culverts and cross drains allow water to move off of forest roads into existing vegetation or downslope ditches to prevent soil erosion *(Image courtesy of Univer-sity of Arkansas at Monticello Forest Resources Center)*

drainages, storm drains, and streams. Every resident of Arkansas can contribute to improving water quality by reducing stormwater volumes and velocities from their property, by capturing and utilizing stormwater on their property, and by filtering pollutants from or keeping harmful pollutants out of stormwater.

Maintaining, enhancing, or creating **riparian buffers** next to waterways on a property filter pollutants from stormwater runoff, prevent streambank erosion, and help to regulate water temperature.

Practicing **nutrient management** by soil testing before fertilizing, timing and placing fertilizer applications appropriately, and fertilizing with only the recommended amount and type of fertilizer can help reduce nutrient runoff and protect water quality. Taking time to make sure that none of the fertilizer product that might have landed on streets, driveways or sidewalks gets swept or blown back onto landscaped areas can also make a big difference in preventing fertilizer pollution.

Additionally, homeowners or property managers can verify that their landscape or lawn management service has been trained in nutrient management and certified.

Home landscape design is a critical factor in helping to protect water quality as the design of a landscape can greatly affect natural watershed hydrology and runoff potential. Minimizing impervious surfaces and land alterations can help limit stormwater runoff. Additionally preserving native plants during development and using them in landscaping can help maintain natural watershed hydrology and reduce the need for fertilizer, water, and pesticide use. Maintaining vegetative cover or eliminating bare soil patches by mulching or planting can help reduce soil erosion and transport to waterways.

Incorporating **rain gardens** into new designs or retrofitting a yard can help decrease stormwater runoff and filter pollutants. Rain gardens are landscaped depressions planted with hardy **native plants** that can withstand both drought and flood conditions.

Rainwater harvesting with **rain barrels** (Fig. 56) or cisterns is a great way to capture rooftop runoff so that it can be stored and used later to water landscape features.

Using **integrated pest management (IPM)** and **proper pesticide applications procedures** greatly decreases the amount of pesticides that can be transported to waterways. The IPM approach of using mechanical, biological, cultural, and chemical methods to get rid of pests greatly reduces the need for pesticide applications. Additionally, using the least toxic pesticide product before a more toxic product, and making sure that you are using the right product for the right pest will lessen your pesticide application needs. If you are unable to identify a pest, but suspect you have a pest problem it is best to contact a qualified professional. If using pesticides yourself, always carefully follow the label directions. Never discard pesticides by dumping them on the ground, down household drains, storm drains, or into a waterway. Instead dispose of the product at a local household hazardous waste collection site.

Managing yard waste by **composting** can help turn lawn clippings and leaves into a valuable soil amendment that will act as a fertilizer and soil builder in the landscape. Lawn clippings and leaves should never be swept or blown into storm drains or dumped into waterways. Leaving lawn clippings in place by **grasscycling** and mulch mowing leaves are also options for managing yard waste to prevent pollution to waterways.

Pet waste management is the process of picking up and disposing of pet waste properly in the trash, toilet,

Fig. 56. Rain barrels can harvest rain water and help prevent rooftop runoff from flooding neighbors or encountering pollutants on its way to a stream *(Image courtesy of University of Arkansas Division of Agriculture)*

or placing in a pet waste septic system (Fig. 58). All of these management actions remove bacteria, nutrients, and viruses from the landscape where they can otherwise be transported by stormwater to waterways.

Preventing illicit discharges of water from vehicle washing, lawn watering, and pool emptying can prevent the transport of nutrients and other pollutants from entering waterways.

Septic system management aids in the proper functioning of a system to safely process household wastewater and sewage. Failing septic systems are hazards to groundwater and surface water as they can transmit nutrients and bacteria to ground or surface waters.

Trash management can ensure that waste does not get transported offsite in stormwater to a storm drain or stream. Disposal of trash by illegal dumping, burying, or burning can have negative impacts on water quality. The EPA estimates that the average American produces 4.6 pounds of trash per day. Trash that is not properly disposed of can end up in storm drains and eventually in waterbodies. There, trash can impair the growth of aquatic vegetation, impair aquatic habitat.

Pasture and animal paddock management is critical, perhaps even more so, on small acreages than large acreages since it is very easy to over stock and overgraze a small pasture. It's best to use a proper stocking rate to prevent overgrazing so that optimum forage growth

Fig. 57. Properly managing pet waste can reduce bacteria in urban runoff *(Image courtesy of University of Arkansas System Division of Agriculture)*

and grazing conditions will exist. A less compacted soil and more vegetated pasture will produce less nutrient, sediment, and bacteria runoff as compared to an overgrazed pasture. Limiting livestock access to streams, using pasture fencing to control grazing, practicing nutrient management and manure management can also limit pollutants in runoff from these areas (Fig. 57).

Household Hazardous Waste (HHW) Management is the practice of identifying household products that contain corrosive, toxic, ignitable or reactive ingredients, limiting their use, and properly disposing of them as not to pollute the environment or pos e a threat to human health. Improper disposal of these products includes pouring them down the sink, on the ground, into storm drains, or in some cases, putting them in the trash. Below are recommended actions for managing HHW.

- Select less hazardous products when buying cleaning, automotive, pesticide, or home improvement products.
- Buy only what is needed to avoid having excess product and using more than the amount recommended.
- Read the product label to ensure that you are properly using the product and only applying the recommended amount.
- Properly store HHW so that spills are prevented and cleanup supplies are handy (Fig. 57).

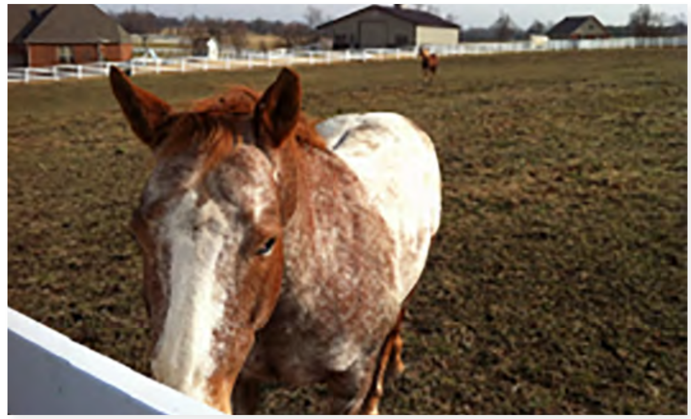


Fig. 58. Proper management of small pasture and paddock areas in suburban settings can help improve water quality *(Image courtesy of University of Arkansas System Division of Agriculture)*

- If you live in a Special Flood Hazard Area, consider storing HHW off of the ground or in an attic.
- Dispose of products properly by taking them to a HHW recycle center or following label directions.

Well Management is very important in groundwater and human health protection. Frequent inspection and maintenance of established wells is an important part of protecting groundwater. Other aspects of well management to protect groundwater are locating wells away from pollution sources like septic systems, SFHAs, and HHW use and storage areas. Fencing off well heads that are in pastures and installing backflow preventers can also help protect groundwater supplies from surface contaminants.

Summary

Best Management Practices (BMPs) are management strategies that, when properly implemented and maintained, address, reduce, or control a potential water quality problem. There are many BMPs available for use by all watershed stakeholders and many of them are free or low cost. There are also many BMPs that are costly and may require cost share assistance. Not all BMPs apply to every situation and may vary in their effectiveness due to the nature of stormwater runoff. The best way to determine if you need to implement BMPs on your property is to request a NMP at your local conservation district office or contact your local County Agent.

Fig. 59. Cleanup after a spill is easy with absorbent material *(Image courtesy of University of Arkansas System Division of Agriculture)*

KEY POINTS TO REMEMBER:

- The watershed approach is a collaborative and inclusive approach to dealing with water quality and quantity issues within a watershed.
- Watershed Management Plans (WMPs) and TMDLs are two very different water quality improvement mechanisms.
- Best Management Practices (BMPs) are methods that have been proven to be the most effective, practical means of preventing or reducing pollution from nonpoint sources.
- BMPs can be implemented to control many types of nonpoint source pollutants on any setting within a watershed.

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Notes

Chapter 6

Community- Driven Watershed Protection and Management

Arkansas Watershed Steward Handbook

Importance of Local Watershed Involvement

IN THIS CHAPTER, YOU WILL LEARN ABOUT:

- The importance of being involved in your watershed
- How to form a successful watershed partnership
- Activities that you can participate in or organize in your watershed

Water pollution can affect the quality of life of everyone in Arkansas. Although Arkansas is such a "water rich" state, currently only a small portion of Arkansas residents take responsibility for helping to protect and maintain its quality. Currently, most nonpoint pollution reductions are made through voluntary actions. Additionally, even with all of the regulations that could possibly be instated, water quality problems would likely still exist in Arkansas. Only watershed residents and landowners, through their personal actions and involvement, can ensure that their watershed and the water resources it contains are protected.

Citizen involvement is vitally important.

So, how do we get there? Community-driven watershed management is an approach that encourages citizens to get involved in identifying and addressing key issues within a watershed. Local stakeholders are critical because they actually live in, benefit from, use the resources of, and have the biggest stake in the watershed.

Stakeholders at the watershed level include any individual or group of individuals who could be affected by water quality impairment or by activities implemented to protect water quality of a particular watershed. These include regulatory management programs like TMDLs and voluntary programs like WMPs. Local stakeholders (Fig. 60) include:

- Watershed residents
- Landowners, managers and tribes
- Municipal officials and decision makers
- Businesses and industries
- County, state and federal agencies
- Recreation organizations
- Religious organizations
- Environmental and conservation organizations
- Universities, colleges and schools

Fig. 60. Stakeholder involvement in the Conservation Reserve Enhancement Program meeting.

Stakeholders can also include individuals, groups and organizations who are not directly affected by management activities but who are interested in the watershed and/or the particular management activity that is being proposed or implemented in the watershed. Some individuals and organizations may even be located outside of the watershed (Table 10). Remember, watersheds are connected across landscapes, so the management decisions in one

Table 10. A Brief Listing of Stakeholders and Potential Roles They Can Serve

STAKEHOLDER GROUP	POTENTIAL ROLE
Federal and state agencies	• Provide financial or technical assistance • Enhance visibility and credibility for programs and management decisions
Mass media	• Coverage of watershed events • Human interest stories • Understanding of local information needs • Ability to get information out quickly
Watershed or adjacent watershed stakeholders	• Serve as role models • Participate in programs • Spread information by word of mouth • Increase community involvement
Business and industry	• Fund programs with grants or sponsorships • Donate services for programs or field days • Provide volunteers
Environmental, conservation and recreation groups	• Provide volunteers • Participate in programs • Awareness of problems and issues • Committed and knowledgeable members
Farm organizations	• Donate equipment and services • Provide funding for programs • Participate in programs • Distribute information
Absentee landowners	• Exert peer pressure • Participate in programs • Become role models

watershed may also affect conditions in neighboring watersheds.

With the commitment of all types of stakeholders, trust and support for the management processes and outcomes can be established, responsibility for decisions and actions can be shared and communication and the coordination of resources can be enhanced. Locally developed solutions allow citizens to take into account unique social, economic and environmental circumstances in their community. When citizens are involved, they feel a sense of ownership of the problems in the watershed and the solutions being applied to resolve those problems. This better prepares the community and ensures long-term support for future watershed management plans and activities.

Forming and Sustaining Community Watershed Organizations and Partnerships

One of the most effective ways for stakeholders to become actively involved and truly make a difference in their watershed is to form a community watershed group. The Arkansas Watershed Steward Program can serve as the foundation for that process.

Watershed organizations – also referred to as partnerships, alliances, associations, coalitions and groups – are voluntary organizations made up of all types of stakeholders who share a common interest in protecting and helping their watershed.

Consequently, a community watershed group helps the entire community create a common vision for their watershed and works to keep the community focused on the most important issues.

Watershed organizations often begin when a water quality issue occurs in a stream, lake or other body of water within a watershed. As a result, organizations develop simply because local citizens recognize the need to be proactive in protecting their watershed. The driving force may be the desire to identify new threats to the watershed caused by changes in land use (such as sprawl development) or to address existing problems that have not been resolved. Sometimes, reports of problems in other watersheds stimulate local citizens to be proactive to protect their local resources. A watershed partnership may begin as a small gathering of citizens who share a common interest or concern and recognize the need to involve other citizens and take action to get something done. These small groups can be very effective when working within their communities (Fig. 61). With time, small watershed groups can evolve into independent watershed organizations with a common goal of improving water quality and watershed health that even have their own budgets, staff and board of directors.

Fig. 61. Members of the Beaver Watershed Alliance, City of Fayetteville and Fayetteville Natural Heritage Association by their new informational watershed kiosk

DID YOU KNOW?

Significant improvements in a watershed can take place much more quickly when local citizens realize and agree that the local environment matters to them and is at risk and believe that doing something about it will improve their own lives and strengthen their community for generations to come.

Working together in an organized partnership has its advantages, especially when dealing with something as large and as complex as an entire watershed. Watersheds sustain many different types of people, land uses, activities and interests. Successful and effective watershed organizations help merge these differences into a common vision and increase a community's sense of responsibility, involvement and commitment to protection of the watershed. Watershed partnerships can also lead to more efficient use of financial resources, an increase in sharing and cooperation and more creative and socially acceptable approaches to protecting and managing the natural resources in the watershed based on the needs and goals of the local community.

How Do Watershed Organizations Actually Start?

The formation and growth of successful watershed partnerships usually follows this sequence of steps:

1) One or more individuals who are passionate about the watershed and are willing to talk to others about it act as a catalyst. The actions of just one person (who could be an Arkansas Watershed Steward, school teacher, student, business professional and so on) can connect with people and motivate others who care about local water issues.

2) As a result, a core planning group develops to organize a community-wide information meeting. Such meetings are not just called in "crisis" situations but

can occur whenever citizens want to get together to improve their watershed or when they see symptoms that could lead to water quality or quantity problems.

3) A community-wide meeting is held so that people can exchange information and ideas about their watershed and what might be done to improve conditions.

4) A group of volunteer citizens meets regularly around a growing vision for their watershed. This vision is created as they improve their knowledge of the watershed and reflect upon its past, present and future.

5) Experts, including state and federal agency personnel, can be invited to discuss the science of the ecological system and provide technical information and advice so that the watershed group and community at large can better evaluate problems and propose solutions to those problems.

6) The watershed group develops a clear mission statement with objectives to guide actions and puts in place a leadership structure for guiding group activities.

7) Citizens in the watershed group undertake activities that support the intent and mission of the group.

8) The group communicates often with the whole watershed community about what is being learned and what is being planned and how it is being executed. The group continually invites others to participate and achieves community buy-in.

9) The group adaptively manages its plan and works to strengthen relationships and knowledge about social, political and environmental issues that affect the watershed and the community as a whole. The group negotiates, leverages and cooperates with others to achieve the community watershed vision.

Five Stages of Group Development

It takes many watershed groups a long time to progress to step 9, listed above, and some groups may never quite get there. Any successful group, including a watershed organization, needs time to develop. In the development process, groups generally experience five different stages, each characterized by high points and low points. Mixed feelings and experiences are normal in the group development process. While each of the stages is unique, they are not mutually exclusive. Rather, the stages blend into one another as the group dynamic takes shape and as time progresses.

1) ***Forming stage:*** When a watershed organization forms, there are often feelings of excitement and optimism, mixed with skepticism and anxiety. Group members are like hesitant swimmers, afraid to jump in the water with both feet. Despite these initial fears and hesitations, this particular state is a critical one with regard to the group's formation and distinctiveness. It is during this stage that the group begins to form and realize its identity and begins laying the groundwork for its future goals and expectation. In addition, the organization also begins establishing ground rules and working on group communication skills. The expected outcome of this first stage is commitment to the group. Trust and communication among group members, and agreement to the basic rules of group participation, are essential for establishing and sustaining this commitment.

2) ***Storming stage:*** This is often viewed as the most difficult stage for new watershed organizations. Reasons are the possible lack of familiarity among group members, confusion over individual roles, group transformation, and the lack of a unified direction. What started out as polite conversations and meetings may degenerate into conflict as group members become more comfortable with each other and begin to feel the need to exert more control or dominance over group decisions. Members might also begin rethinking previously agreed upon objectives and activities for achieving the groups goals. To get past this stage and to minimize group tension, it is important to recognize and address the conflict right away - ignoring it will lead to distrust and possibly cause the group to collapse. How a group overcomes this particular stage will influence its future success and progress. The expected outcome of the "Storming" stage is clarification. Conflict and power issues must be resolved for the group to move forward (Fig. 62).

3) ***Norming Stage:*** Groups that progress to this stage have made significant strides in the development process. At this point, group cohesion and action are prominent and help set the stage for the development of a solid group structure and a sense of community. Group identity is based upon the positive interpersonal relationships between members. Members are able to share their ideas and feelings, recognize each other's strengths, and give and receive feedback in a positive and constructive

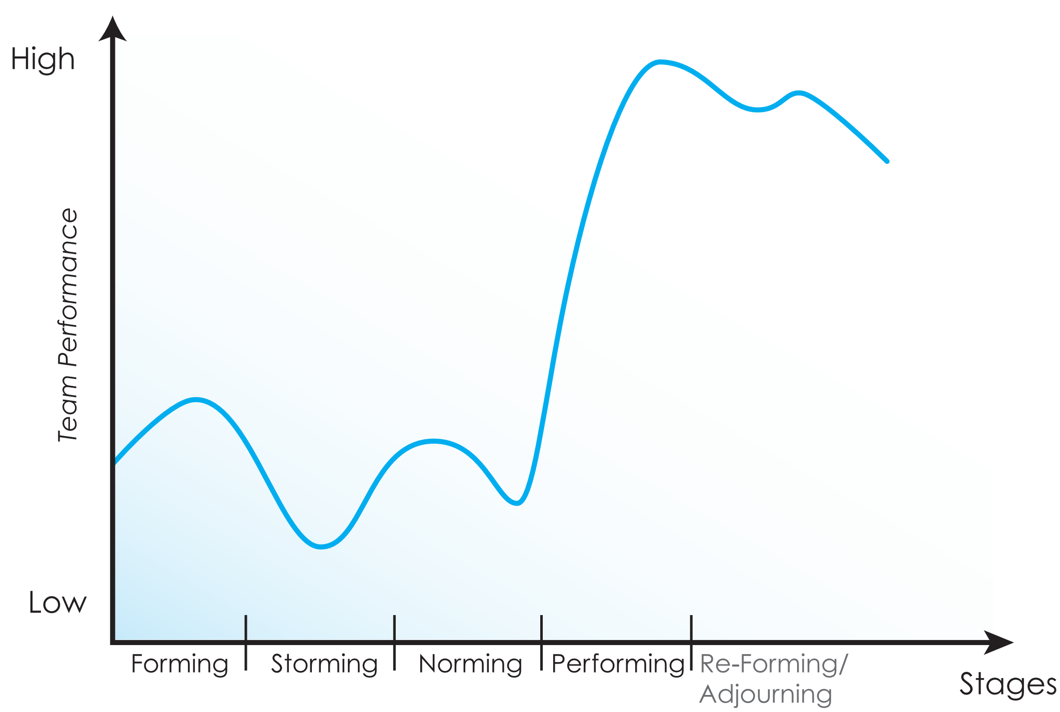

Fig. 62. Team performance scale

manner. The expected outcome for the "Norming" stage is clear commitment and cooperation. In achieving this, members begin to identify the overall responsibilities and roles of the group and establish agreement on the group's purpose and function in the community.

4) ***Performing Stage:*** This is the optimal stage of group development and performance. Members feel comfortable with each other and with the group's direction. They are aligned toward achieving goals and producing results, and a strong trust has been established among group members who share the decision-making responsibilities with less anxiety. At this point, group members have learned to effectively listen to one another, engage in dialogue, challenge their own assumptions, and change their opinions. The expected outcome of the "Performing" stage is high productivity which is accomplished through collective decision-making and effective problem-solving.

5) ***Transforming stage:*** This particular stage is often the celebration stage for groups that have accomplished many tasks, both internally and in the community. At this point, groups take time to consider their next steps, either deciding to re-organize themselves and move in a different direction, or renew their commitment to their original goals and keep pressing onward. Some groups may change members or develop new relationships with other groups transforming into a network, coalition or collaboration in order to tackle new challenges in the community. The expected outcome for the "Transforming" stage is sustained interest for renewal and/or redirection.

Each watershed group proceeds through the development stages at a different speed, and sometimes in a different order. Some groups may start at the first stage and progress consecutively all the way through to the last stage. Other groups may progress initially, but later find themselves back in one of the earlier stages. Some groups begin with a history of working together and may already have a well-defined task list and organizational structure. This will help them move through the initial stages much more quickly. It is important to remember that each group will develop and progress at its own pace. A group should not be discouraged if they take a few steps back, especially if this helps them refocus and sustain themselves in the long-term.

The basic foundation for sustaining local interest in a watershed group is a: 1) clearly defined vision; 2) mission; 3) list of objectives; and 4) stakeholder buy-in. For a new group to successfully form, members must view the group as doing meaningful work and want to be a part of that effort. Once the intent and objectives of the group are evident, other organizational practices can be applied to support development and sustainability.

Making Your Watershed Group Successful

FOOD FOR THOUGHT

As a watershed group progresses, members should continue asking themselves:

- What stage is our group currently in?
- Which tasks and processes can we focus on to progress to the next stage?
- What tasks do we need to complete in order to achieve goals?
- What tasks are we not focusing on that we need to?
- What group processes are occurring that are blocking us?

There are key strategies for forming and sustaining a watershed partnership or organization. Using these strategies during the group development process will pave the way for the group's success, visibility and respect in the community. Successful watershed organizations usually have certain characteristics that make them effective. Perhaps the most important are collective involvement/broad membership, a common vision, and measurable and attainable goals. It is important to remember, however, that each watershed group is different and certainly does not have to exhibit these characteristics to be successful and effective. Some of the most important characteristics of successful watershed organizations are discussed below.

Collective involvement/broad membership. A good mix of stakeholders, including individuals and community organizations, is very important to successful watershed partnerships. Watersheds can be very large and can undoubtedly include a wide variety of stakeholders, all with individual interests, experiences, backgrounds, and concerns. Including a broad array of such members in a watershed partnership is the best way to ensure that all views and concerns are included in planning and management efforts. Each member of the partnership will play a different role in the group, which might include leadership, technical, communication, educational, political, or policy roles. Broad group membership and collective involvement will ensure that each of these roles is filled with appropriate and knowledgeable individuals. While all watershed stakeholders should be welcome, soliciting individuals with specified skills that will be beneficial to the group can be important. Typical partners in a watershed organization include state and local agency representatives, local governmental officials, nonprofit organizations, local businesses, landowners, and local citizens.

Common mission. Watershed organizations are more likely to be successful if all the members share in one common mission for the entire group. It is very difficult to make progress if group members do not agree with the group's purpose, goals, and future directions. To help unite group members towards a common mission, it is important to establish a need and a direction for the group and to make sure that all members know what is expected of them and the group from the very beginning. The group should ask itself key questions, such as:

- What characteristics of this watershed do we want our children and future generations to be able to use and enjoy?
- How do we envision this watershed in the next 5, 10, or 20 years?

Organizational Structure. A well-defined organizational structure is critical for watershed groups because it forms the basis for group leadership, management, and decision-making. With that said, there is no one structure that fits every watershed group, or ensures group success. Each watershed group will be unique in the way it chooses to organize and manage itself.

General leadership responsibility is one of the first things to consider. Some groups choose to follow a leader/co-leader type of structure. In this case, the leader and co-leader (or chair/co-chair; president/vice president) are elected or appointed by group members. Persons serving in these roles have primary leadership responsibility for the group including setting up and leading regular meetings and facilitating group decisions. In other cases, groups may choose to share leadership responsibility among a larger portion of their members. Here, a steering committee comprised of several members shares leadership roles and responsibilities. In both cases, committees or work groups can be formed to focus on specific projects and/or to give recommendations to the steering committee. In addition to a general leadership structure, it is important for groups to establish a set of ground rules or bylaws. These rules can be used to formalize the mission and goals of the group, and to define various desires or expectations the group has, such as meeting attendance requirements, voting guidelines, and other important items.

Measurable/attainable goals. Establishing realistic goals and objectives makes it easier to measure the group's progress toward them. Articulation of a common mission sets the stage for developing the group's progress toward them. Articulating a common mission sets the stage for developing the group's goals and objectives. While there is one mission for the group, there can be several different goals and objectives. Goals should be both measurable, and attainable to keep the group focused, on task, and in a positive frame of mind. While failure to achieve some goals might actually make a group stronger, too many failures can lower morale and produce negativity among group members.

MISSIONS, GOALS AND OBJECTIVES

Mission Statement. The mission statement defines the intent of the group and its reason for existing. The mission statement should offer a clear message that can keep the watershed group focused and can be used to gather public support for watershed activities.

Parts of your group's mission may already be defined by city and county planning, Soil and Water Conservation Districts and regional Resource Conservation and Development agencies. The general public, however, may not be aware of or committed to this mission. One role of the watershed community group could be to encourage discussions and help to develop a common mission that incorporates the thinking of citizens, business and industry, nonprofit organizations, natural resource agencies, elected officials and regulatory agencies.

Goals. To accomplish the mission statement, your group will need to establish short-term and long-term goals. Goals are measureable, attainable and focused statements about what the group wants to accomplish. Goals should be established for general strategies (e.g., encourage all city officials to attend an Arkansas Watershed Steward training during their term in office). Focus on the future in setting clear and attainable goals. Watershed group members should assume specific responsibilities to accomplish the set goals within a definite time frame.

Tasks. *To achieve the group's goals, specific tasks will need to be outlined by group members. Tasks are specific actions that are planned to accomplish the stated goals of the group. Tasks can range from very simple (e.g., identify local, state, and federal agencies that can help achieve goals or arranging a location for and announcing group meetings), to more difficult (e.g., write a grant and submit to support the development of a watershed protection plan).*

EXAMPLES

Mission Statement of Ozarks Water Watch: *"To promote water quality in the upper White River basin + watershed through bi-state collaboration on research, public policy and action projects in Arkansas and Missouri."*

Goals:

1) Emphasize public information, education, promotion and communication about water quality issues.
2) Serve as an advocate on policy issues which affect water quality and watershed groups working for common purpose.
3) Monitor and report on water quality in the basin.
4) Support, encourage and capitalize on allied watershed groups working for common purpose.
5) Seek long term funding support for the organization and water quality work in the basin region.
6) Support and administer water quality action projects throughout the basin.

Tasks:

1) Create educational materials and distribute them to watershed stakeholders.
2) Write articles for news media or other organizations to distribute.
3) Organize an annual water quality monitoring and creek cleanup activities.
4) Work with other watershed groups on projects,
5) Write grants and seek sponsorships and donations.
6) Carry out water quality improvement projects.

Local knowledge. The expertise of individual citizens residing within communities and watersheds is critical to effective watershed partnerships. Local citizens usually have in-depth knowledge of the resource base and the local economy, and most often share a desire to protect their watershed. Drawing on this localized knowledge of the community will strengthen a watershed organization and add vital insight to various watershed processes.

Effective communication. Because a watershed partnership is made up of many types of members, the potential for conflict and discord can be rather high. Many watershed organizations fail because they are unable to overcome differences among members and unite with a common purpose. Using effective communication skills can help prevent conflict.

Established ground rules. Ground rules can be established for anything related to your watershed organization, including meeting participation, discussion confidentiality, constructive feedback, decision-making, and more. Having well established guidelines and adhering to those guidelines will minimize any controversy within the group and help it function more effectively.

Collaborative decision making. Decision making is an important function of group members. Decisions can be as simple as setting a future meeting date or as complicated as establishing budgets for various projects. With every decision an effort should be made to use a collaborative process so that difficulties caused by different ideas and opinions can be avoided. Collaborative decision making uses Consensus to ensure that each member's needs and concerns are addressed before a final decision is agreed upon. Collaborative decision making involves the following five steps (Hacker, Willard, Couturier, 2002):

1) Determine the parameters and constraints of the decision. When does the decision have to be made? How much time is needed to make the decision? Are there budget constraints, legal requirements, or other things that need to be considered?

2) Identify the needs of stakeholders and the potential effects of the decision on stakeholders. What does each party need out of the decision? Who may be affected negatively and positively? What must be satisfied in order to achieve an effective decision?

3) Gather information. What information is needed to make an informed decision? Have all the needs of the stakeholders been determined?

4) Identify alternative options. Are there additional options, beyond the most favored ones, that should be considered? How well does each alternative meet the needs of the stakeholders?

5) Make decision and follow through. How will the decision be implemented? Do you need to let other parties know about the final decision? How will you determine if the decision was a good one?

Fig. 63. West Fork cleanup gets boatloads of trash off of the river each year

Steady Progress. Some groups can fall victim to periods of inactivity during which membership, motivation, and energy levels are not as high as when the group first formed. To overcome this, it is a good idea to constantly challenge the group with new information, facts and ideas to spur involvement and action among the group. Begin by planning small projects or outlining a few small tasks (e.g., write a series of newspaper articles, organize a stream walk/cleanup, etc.) that have a good chance for success. Recognize and reward group members for their participation and ideas and use the power of positive feedback to motivate and encourage. This might help the group realize its potential and stimulate additional tasks, projects and action in the watershed. Ways to encourage and maintain participation in a watershed partnership are discussed later in this section.

Shared resources. Pooling resources (Fig. 65) from industries, organizations, individuals and other stakeholders within a watershed can significantly increase the efficiency, effectiveness and visibility of a watershed organization. Examples of available resources might include an existing education display created for a local school, water testing kits from a state agency, help with an outreach activity or access to an individual who specializes in grant writing. For example, the Beaver Watershed Alliance works with the Watershed Conservation Resource Center, University of Arkansas System Division of Agriculture, Ozarks Water Watch, Washington County, the City of West Fork, and Beaver Water District each year at their annual river cleanup event.

Finding and using all available resources within the watershed will help avoid unnecessary duplication of effort and expenditures of time and money, and will improve the actual on-the-ground progress made by the partnership. Group members should learn about the mission and activities of other local and recreational groups, organizations and agencies that might be able to help with different tasks and projects.

Team building. This is particularly important in the “Forming” stage when group members are just getting to know one another and might be hesitant to initiate communication with members they don’t know. Team building can be accomplished in several different ways. Encourage group members to discuss their interest in the watershed and why they want to be involved in the partnership. Also, work together on common activities and small projects that can be easily accomplished. A quick victory in a group just starting out will help build trust and commitment among group members.

Member development. Working to increase the knowledge, skill, confidence and involvement of group members and stakeholders will be essential to perpetuating the group by ensuring that there are others interested and willing to take on leadership roles over time.

Mutual respect. We’ve already established that watersheds are comprised of many diverse interests and groups of people. As a result, controversy is likely, and overt conflicts may break out from time to time. While some conflict can be healthy for a watershed organization to experience, conflict that stems from a lack of mutual respect and involves personal attacks will quickly diminish the organization’s effectiveness.

Being an Effective Watershed Group Member

There are specific roles and responsibilities for individual group members that help ensure a successful group dynamic. Group members should:

- Be advocates for the group’s vision, mission, goals and objectives
- Serve as liaisons between interested community citizens and other group members
- Actively assist in creating innovative solutions to water quality issues in the watershed
- Listen to the ideas of other group members and provide constructive feedback

- Follow the rules of the group, actively participate in group discussions, and be involved in group decision making
- Be willing to serve on committees and/or work groups when necessary

What Kinds of Activities Do Local Watershed Groups Do?

Community watershed groups can partner with all types of federal, state and local organizations, including city and county governments, state and federal agencies, conservation and recreation organizations, farmers, businesses, non-profits, and municipalities to improve their watershed.

Watershed groups can often organize and participate in many different types of activities and projects in their watershed to help increase visibility for their cause, get other members of the community involved, and improve overall watershed health. Take a look at Appendix B to find a more detailed list of activities that watershed groups can organize and participate in.

Some examples of activities include:

- Organize or sponsor special activities in your watershed (listed below)
- Help establish communication networks with other watershed residents and groups
- Educate others and motivate them to get involved
- Conduct demonstration and field trials of best management practices (Fig 68)
- Collect local data from water quality monitoring, wildlife inventories, resource inventories, and surveys of farmer, industrial, municipal and resident land use practices
- Identify priorities for allocating limited public financial resources
- Set local water quality and quantity goals and plan strategies for achieving those goals
- Offer innovative solutions for controlling potential sources of pollution

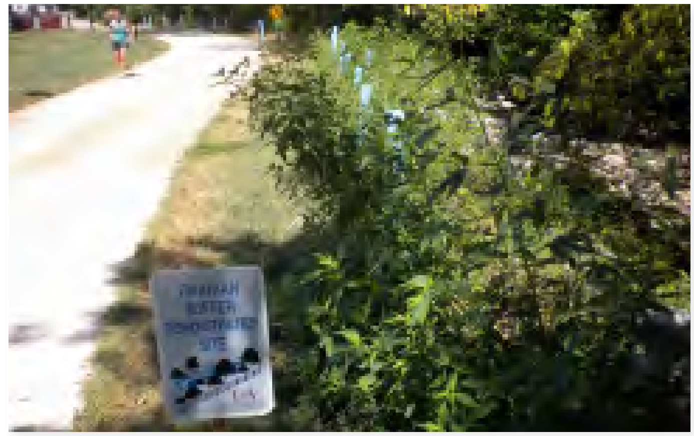

Fig. 64. Riparian buffer demonstration site located along a heavily used city trail near a creek

- Identify sources of and seek additional funds to support local efforts to solve water quality problems

Stakeholder survey: A watershed organization should always function with the best interests of all community members in mind. A good way to find out what the community wants for the watershed and any concerns they might have is to conduct a brief stakeholder or community survey. Ask residents how much they know about their watershed, what issues they might have, and if they want to get involved to help improve the health of the watershed. Survey results will help the partnership decide which management activities might be most successful.

Civic involvement: Watershed groups can greatly influence local decisions about water quality management, but they must actively participate in the community to make these positive changes happen. This could include being on the mailing list for new wastewater permit applications received by DEQ, and monitoring city council agendas for new development plans or water/wastewater issues. Individuals can also become members of local planning and zoning commissions and economic development boards to ensure that environmental considerations are included in long-term planning for their communities (Fig. 61). As an Arkansas Watershed Steward, or as an organized watershed group, you should seek opportunities to work constructively with local and state entities to improve and protect your watershed and its resources.

Field Trips: Take a field trip anywhere you want, like a local park, ranch, lake, etc. Field trips help group members get to know each other and feel comfortable with each other, especially if the group is just forming. Field trips also help build group coherency and get other members of the community involved, and they can be a lot of fun. In addition, field trips can help community members discover all the different ways the watershed is used and how those different uses are connected.

Watershed tours: There is no better way to learn about your watershed than by taking a tour of the watershed itself. A watershed tour is a great way to bring a wide variety of people together to learn about the watershed, visit different areas in the watershed (urban, agricultural, industrial, homes), and have an open dialogue about issues that should be addressed. Invite technical experts along to share their knowledge and facilitate discussions.

Fig. 65. Master Gardeners, West Fork Watershed Partnership, West Fork Library, Beaver Water District and Beaver Watershed Alliance worked together as part of an EPA and ANRC 319 Grant to implement rain gardens to manage stormwater runoff

Canoe/float trips: This is a great way to help community members get an "up close" look at streams, rivers and lakes in the watershed. A float trip can help people understand how bodies of water are connected to the watershed, learn more about water and watershed in general, and just have fun. This might be an effective way to bring group members closer together, especially if the group is just starting out. It could also be a great way to attract different members of the community to your group's cause - Folks who otherwise wouldn't have known about or gotten involved with the group.

Volunteer water quality monitoring: Volunteer water quality monitoring is a special way for the people to be actively involved in gauging the health of their watershed. To start a volunteer water quality monitoring group, consider contacting Arkansas Stream Team, a network of volunteers and partners who are trained to collect water quality data. Pick some easily accessible sites along a popular stream, river, lake or other body of water and test the quality of the water at those sites regularly. Keep track of your data and monitor how it changes over time. If problems are identified, the partnership could encourage action to protect or restore watershed health.

Stream cleanups: Stream cleanups can be very successful because participants can see a visible effect afterward and know they are making a difference to the land and water resources in their community. There are many federal, state, and local entities (American Rivers, Arkansas Stream Teams, Keep Arkansas Beautiful, County Environmental Offices) that have experience in organizing and conducting stream cleanups. They will often sponsor the event and provide trash bags and other materials at no cost.

Educational programs and exhibits: These are great tools for increasing community awareness about the watershed and informing people of steps they can take to help improve watershed health A short presentation to a school class or community group can really make a difference and can also garner more support for watershed improvement. You can also create posters and other visuals to display at local libraries, shopping centers, coffee shops, and other popular places around town. For example, a balanced exhibit that showcases your group's mission and goals, and describes concerns the group has about the community watershed and also positive examples about what is helping solve watershed issues is great place to start.

Media Campaign: An effective way to get the word out about water quality issues in your watershed is to advertise. Options include mass mailings flyers, public service announcements, watershed facts sheets, newsletters and newspaper articles. These efforts help raise awareness in the community, get more individuals to join your watershed group, and encourage people to take responsibility to take personal action to protect your water resources.

Watershed festival: Watershed festivals are fun community events that increase the awareness and motivation of community residents and other stakeholders. Invite people from state and local environmental organizations, as well as other local entities and businesses, to celebrate in protecting and caring for the watershed.

How to Obtain Funding For Your Watershed Organization

Water quality improvement projects and activities don't just happen. Most require some type of funding. And all watershed groups need funding to support their operational costs. Some activities can be carried out at very little cost, using the expertise of group members. For example, if a member of the watershed group works in marketing, that person could develop marketing tools for the partnership rather than having to pay someone to do it. It is also a good idea to regularly encourage members of the media to participate in the group and to publicize group meetings and activities. This will undoubtedly increase visibility for the group and may increase your funding opportunities. Other types of in-kind contributions that can be provided by group members include accounting skills, planning, public relations, technical expertise, office equipment donations, and more.

One of the biggest frustrations for watershed groups can be funding the activities and operation of the group as a whole. Locating and securing funding from external sources can be challenging. Most watershed groups acquire funding from a number of different sources, often tied to specific tasks or projects. Examples of funding sources include:

DID YOU KNOW?

Many foundations and corporations give grant money only to 501(c)3 nonprofit organizations. If you choose not to pursue nonprofit status right away (or not at all), you can still often access this funding by working with another group that is a registered nonprofit. The two groups don't even have to be involved in a joint project and can simply agree to form as a "fiscal partnership or sponsor." You can then explain this relationship and agreement in the grant proposal.

- **Membership dues:** Most groups do not require direct financial support from members. Instead, contributions are often in the form of the time and energy in serving the organization. However, some watershed groups collect annual membership dues that can range from a few dollars to a few thousand dollars, depending on the circumstances. These funds, even if nominal, can go a long way in paying for operating costs and in supporting watershed activities. Groups that don't require membership fees generally rely more on government funding, private foundation funding, special event revenue, sponsorships, general donations (discussed below) and in-kind contributions in the form of time, talents and goods.
- **Grants:** Grants can be obtained from a number of different sources including government-sponsored funding mechanisms that are watershed specific, community/philanthropic foundations with specific interests in the group's mission and objectives, eco-friendly corporations and businesses, and even local banks. Some examples of funding sources include the EPA, USDA-NIFA, ANRC, AWRC, Arkansas Stream Teams, and more.

A written grant proposal is usually required to obtain these funds. Although the requirements of each proposal will vary, most granting agencies expect a project summary, problem statement, project description, and detailed budget description. The internet is a great tool to use when researching potential funding sources. Use your group members and stakeholders who might have connections within the community and who might specialize in grant writing.

- **Contracts:** In many cases there is a need for source water protection, forest or unpaved road management, riparian restoration, and etc. that a watershed group or organization can provide in return for a payment for services.
- **Special event revenue:** Your watershed group may decide to sponsor a special event such as a dinner, some type of sports tournament (golf, baseball, etc.), a concert, or some other special event to generate revenue. Such events are fun for the community and also productive for the watershed partnership, especially if they generate enough funds to help cover some operational costs and/or project costs.

WATERSHED ORGANIZATION SUCCESS STORY

The Illinois River Watershed Partnership (IRWP) was formed in 2005 by a group of passionate stakeholders that agree that public education is the best way to protect the valuable natural resource that is the Illinois River. The IRWP board of directors represents interest groups from agriculture, business, conservation, construction, government, and the technical, research, and education fields. IRWP's stakeholders' interests align with this vision:

The Illinois River and its tributaries will be a fully functioning ecosystem, where ecological protection, conservation, and economically productive uses support diverse aquatic and riparian communities, meet all state and federal water quality standards, promote economic sustainability, and provide recreational opportunities.

The Illinois River Watershed is home to over 400,000 residents, businesses and industries, 22 municipalities, 7 counties and spans across 2 states. The headwaters of the Illinois River are located in Hogeye, Arkansas – just south of Fayetteville. In 2021, the major point of concern in the Illinois River Watershed is streambank erosion, which contributes the majority of phosphorus to the river and continues to be a source of impairment in Oklahoma.

With the origin of the river being located in a rapidly urbanizing area of Northwest Arkansas, IRWP has focused on implementing conservation and restoration practices (or best management practices, aka BMPs) near the source to slow, spread, and soak stormwater before it arrives at the channel. Increased impervious surface area from urbanization leads to an increase in stormwater that becomes runoff, and subsequently increases the volume and velocity of the water in the tributaries. IRWP hopes to be a catalyst for proactive stormwater management in Northwest Arkansas and beyond, advocating for, fundraising around, and educating the public on water quality and sustainable stormwater. Our mission is to improve the integrity of the Illinois River Watershed through public education and community outreach, water quality monitoring and the implementation of conservation and restoration practices throughout the Illinois River Watershed.

State and federal agency partners include Arkansas Natural Resources Commission, Arkansas Game and Fish Commission, Arkansas Forestry Commission, USDA Natural Resource Conservation Service (NRCS), USDA Farm Service Agency (FSA) and the University of Arkansas System Division of Agriculture Cooperative Extension Service, among others. Additionally, IRWP collaborates with municipal and nonprofit organizations. IRWP strives to be representative of the diverse interest groups that live, work, and play in the Illinois River Watershed.

IRWP's 2021-2022 programs include the Riparian Restoration Program, Unpaved Roads Demonstration Projects, Septic Tank Remediation Program, Landowner Services Program, Youth Education Program, Blue Neighborhoods/Blue Cities Programs, streambank and water quality monitoring programs, ecological assessment program, minerals impairment studies, and civic engagement.

Regardless of how the group initially obtains funds, it is important to always be on the lookout for the next funding opportunity. Simply relying on one or two funding sources to support the full work of the organization can be risky. It is important to diversify the group's funding base to ensure that its work will be sustainable. Take a look at Appendix C to learn where to find potential funding opportunities for your watershed group.

Characteristics of Unsuccessful Watershed Groups

Regardless of how the group initially obtains funds, it is important to always be on the lookout for the next funding opportunity. Simply relying on one or two funding sources to support the full work of the organization can be risky. It is important to diversify the group's funding base to ensure that its work will be sustainable. Take a look at Appendix C to learn where to find potential funding opportunities for your watershed group.

While there are many benefits associated with watershed partnerships, creating them and making them successful can be challenging. New groups just starting out often want to see positive results right away. This is not realistic. Maintaining the motivation, enthusiasm and leadership of a group is perhaps the single greatest challenge. Securing funding to accomplish some of the major goals of a group also can be difficult. All groups encounter challenges. The way in which they tackle and overcome these challenges will be the deciding factor in their long-term success. Always remember that the overall benefits of watershed organizations far outweigh the challenges associated with them.

While there are many characteristics that help make a watershed partnership or organization successful, there are also many more that can spell the end for a new or even veteran watershed group. If your group has any of the following characteristics, it isn't necessarily destined for failure. But it might mean that there are issues among members or with the watershed partnership itself that need to be addressed and resolved right away. Otherwise, conflicting interests and differing opinions might cause the group to end in failure. Look for these characteristics of unsuccessful watershed groups:

- Conflict among key interests remains unresolved
- Size and complexity of the watershed is too overwhelming and the group flounders
- The group has no clear purpose
- The group is unable to overcome past failures
- Goals or deadlines are unrealistic
- Covert agendas exist
- Key interests or decision makers are not included or refuse to participate
- Not all participants stand to benefit from the partnership
- Some members stand to benefit considerably more than others
- The partnership isn't needed because one entity could achieve the goals alone
- Managers are unwilling to give up their role and share authority with volunteer or board members
- Financial and time commitments outweigh potential benefits; funding runs out
- Members are uncomfortable with the commitments required
- Feedback from key stakeholders is not utilized and community buy-in is lost
- "Experts" are unwilling to give up their role and share authority with citizen stakeholders

Most of these obstacles are related to internal group conflict - the main reason watershed partnerships fail. To help overcome these potential stumbling blocks, it is important to clearly identify problems and address them directly. If at all possible, however, try to anticipate and prevent problems from occurring in the first place. One way to do this is to spend a lot of time at the beginning getting to know each other, establishing ground rules, and agreeing to individual roles and responsibilities. Then, when a conflict occurs, the group knows right away how to resolve the issue and move forward.

Another way to approach conflict among members is to have the group think of it as a group challenge rather than a problem of individuals. It is human nature to blame another individual when, in fact, many conflicts occur because a group lets them happen. One of the best ways to overcome obstacles is to build consensus among group members. Confronting and overcoming conflict as a group will unite group members toward a common vision and strengthen the groups resolve. When a group member is being difficult and seems to be a constant cause of conflict, it is especially important to handle the situation carefully and not over-react. The entire group should speak with the person, hear his or her thoughts and concerns, and work toward a group resolution.

A common stumbling block many groups face is waning participation of group members in community watershed activities and projects. Even if a group has members, a mission statement, and organizational structure, a planned project and maybe even a little project funding, it may not know how to maintain its longevity in the community and keep its members interested. It isn't enough to simply announce meetings and activities and assume people will show up because they "should." To encourage participation from stakeholders and partners, communication and education are critical. In addition, watershed groups should:

- Use the media to announce ongoing events and meeting, and to publicize special activities such as a watershed festival or stream cleanup
- Use peer-to-peer networking by having group members talk to neighbors, colleagues and others who may have an interest in learning more about the group's activities
- Use field or site visits to make the issue more tangible and to build enthusiasm
- Use newsletters and brochures to advertise the partnerships efforts
- Work through local schools to educate the public about partnership goals and activities

- Consider innovative outreach methods such as photography and fun displays to publicize the partnership
- Appeal to people's sense of stewardship, citizenship and service. Let them know that the issues being addressed by the partnership affect all citizens in the watershed and that each person can contribute to the solution

To maintain participation among group members, it is necessary to constantly motivate them keep them enthusiastic, and genuinely listen to their concerns or ambitions. To accomplish this:

- Start with small, manageable projects that are likely to be successful
- Document and celebrate success
- Use on-the-ground projects to give participants a sense that they are making a difference (stream cleanups, tree planting, etc.)
- Use positive feedback, recognition and rewards as incentives for continued participation
- Maintain a stable structure to reassure members that the partnership is accountable to them and that something will get done
- Offer opportunities to participate at different levels (regularly, occasionally, professionally, etc.)
- Build on sources of community pride
- Make explicit what member organizations and individuals stand to gain and specifically identify these benefits
- Continually revisit and stress successes and achievements
- Make group meetings and activities fun (plan social events, provide refreshments at group meetings, etc.)

Summary

As an Arkansas Watershed Steward, you have a wonderful opportunity to help protect your community's water resources and your entire watershed for future posterity. Becoming educated about the issues that affect your watershed is only the first step. The next step is committing just a little of your time and energy to apply this knowledge and create solutions that will improve the water quality and overall health of your watershed and community. Get your friends, neighbors, family and colleagues involved, too; start a watershed organization and make a difference. Only you, and other citizens like you can protect water quality in your community. Working together, you can help ensure that future generations of Arkansans will be able to enjoy the state's valuable water resources.

IMPORTANT THINGS TO THINK ABOUT

- Local groups must understand their water issues and believe they can make a difference. Agencies that convene local groups must be prepared to let citizens make a difference.
- Communication among citizens, business and industry and the local/state/federal agencies supporting local groups must be as open and voluntary as possible.
- Local community priorities (as well as watershed resource system they are a part of) are dynamic and will be constantly changing.
- Free exchanges of information and communication among citizens and natural resource experts are essential if they are to learn from each other and develop action strategies that make a difference.
- Local groups are always nested in other decision making structures within the county, region, state and nation. Environ-mental, economic, social and political decisions within and outside of the watershed influence what kinds of actions are possible.
- Reliance on government agencies alone to solve complex resource management problems may overlook important watershed issues and solutions.
- People engage and respond to change best when given an opportunity to co-create their environment.
- Conflict is inevitable when people feel strongly about their environment. The challenge is to redirect conflict and controversy to energize people to better manage and protect their water resources.

Source: Lois Wright Morton et al., 2006, Department of Sociology, Iowa State University Extension

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Chapter 7

Featured Digital Tools Available for Watershed Management

Arkansas Watershed Steward Handbook

Rapid advancements in web-based mapping and mobile technologies have allowed policy planners, community leaders, watershed organizations, educators, and agencies to use a variety of data for decision making without undergoing any special training or investing in expensive hardware and software. The acceptance of these technologies is helping in transforming traditional one-way flow of information from research and educational institutions to end-users, by using a more user-friendly and accessible process. The technology is making data collection from varied sources and its presentation to the end user better through user friendly and easy to understand interfaces. This chapter provides a quick summary of some selected web-based and mobile-based watershed management resources developed by universities, federal agencies, non-governmental entities and private industry. Given the fact that new information and new tools are getting available at a much faster pace now than before, readers are encouraged to keep informed about such developments by searching them over the internet using appropriate keywords.

IN THIS CHAPTER, YOU WILL LEARN ABOUT:

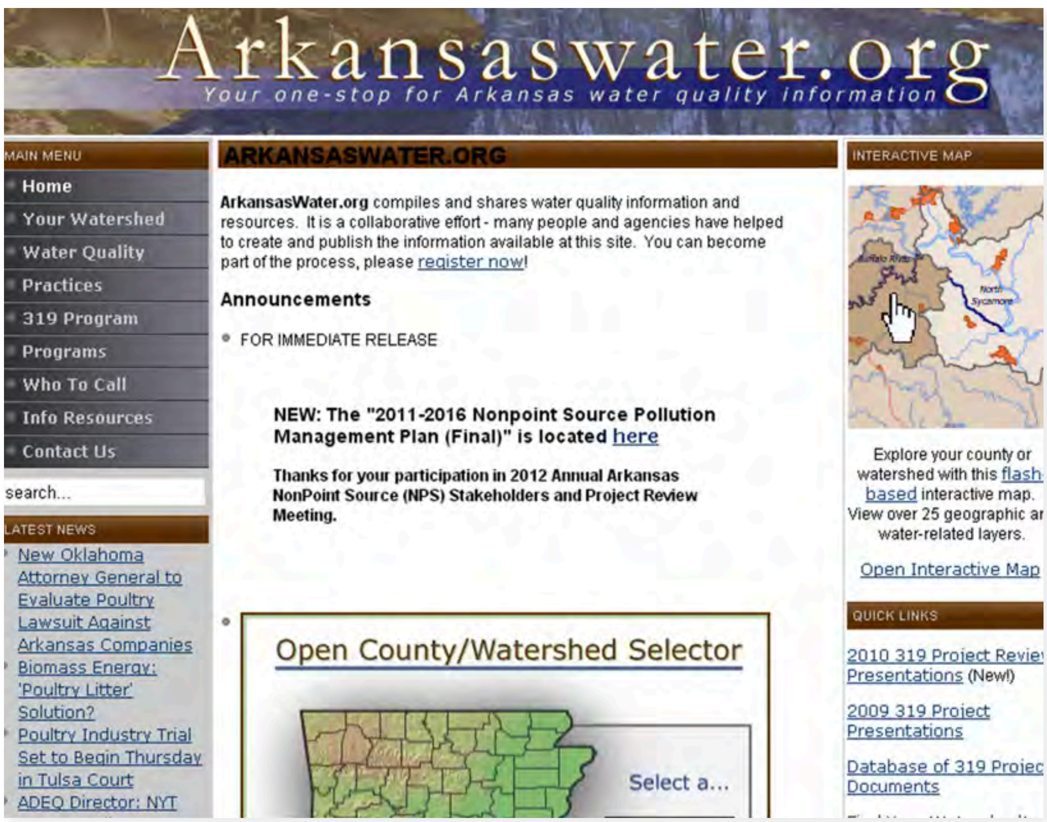
- *Federal and state agencies that offer free web site tools*

Watershed Information Resources

Arkansaswater Web Site

www.arkansaswater.org

The Arkansaswater.org web site is the primary source of water quality information in the state of Arkansas. The motto of the website is to be a "one-stop for Arkansas water quality information" (Fig 70).



Arkansas Division of Environmental Quality – Office of Water Quality

http://www.adeq.state.ar.us/water/default.htm or https://arkansasdeq.maps.arcgis.com/apps/webappviewer/index.html?id=fb5a6aa70fd940cda4c9a3d7bc2fbb15

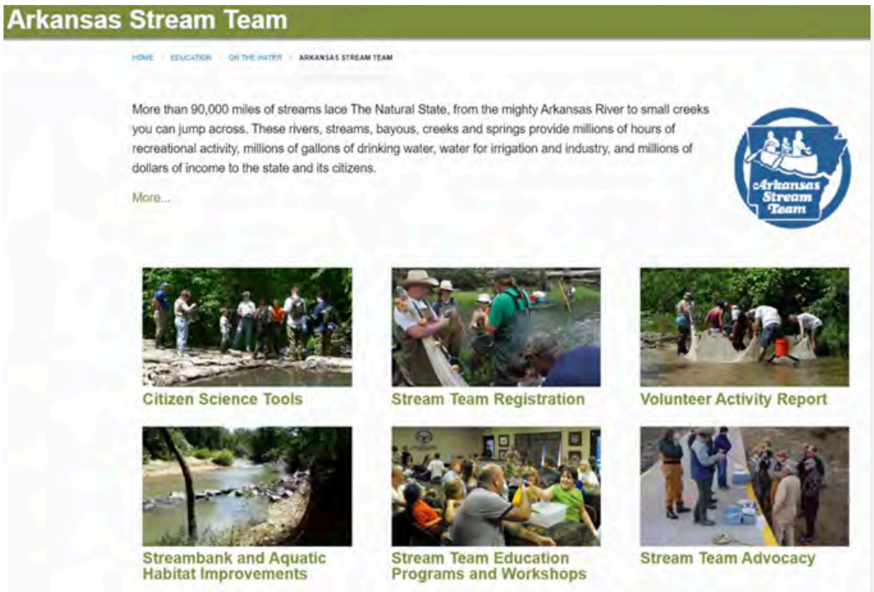
This webpage of the ADEQ contains the current 303(d) impaired rivers listing and 305(b) Integrated Water Quality Assessment Reports for Arkansas in addition to many other searchable permit related databases. This viewer includes all DEQ water quality monitoring stations, biological monitoring stations, impaired waterbodies, TMDLs, and Outstanding Resource Water designations (Fig 71).

The web site has a tool that allows users to use over 25 geographic and water quality layers interactively. It has a search tool to find a database of projects completed in any of the 58, eight-digit Hydrologic Unit Code (HUC) watersheds in the state. It provides all relevant information pertinent to the Clean Water Act program implemented in the state and is a resource accessed by thousands of local users, users from other states as well as from abroad.

Arkansas Game and Fish Stream Team

https://www.agfc.com/en/education/onthewater/streamteam/

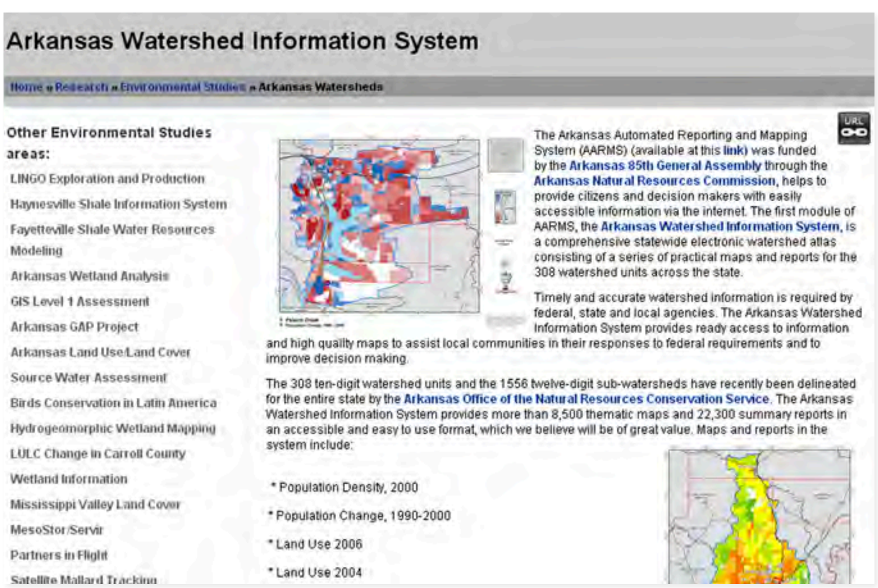
The AGFC Stream Team page has a Citizen Science Tools landing page that includes our Data Visualization Tool, standardized collection protocols, and data management guide. There is also other information such as Stream Team Advocacy, Streambank Stabilization and Aquatic Habitat Restoration, and Educational Projects and Outreach (Fig 72).



Arkansas Watershed Information System

http://watersheds.cast.uark.edu/

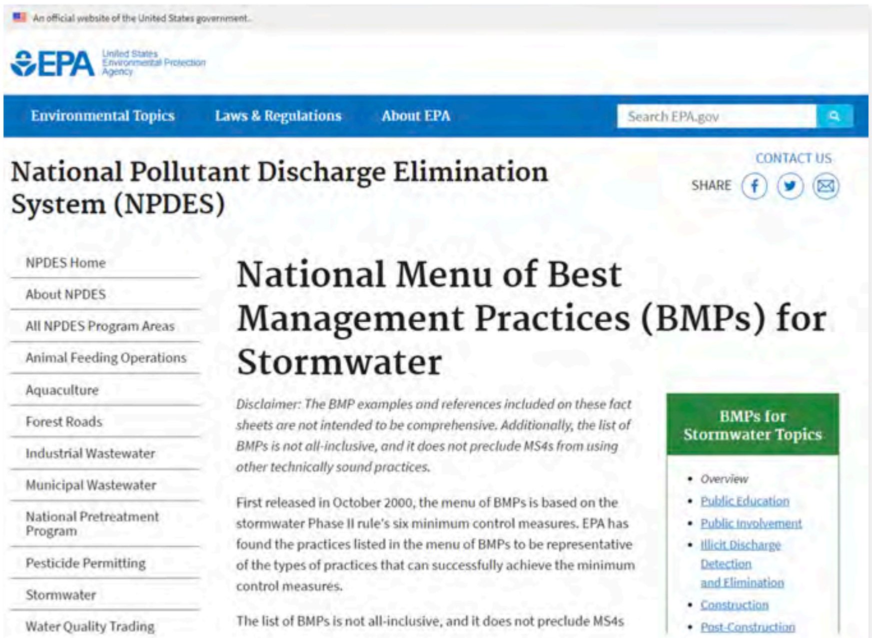
The Arkansas Watershed Information System is a statewide electronic watershed atlas consisting of a number of maps and reports for 308 10-digit and 1,556 twelve-digit watersheds across the state (Fig73).



EPA National Menu of Stormwater BMPs

https://www.epa.gov/npdes/national-menu-best-management-practices-bmps-stormwater

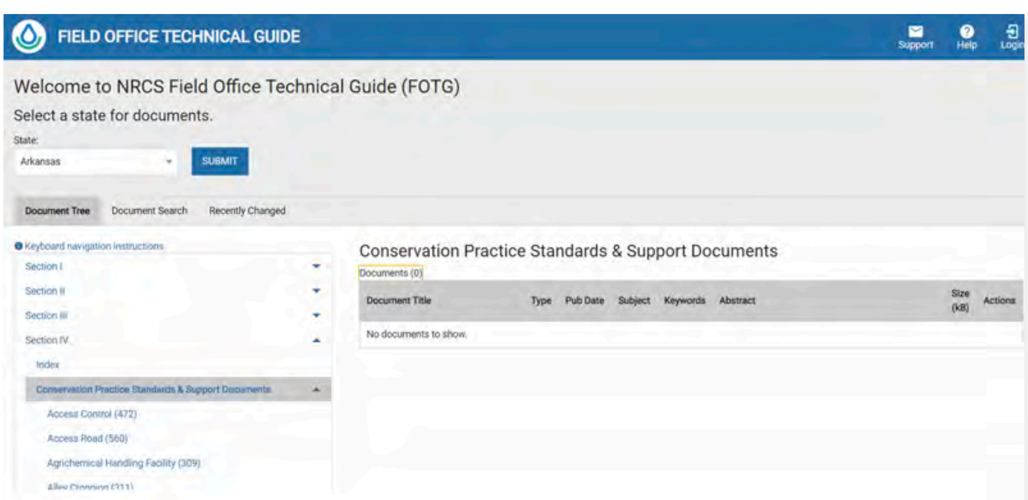
The National Menu of Stormwater BMPs is a great online resource for learning more about water quality best management practices that can be utilized in your county or city to best address potential water quality pollution issues (fig 75).



USDA-NRCS Agricultural Field Technical Office Guide of BMPs

https://efotg.sc.egov.usda.gov/#/details

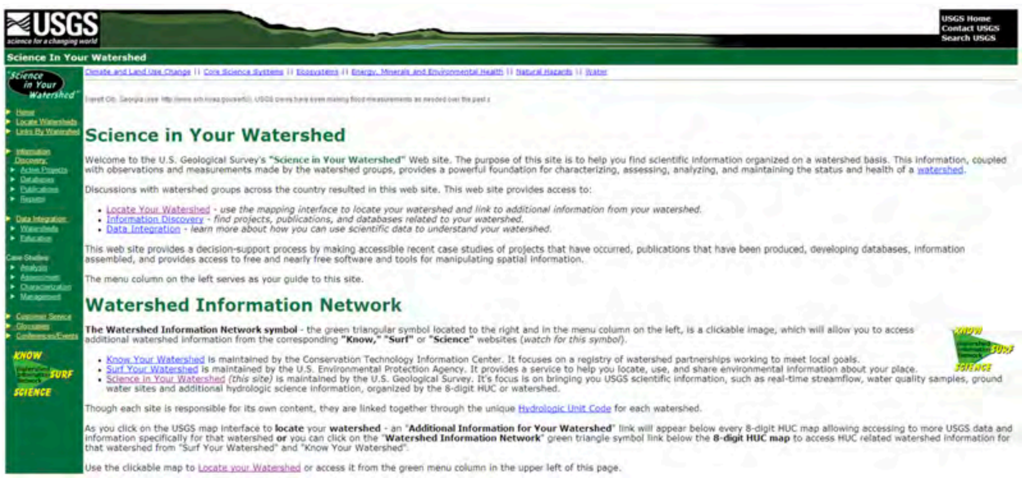
This website contains a complete guide of agricultural best management practices, including complete BMP listings and descriptions for each county in Arkansas. Technical guides are the primary scientific references for Natural Resources Conservation Service (NRCS). They contain technical information about the conservation of soil, water, air, and related plant and animal resources.



USGS Science in Your Watershed

http://water.usgs.gov/wsc/

The U.S. Geological Survey's "Science in Your Watershed" web site is a helpful tool for finding scientific information organized on a watershed basis. This information, coupled with observations and measurements made by the watershed groups, provides a powerful foundation for characterizing, assessing, analyzing and maintaining the status and health of a watershed. This web site provides a decision-support process by making accessible recent case studies of projects that have occurred, publications that have been produced, developing databases and information assembled and provides access to free and nearly free software and tools for manipulating spatial information (Fig 75).



Watershed Mapping and Water Quality Database Resources

http://water.usgs.gov/wsc/

EPA Drinking Water Mapping Application to Protect Source Waters (DWMAPS). DWMAPS is an online mapping tool that helps state and utility drinking water professionals update their source water assessments and protection plans.

EPA Drinking Water Mapping Application to Project Source Waters (DWMAPS)

https://www.epa.gov/sourcewaterprotection/drinking-water-mapping-application-protect-source-waters-dwmaps

Watershed Observation Reporting

Arkansas Division of Environmental Quality – Office of Water Quality

http://www.adeq.state.ar.us/water/default.htm or https://www.adeq.state.ar.us/complaints/

Reports from citizens are vital for effective enforcement of Arkansas' environmental laws. You can report anything that you think is polluting air, land, or water.

Submit a pollution complaint by using one of the online complaint reporting forms below, or use DEQ's mobile app that will allow users anywhere in the state to report environmental hazards directly from some smart phones.

The information you submit will be forwarded to DEQ environmental enforcement personnel. If you send a complaint to the wrong office, it will be referred to appropriate staff.

KEY POINTS TO REMEMBER:

- *A lot of helpful watershed databases exist, are free to use and are user-friendly.*
- *Vetted watershed information is the best kind to use for many purposes.*
- *Much of the watershed information that you need to get started learning about your watershed is available online at the featured web sites in this chapter.*

Glossary of Terms and Acronyms

Arkansas Watershed Steward Handbook

303 (d) List – A list of water bodies that do not meet state water quality standards

305 (b) Report – An integrated report developed by the Arkansas Division of Energy and Environment - Division of Environmental Quality that lists and maps all of the water bodies that do not meet state water quality standards and is submitted to the Environmental Protection Agency (EPA) every two years.

Acre-foot – The volume of water required to cover one acre of land (43,560 square feet) to a depth of one foot. It is equal to 325,851 gallons.

Agricultural water supply – This beneficial use designates waters which will be protected for irrigation of crops and/or consumption by livestock.

Alternative watering – A method of providing water for livestock fenced out of streams and ponds. Alternative watering is also designed to deliver water to livestock at multiple places on a farm which enhances a rotational grazing system. The use of alternative watering enhances pasture nutrient distribution by grazing animals and prevents streambank erosion.

Alluvial aquifer – An unconfined aquifer with geologic materials deposited by a stream, such as sand and silt particles, that retains a hydraulic connection with the depositing stream.

Ammonia (NH3) – A common form of nitrogen that can be toxic and also contributes to the nutrient enrichment of waters.

Ammonium (NH4) – A common form of nitrogen that can contribute to the nutrient enrichment of waters.

Anthropogenic – Of, relating to, or resulting from the influence of human beings on nature.

Anti-degradation policy – A policy designed to prevent deterioration of existing levels of good water quality and further deterioration of water bodies exhibiting poor water quality.

Aquifer – An underground body of porous materials, such as sand, gravel or fractured rock, filled with water and capable of supplying useful quantities of water to a well or spring.

Arkansas Association of Conservation Districts (AACD) – The Arkansas Association of Conservation Districts are districts of the state of Arkansas that serve the soil and water conservation needs of the people of Arkansas.

Arkansas Department of Agriculture - Arkansas Oil and Gas Commission (ADA-AOGC) – The state agency that serves the public regarding oil and gas matters, prevention of waste, encouraging conservation, and protecting the correlative rights of ownership associated with the production of oil, natural gas and brine, while protecting the environment during the production process, through the regulation and enforcement of the laws of the State of Arkansas.

Arkansas Department of Agriculture – Natural Resources Division (ADA-NRD) –The state agency charged with managing water and land resources for the health, safety and economic benefit of the State of Arkansas.

Arkansas Department of Agriculture – Plant Industries Division (PID) – The state agency responsible for regulating products and services such as seed, feed, fertilizer, pesticides, weights and measures, petroleum, honeybees, plant pests, nurseries, pest control services and many others.

Arkansas Department of Energy and Environment – Division of Environmental Quality (DEQ)–The state agency charged with protecting, enhancing, and restoring the environment for Arkansans. DEQ strives for environmental quality through programs of regulation, education and assistance.

Arkansas Division of Forestry (DFC) – The state agency with the mission to work with agencies, organizations and residents to prevent and suppress wildfires, control forest insects and disease, grow and distribute trees and gather and disseminate information concerning the growth, use and renewal of forests.

Arkansas Game and Fish Commission (AGFC) – The primary agency responsible for the protection and management of Arkansas' Fish and wildlife resources.

Arkansas General Assembly –The state legislature of Arkansas, which is composed of the 35-member Arkansas Senate and 100-member Arkansas House of Representatives. All 135 representatives and state senators represent an equal amount of constituent districts.

Arkansas Geological Survey (AGS) – Established by Act 573 of 1923 and is the stage agency charged with serving the people of Arkansas by providing geological information in order to develop and enable effective management of the State's mineral, fossil fuel and water resources while protecting the environment.

Arkansas Department of Health (ADH) – The state agency with the mission to protect and improve the health and well-being of all Arkansans. ADH promotes source drinking water protection and tests public water systems to ensure they are meeting federal drinking water standards.

Arkansas Pollution Control and Ecology Commission (APCEC) – The Commission is the environmental policy-making body for Arkansas. With guidance from the Governor, the Legislature, the EPA and others, the Commission determines the environmental policy for the state and the Arkansas Department of Energy and Environment implements those policies.

Arkansas Unpaved Roads Program – A program established by Act 898 of the 90th General Assembly officially established the Arkansas to provide grants for unpaved road improvements.

Arkansas Water and Air Pollution Control Act – legislation of 1949 that makes it unlawful to "cause pollution. . .of any of the waters of this state," or to "place or cause to be placed any sewage, industrial waste or other wastes in a location where it is likely to cause pollution of any waters of this state."

Arkansas Water Plan – Arkansas Water Plan ("AWP") is the state's policy for long-term water management. The AWP brings data, science, and public input together to define water demands, water supplies, issues and potential solutions to meet our future needs.

Arkansas Waterways Commission – The sole state agency responsible for developing, promoting and protecting waterborne transportation in Arkansas. The commission also promotes economic development for ports on the five commercially navigable rivers of the state: The Arkansas, Mississippi, Ouachita, Red and White Rivers.

Artesian aquifer – A confined aquifer with pressurized water contained below a confining layer of rock or clay that will flow out of an artesian well without pumping.

Bacteria – A single celled organism, capable of causing disease and contributing to pollution, that is used as a biological water quality indicator.

Bankfull – Bankfull discharge is the maximum discharge that the stream channel can convey without overflowing onto the floodplain. This discharge is considered to have morphological significance because it represents the breakpoint between the processes of channel formation and floodplain formation.

Benthic macroinvertebrate – Bottom dwelling organisms of waterbodies that spend part of their life cycle under water in streams and lakes. Benthic macroinvertebrates are large enough to be seen with the naked eye, lack a backbone and serve as biological water quality indicators.

Best management practices (BMPs) – Methods that have been determined to be effective, practical means of preventing or reducing pollution from nonpoint sources.

Best management practice maintenance – The frequent checking and upkeep of BMPs to ensure they are still functioning properly.

Biochemical oxygen demand (BOD) – A measure of the amount of oxygen consumed by microorganisms in the process of decomposing organic matter in a body of water.

Biofilter – Natural substances and organisms such as soil, plants, and fungus, that naturally filter pollutants from water.

Biogeochemical – the chemical, physical, and biological reactions and transformations that occur between water, soil and air.

Bioswale – A vegetated swale or depression that is a form of biofiltration and bioretention. Bioswales can remove pollutants from water and help reduce flooding as they convey water away from infrastructure.

Buffer strip – An area of vegetation located down slope of disturbed soil, working lands, or developments that filters the runoff water from those areas.

Buffer zone – The area of land next to (adjacent) a body of water where activities such as construction are restricted in order to protect the water quality.

Certified Floodplain Manager (CFM) – A national program for professional certification of floodplain managers. The program recognizes continuing education and professional development that enhance the knowledge and performance of local, state, federal and private-sector floodplain managers. The Arkansas Floodplain Management Association (AFMA) administers the Arkansas State Program

Clean Water Act (CWA) – A set of laws passed in 1972 to regulate water pollution in the United States. Today it forms the basis of water quality protection in all surface water and groundwater sources.

Climate –The average weather conditions of a location/ region/area over a long period of time.

Compost – An organic fertilizer or soil amendment resulting from the mixture of decaying organic matter like leaves, manure, and food scraps that can improve soil structure and provide nutrients.

Community Rating System (CRS) – A voluntary program for compliant NFIP-participating communities. It awards community efforts beyond that go beyond the minimum standards by reducing flood insurance premiums up to 45% for policyholders. These discounts provide an incentive for new flood protection activities that can help save lives and property in the event of a flood.

Community water system – A public water system that serves at least 15 service connections used by year round residents or regularly serves at least 25 year-round residents

Condensation – The process in which water vapor transforms into liquid.

Conductivity – A measurement of a solution's ability to conduct an electrical current which is used as an estimate for salinity.

Confined aquifer – Soil or rock located below the land surface that is saturated with water with layers of impermeable material both above and below it. It is under pressure so that when the aquifer is penetrated by a well, the water will rise above the top of the aquifer.

Conservation easement – a legal agreement between a landowner and a land trust or government agency that permanently limits uses of the land in order to protect its conservation values. It allows landowners to continue to own and use their land, and they can also sell it or pass it on to heirs.

Conservation Reserve Program (CRP) – A voluntary U.S. Department of Agriculture program that takes highly erodible or environmentally sensitive cropland out of production for 10 to 15 years. Farmers receive an annual rental payment in return.

Cross drains – Provide drainage relief to upslope forest road ditches to prevent erosion by allowing water to move underneath the road, usually with a culvert, and into a vegetated area or downslope ditch.

Desalination – The removal of salts from saline water to provide fresh water. This method is becoming a more popular way of providing fresh water to populations.

Designated use– The simple narrative description of water quality expectations or water quality goals. A designated use is a legally recognized description of a desired use of a water body, such as (1) support aquatic communities, (2) body contact recreation, (3) fish consumption and (4) public water supply.

Discharge –The volume of water that moves over a designated point during a fixed period of time; Used to describe streamflow and the release of wastewater.

Disinfection byproducts – A chemical compound formed (e.g. trichlorohalomethane) by the reaction of a water disinfectant (e.g. chlorine) with a precursor (e.g. natural organic matter) in a water supply.

Dissolved oxygen (DO) – Gaseous oxygen dissolved in water and other aqueous solutions.

Doctrine of Prior Appropriation – The system for allocating water to private individuals used in most Western states. The prior appropriation doctrine is based on the concept of "First in Time, First in Right." The first person to take a quantity of water and put it to beneficial use has a higher priority of right than a subsequent user. The rights can be lost through nonuse; they can also be sold or transferred apart from the land.

Domestic wastewater – Wastewater derived principally from residential and commercial buildings and institutions. It may or may not contain groundwater, surface water or stormwater.

Domestic water supply – This beneficial use designates water which will be protected for use in public and private water supplies. Conditioning or treatment may be necessary prior to use.

Drainage basin – A land area where precipitation runs off into streams, rivers, lakes and reservoirs. It is a land feature that can be identified by tracing a line along the highest elevations between two areas on a map, often a ridge. A drainage basin is also referred to as a watershed.

Drainage flooding – Occurs chiefly in urban or developed areas when the volume of runoff exceeds the capacity of the drainage system. Drainage floods can be the result of over-development, inadequate drainage, riverine flooding, flash flooding or a combination of these.

Dredging – The removal of sediment from a channel or waterbody to produce sufficient depths for navigation or to recover water storage capacity.

Ecologically sensitive waterbody – This beneficial use designation identifies stream segments known to provide habitat within the existing range of threatened, endangered or endemic species of aquatic or semi-aquatic life forms.

Ecoregion – Areas of general similarity in ecosystems and in the type, quality and quantity of environmental resources. They are designed to serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components.

Ecosystem – An ecosystem is a community of living organisms (plants, animals and microbes) in conjunction with the nonliving components of their environment (things like air, water and mineral soil), interacting as a system.

Ecosystem services – Resources and processes that are provided by ecosystems such as water filtration, flood control, habitat, and oxygen production.

Effluent – Water that flows from a sewage treatment, manufacturing, or water treatment plant after it has been treated.

Environmental Protection Agency (EPA) – The federal agency responsible for enforcing and regulating environmental laws such as the National Environmental Policy Act, Clean Air Act, and Clean Water Act.

Environmental Quality Incentives Program (EQIP) – A voluntary program administered by the Natural Resources Conservation Service that offers incentives for landowners to adopt management practices that protect environmental quality.

Emergent aquatic vegetation – plants rooted in the lake bottom with leaves and stems extending out of the water.

Ephemeral stream – A stream that has flowing water only during, and for a short duration after, precipitation events in a typical year. Ephemeral streams may or may not have a defined channel, and their streambeds are located above the water table year-round. Groundwater is not a source of water for the stream.

Erosion – The process in which a material is worn away by water or air. Stream bank or stream bed erosion is often increased by the presence of abrasive particles.

Eutrophication – The process by which a body of water acquires a high concentration of nutrients, especially phosphates and nitrates. Excessive nutrients typically promote excessive growth of algae and degrade water quality, designated uses and ecosystems.

Evaporation – The process of liquid water becoming water vapor, including vaporization from water surfaces, snow fields, and land surfaces.

Evapotranspiration – The combined loss of water to the atmosphere via the processes of evaporation and transpiration.

Extraordinary resource waters – This beneficial use is a combination of the chemical, physical and biological characteristics of a waterbody and its watershed which is characterized by scenic beauty, aesthetics, scientific values, broad scope recreation potential and intangible social values.

Fecal bacteria – Bacteria that are found in the waste of humans and other warm blooded animals. Detection of fecal coliform bacteria may indicate the presence of pathogenic bacteria, viruses and parasites.

Federal Emergency Management Agency – Agency of the United States that is the single point of contact for emergency preparedness planning and disaster relief.

Federal Safe Drinking Water Act – A Federal law that established drinking water standards to protect surface and groundwater sources used for drinking water.

Fencing – Placing fence to control livestock access to grazing pastures, paddocks, and environmentally sensitive areas. This helps maintain vegetative forage cover which prevents sediment, nutrient and bacteria in runoff.

Fill – Material placed in waters of the United States where the material has the effect of: replacing any portion of a water of the United States with dry land; or changing the bottom elevation of any portion of a water of the United States.

Fisheries (fishable) – This beneficial use designation provides for the protection and propagation of fish, shellfish and other forms of aquatic life.

Flash flooding – A result of heavy, localized rainfall, possibly from slow-moving intense thunderstorms that cause small creeks, streams, branches and rivers to overflow. They are most common when rain falls on areas with steep slopes or developed areas where impervious surfaces, gutters and storm sewers concentrate and speed up the flow of runoff.

Flood – Any general or temporary condition of partial or complete inundation of normally dry land areas from the overflow of inland waters or the unusual and rapid accumulation of runoff of surface waters from any source.

Flood Insurance Rate Map (FIRM) – The official map of a community on which FEMA has delineated both the Special Flood Hazard Areas and the risk premium zones applicable to the community.

Flood Mitigation Assistance – FEMA programs created with the goal of assisting states and communities to reduce or eliminate future flood claims under the NFIP.

Floodplain – A strip of relatively flat and normally dry land alongside a stream, river or lake that is covered by water during a flood.

Floodplain management program – A voluntary program of ANRC that encourages the public health, safety and general welfare of Arkansans through minimizing public and private losses due to flood conditions.

Floodplain management – The careful and thoughtful planning and management of floodplains to prevent flood problems and pollution to waterways.

Glide – Smoothly flowing water beginning at the downstream end of pools and ending at the upstream end of a riffle or run.

Green infrastructure – The planning of open green spaces and preservation of natural landscape features in the development or retrofit process to manage wet weather, limit hydrologic modification and maintain ecosystem services.

Green roof – A vegetated roof, sometimes referred to as a living roof, that provides stormwater management, pollution reduction and energy efficiency.

Groundwater – Water that flows or seeps downward into a saturated zone and saturates soil and rock, supplying springs and wells.

Groundwater discharge – The water output from a groundwater system. Natural groundwater discharge may occur in the form of springs or seepages. Groundwater also discharges into rivers and lakes via bank seepage or by upward flow in river and lake beds.

Groundwater Inflow – A diffuse flow (or discharge) from the groundwater system into a surface water such as a stream, pond or lake.

Groundwater Protection Act – allows the ADA-NRD to first designate critical groundwater areas and then, if necessary, to initiate a regulatory program requiring that anyone who wants to withdraw groundwater from an existing well or construct a new well within the area obtain a water right.

Groundwater Protection Program – A program conducted by DEQ that includes budgeting and grant administration, ground-water quality planning and water-quality monitoring and addressing gaps in ground-water protection through the development of guidelines and regulations.

Ground Water Protection and Management Program – A program of the ADA-NRD to manage and protect the groundwater resources in Arkansas for human, environmental and economic benefit.

Groundwater recharge – The inflow of water to a groundwater reservoir from the surface. One form of recharge is the infiltration of precipitation and its movement down to the water table.

Habitat – The setting where living organisms can be found and is the place where they live, grow, and reproduce.

Harmful Algae Bloom - Harmful algal blooms, or HABs, occur when colonies of algae — simple plants that live in the sea and freshwater — grow out of control and produce toxic or harmful effects on people, fish, shellfish, marine mammals and birds.

Heavy use area – An area that is not able to maintain normal vegetation levels due to animal and equipment traffic and holding practices. These areas also provide the potential for runoff water to transport nutrients, chemicals, bacteria and pathogens to receiving water bodies.

Heavy use area management – The system of BMP design, implementation and management to minimize and treat runoff water from heavy use areas while also providing livestock and equipment management benefits.

Home landscape design – The thoughtful design of a structure and landscape to maintain or increase infiltration and decrease erosion and nutrient loss.

Household hazardous waste (HHW) management – The practice of identifying household products that contain corrosive, toxic, ignitable or reactive ingredients, limiting their use, and properly disposing of them as to not pollute the environment or pose a threat to human health.

Hydric soil – Soil that is wet or inundated by water long enough for anoxic (no oxygen) conditions to develop. This soil is prominent in wetlands.

Hydrologic cycle – The cycle in which water evaporates from the oceans and the land surface, is carried over the earth in atmospheric circulation as water vapor, precipitates again as rain or snow, is intercepted by trees and vegetation, provides runoff on the land surface, infiltrates into soils, recharges groundwater, discharges into streams, and ultimately, flows out into the oceans, from which it will eventually evaporate again.

Hydrologic unit code (HUC) – The two- to twelve-digit series of unique numbers used to identify a watershed.

Hydrologic modification – Hydrologic modification is the alteration of stream flow by human activities.

Hydrology – The study of water distribution and its movement on earth, its physical and chemical properties, and interaction with the environment.

Hypoxia – A condition describing low levels of oxygen in water, blood or tissue.

Impaired waterway – A waterway that is not meeting one or more of its designated uses.

Impaired Waterbodies List – The list of impaired waterbodies in Arkansas created by DEQ and approved by the EPA.

Impermeable – Not easily penetrated. The structure or property of a material or soil that does not allow the passage of water.

Indicator – A direct or indirect measurement of some valued component or quality in a system. Indicators can be used to measure the current health of the watershed and provide a way to assess progress toward meeting the watershed goals.

Industrial water supply – This beneficial use designates water which will be protected for use as processing or cooling water. Quality criteria may vary with the specific type of process involved and the water supply may require prior treatment or conditioning.

Infiltration – The movement or flow of water from the land surface into the subsurface cracks and pores in soil and rock.

Infiltration systems – Stormwater management systems designed to capture and store rainfall so that it can infiltrate into the soil profile or be reused later instead of contributing to stormwater runoff.

Integrated pest management (IPM) – An approach that utilizes mechanical, biological, cultural and chemical means to manage pests. This strategy reduces the need for chemical treatment and can help protect water quality.

Intermittent stream – A stream that flows more than 30 days a year, has a defined channel and is marked on most topographic maps with a series of blue dashes and dots. Also known as a seasonal stream.

Irrigation tailwater recovery – Conservation of farm irrigation water supplies to improve water quality by collecting the water that runs off the field surface for reuse on the farm.

Irrigation water management – The efficient use of water to produce profitable yields, conserve water and minimize the leaching of nutrient into groundwater.

Karst – A geologic description for a landscape containing sinkholes, springs and fissures. Karst systems most commonly develop on limestone.

Leaching – The process by which soluble materials in the soil, such as salts, nutrients, pesticide chemicals or contaminants percolate into a lower layer of soil or are dissolved and carried through the soil with drainage to groundwater.

Legume establishment – Planting legumes, such as clover, in pastures to fix nitrogen in the soil to reduce nitrogen fertilization needs.

Lentic – Standing or relatively still water. A description of an aquatic ecosystem.

Litter stacking shed – A shed where dry manure can be stored until it is time to be land applied or hauled off the farm. Dry storage of manure prevents loss of manure nutrient content and potentially negative environmental impacts by protecting the fertilizer source from rain and nutrient transport in storm runoff.

Locating log decks – The process of designing log decks to protect water quality. Log decks are areas of concentrated equipment use and traffic during timber harvesting.

Lotic – Flowing water. A description of a river ecosystem.

Low impact development (LID) – An approach to managing stormwater runoff with soft engineering such as vegetation and soil. LID mimics natural hydrology by using techniques that capture, infiltrate, filter and detain stormwater runoff close to the source.

Maximum contaminant level (MCL) – The designation given by the U.S. Environmental Protection Agency to water quality standards as outlined in the Safe Drinking Water Act. The MCL is the greatest amount of a contaminant that can be present in drinking water without causing unacceptable risk to human health.

Meander – A turn or winding of a stream in a snake-like or sinuous pattern. Meanders in streams are a part of stream morphology that reduce in channel shear stress on streambanks and aid in the efficient movement of both sediment and water in a way that prevents bank erosion.

Metals – Various opaque, fusible, ductile and typically lustrous substances that are good conductors of electricity and heat, form cations by loss of electrons, and yield basic oxides and hydroxides.

Model – A computer-generated outcome of what might happen under certain circumstances. A schematic description or depiction of a system, theory or phenomenon that accounts for its known or inferred properties and may be used for further study of its characteristics.

Morphology – The study of the forms of things, in particular. The branch of biology that deals with the form of living organisms or natural systems and the relationships between.

Municipal Separate Storm Sewer System (MS4) – A federally identified urbanized area, such as a city or other entity, that must follow stormwater management regulations.

Narrative Water Quality Criteria – Descriptive water quality criteria expressed as written language.

National Environmental Policy Act (NEPA) – The National Environmental Policy Act (NEPA) is a United States environmental law that established a U.S. national policy promoting the enhancement of the environment.

National Flood Insurance Program (NFIP) – A voluntary program of ADA-NRD to encourage the public health, safety and general welfare of Arkansans and to minimize public and private losses due to flood conditions.

National Pollutant Discharge Elimination System – The EPA program that controls water pollution through regulation of point sources that discharge pollutants into waters of the United States.

Native plants – Plants that grew or occurred regionally before European arrival. These plants have developed over very long periods of time in response to the natural physical and biotic processes of the region such as climate, geology and interaction with the other native organisms such as grazing animals, pollinators, soil organisms and other plants.

National primary drinking water regulations – Primary standards set for legal limits of substances in water provided by public drinking water systems.

Natural and scenic waterways – This beneficial use designation identifies segments of waterbodies which have been legislatively adopted into a state or federal system.

Nitrogen – A chemical element that makes up almost 80 percent of the Earth's atmosphere. It is found in the cells of all living things and is a major component of proteins and many fertilizers. A nutrient required by all organisms for the basic processes of life.

Nitrate (NO3) – A common form of nitrogen that is produced from decomposing organic materials like manure, plants and human waste.

Nitrite (NO2) – An intermediate form of nitrogen produced during the conversion of ammonium to nitrate.

Navigable waters – Waters subject to the ebb and flow of the tide and/or used to transport interstate or foreign commerce. A determination of navigability, once made, applies over the entire surface of the waterbody, and is not changed by later actions or events that impede or destroy navigable capacity. In Arkansas, recreational use such as fishing or canoeing may result in a waterbody being classified as navigable.

Non-domestic wastewater – Any wastewater that originates from commercial, industrial or agricultural operations, excluding food establishments. The most common types of facilities permitted for subsurface disposal of non-domestic wastewater are car and truck washes, slaughterhouses and laundromats.

Nonpoint source pollution – Water pollution coming from diffused points of discharge such as runoff from parking lots, agricultural fields, lawns, home gardens, construction, mining and logging operations.

Nonpoint Source Pollution Program – The state of Arkansas' program for addressing and preventing nonpoint source pollution. This program is administered by the ADA-NRD.

Non-transient, non-community water system – A water system that supplies water to 25 or more of the same people at least six months per year in places other than their residences. Some examples are schools, factories, office buildings and hospitals that have their own water systems.

Numeric water quality criteria – A specific number or numeric range that is established as a water quality criterion.

Nutrient – A substance that provides nourishment essential for growth and the maintenance of life (e.g., nitrogen and phosphorus).

Nutrient management – The act of properly planning, storing and applying nutrients to a landscape to maximize plant growth and protect water quality.

Nutrient management plan (NMP) – A legal document that determines timing, placement and record keeping of fertilizer nutrients to a field.

Paddock management – The management of animal paddock's to prevent overgrazing, soil erosion and nutrient loss.

Pasture management – The management of pasture land to maximize forage production and prevent over grazing, soil erosion and nutrient loss.

Perched water table – A water table that is positioned above the normal water table for an area because of the presence of an impermeable rock layer.

Perennial stream – A stream that flows year round, has a defined channel and shows up as a solid blue line on a topographic map.

Pesticides – Any substance that is used to control a pest. Fungicides, herbicides and pesticides are all considered to be a pesticide.

Pet waste management – The process of picking up and properly disposing of pet waste in the trash, toilet or a pet waste septic system.

pH – A measurement of the concentration of hydrogen ions found in a solution that indicates the acidic or basic property of a substance. pH is measured on a scale of 0-14 with zero being very acidic, 14 being very basic and 7 being neutral.

Phosphorus – A chemical element found in rocks, soil and organic material. Phosphorus is a nutrient required by all organisms for the basic processes of life.

Point bar – A low curved ridge of sand and gravel along the inner bank of meandering steams. Point bars form through the slow accumulation of sediment and gravel deposited by the stream when its velocity decreases along the inner bank.

Point source pollution – Water pollution from clearly discernible discharge points such as pipes, wells, containers, manure storage systems, boats or other watercraft.

Pool – A stretch of a river or stream in which the water depth is above average and the water velocity is below average. Usually occurring between riffles and glides.

Potable water – Water that is suitable for human consumption.

Porosity – The percentage of a rock or sedimentary deposit that consists of voids and open space. The greater the porosity the greater the ability to hold water.

Precipitation – Any form of water that falls from the atmosphere such as rain, snow, hail and sleet.

Pre-harvest planning – The process of assessing a tract of land prior to harvesting timber to minimize environmental impacts and achieve land management goals.

Preservation of Natural Landscape Features – The conservation of natural landscape features during the urban or rural development process.

Primary contact recreation (swimmable) - This beneficial use designation is given to waters where a person's body can be fully immersed. Any streams with watersheds of greater than 10 mi2 are designated for full body contact. All streams with watersheds less than 10 mi2 may be designated for primary contact recreation after site verification.

Primary standards – Drinking water standards that protect against contaminants that are harmful to human health, including pathogens, radioactive elements and toxic chemicals. Primary standards set the maximum amount of each pollutant that can be in the drinking water supplied by a public water system.

Proper Pesticide Application Procedures – The use, storage, and disposal of pesticides according to the product label of certified products.

Property drainage assessment –The conscious inspection of water flow and drainage on and away from a property to assess where potential pollution pathways to streams might be located.

Public water system – Any water system which provides water to at least 25 people for at least 60 days annually.

Rain garden – A landscaped depression located downslope of impervious surfaces like roof tops and parking lots that increases infiltration and filters pollutants contained in runoff.

Rain barrel – A barrel used to harvest rooftop runoff.

Rainwater harvesting – Collecting rainfall from impervious areas in barrels, cisterns or other containers for later reuse.

Revegetation – The process of replanting a disturbed area such as a log landing, construction site, heavy use area or lawn to minimize erosion.

Riffle – A stream feature where the flow in between pools is shallower and more turbulent.

Riparian area – The land connected and adjacent to water, such as stream banks and lake shores. This area is a unique ecosystem that separates waterways from uplands.

Riparian buffer – The vegetation in a riparian area that separates waterways from working and developed lands. Riparian buffers filters pollutants, slow runoff, strengthen streambanks, shade waterbodies and provide habitat.

Riparian doctrine – The rights of an owner whose land abuts water. These rights differ from state to state and often depend on a state's classification of a waterbody. Under this doctrine, property owners adjacent to a stream have the right to make reasonable use of water from the stream as long as their use does not impair the rights of other riparian landowners. Riparian rights cannot be sold or transferred for use on non-riparian land.

River basin – A collection of watersheds that are drained by a river.

Riverine flooding – Flooding that occurs along rivers, streams, or channels primarily when there is heavy or prolonged rainfall. Other contributing factors include (1) the elimination of ground cover on drainage slopes as result of tree cutting or wildfires, land clearing or overgrazing; (2) the simultaneous arrival of peak flows from major tributaries; (3) blocked drainage by debris dams or inadequately sized drainage structures; and (4) hydrologic modification within a watershed.

Road location/planning – The planning, reutilization and location of forest roads to minimize surface erosion during and after road construction.

Run – Similar to, and usually occurring after a riffle, but the depth of flow is greater and slope of the streambed is less than that of riffles.

Runoff – The movement of water across a surface that occurs when water accumulates at a rate faster than it can infiltrate or soak into the soil.

Safe Drinking Water Act – The Safe Drinking Water Act (SDWA) is the main federal law that ensures the quality of Americans' drinking water. Under SDWA, EPA sets standards for drinking water quality and oversees the states, localities and water suppliers who implement those standards.

Secchi disk – A circular disk used to measure water transparency in oceans, lakes and streams.

Secondary contact recreation (wadable) – A beneficial use designation of waterbodies for limited body contact activities like boating, fishing or wading.

Secondary contaminants – Contaminents that are not considered to present a risk to human health at the SMCL.

Secondary maximum contaminant levels (SMCL) – The maximum amount of secondary contaminants that can be present in drinking water supplied by a public water system.

Secondary standards – Drinking water standards that protect against contaminants that are not harmful to human health, but pose a nuisance because they can cause unacceptable odor, taste, color, corrosion, foaming or staining.

Section 303(d) – The section of the federal Clean Water Act that requires states, territories and authorized tribes to develop a list of water bodies that do not or are not expected to meet water quality standards. States are then required to prioritize listed water bodies for TMDL development to improve water quality.

Section 305(b) – The section of the federal Clean Water Act that requires states, territories, and authorized tribes to develop a waterbody assessment report of waters that are either fully supporting, threatened or not supporting their designated uses. This information is reported in the National Water Quality Inventory Report to Congress under Section 305(b) of the Clean Water Act.

Section 319(h) – The section of the federal Clean Water Act that provides grants to states, territories and authorized tribes to implement projects under the Nonpoint Source Pollution Management Program. CWA 319(h) grants are available to projects that reduce, control and prevent nonpoint source pollution with the ultimate goal of improving water quality.

Section 404 – The section of the Clean Water Act that regulates the discharge of dredged or fill material into waters of the United States.

Silviculture – The practice of controlling the establishment, growth, composition, health and quality of forests to meet diverse needs and values

Six minumum measures – The legal requirements of stormwater pollution management that municipal separate storm sewer systems (MS4's) must achieve to be in compliance with Phase II EPA regulations for MS4s which are 1) Public Education and Outreach, 2) Public Participation/Involvement, 3) Illicit Discharge Detection and Elimination, 4) Construction Site Runoff Control, 5) Post-Construction Runoff Control, and 6) Pollution Prevention/Good House Keeping.

Skid trails – Skid trails are transport routes for equipment moving trees, logs or other material from the place of felling to a log landing or deck where they are stored or loaded for transport.

Soil pore – The air space in and in-between soil particles.

Sonar – A device that takes measurements and pictures by using sound waves.

Sonde – An electronic device used for testing physical water quality conditions such as flow, temperature, pH and TDS.

Special flood hazard areas – Land areas that are at high risk for flooding are called Special Flood Hazard Areas (SFHAs) or floodplains,the portion of the floodplain subject to inundation by the base flood (1 percent annual chance flood or 100-year flood) and/or flood-related erosion hazards.

Stakeholders – Specific individuals, businesses, or groups of people who have and interest, or stake, in the success of a project, activity, set of activities, process or health of a watershed.

Stewardship – An ethic that embodies responsible planning and management of something valuable.

Stormwater – Water that is generated by a rainfall event and flows across land surfaces. The U.S. Environmental Protection Agency estimates that at least 50 percent of the nation's water pollution is caused by stormwater runoff.

Stream crossings – A culvert, bridge or rock ford that enables equipment and livestock to cross streams, drains, and drainage ditches and reduce negative impacts to the stream from traffic.

Streambank stabilization – The process of preventing an already eroding stream bank from further erosion by protecting it with vegetation, boulders, and other techniques.

Streamflow – The volume of water that moves over a designated point during a fixed period of time. Also known as a discharge.

Streamflow hydrograph – A graph or chart that depicts changes in water quantity over time.

Stream Order – A measure of the relative site of a stream. The smallest tributaries are referred to as first-order, while the largest river in the world, the Amazon, is a twelfth order stream.

Streamside management zones – Forested riparian buffers intentionally left in place along streams in order to help protect water quality.

Storming stage – The second stage in group development; the group may experience many conflicts as group members feel the need to exert themselves more and as the group dynamic continues to develop.

Subbasin – A smaller basin nested within a larger basin.

Submergent aquatic vegetation – Plants that are rooted or suspended and grow below the surface of the water.

Substrate – A surface on which an organism grows or is attached. An underlying layer; a substratum. The material or substance on which an enzyme acts.

Subsurface flow – The flow of water beneath the ground surface; it may eventually return to the surface (e.g., as a spring or by being pumped).

Subwatershed – A smaller watershed nested within a larger watershed.

Surface water – Water that is on the earth's surface, such as in a stream, river, lake or reservoir.

Thalweg – Deepest linear depth within and along a watercourse; most often the strongest current within a stream.

Timber harvesting BMPs – A set of best management practices to protect water quality during timber harvesting.

Topography – The physical characteristics of land, including its elevation, slope and orientation.

Total dissolved solids (TDS) – The amount of organic and inorganic solids dissolved in water determined by chemical assessment.

Total maximum daily load (TMDL) – A calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards.

Total suspended solids (TSS) – The amount of organic and inorganic solids in water determined by physical assessment.

Transforming stage – The fifth stage of group development; this is when groups decide their future direction and work on renewing or redirecting their efforts.

Transient non-community water system – A water system which provides water in a place such as a gas station or campground where people do not remain for long periods of time. These systems do not have to test or treat their water for contaminants which pose long-term health risks because fewer than 25 people drink the water over a long period.

Transpiration – The emission of water vapor from the leaves of plants

Trash management – The careful management of trash so that it is disposed properly or recycled and does not end up in the environment as litter.

Triennial review – The process of review of state water quality standards by DEQ every three years.

Turbidity – A physical water quality parameter that is a measure of the clarity of water.

Unconfined aquifer – An aquifer whose upper water surface (water table) is at atmospheric pressure, and thus is able to rise and fall.

University of Arkansas - Division of Agriculture System - Cooperative Extension Service (UACES) –The state educational agency provided by the U.S. government, state government through the University of Arkansas, and county governments. Extension's mission is to strengthen agriculture, communities and families by connecting trusted research to the adoption of best practices.

United States Environmental Protection Agency – The federal agency established to coordinate programs aimed at reducing pollution and protecting the environment.

Upland – Land that is at a higher elevation than the floodplain.

Utilization of warm and cool season forages – Use of warm and cool season grasses in pastures to increase vegetative ground cover throughout the year which extends forage production, prevents erosion and nutrient loss.

Vegetative filter strips – Strips of herbaceous vegetation used between pasture, cropland, parking lots, construction sites or other areas of potential pollution and waterbodies. These strips of vegetation reduce the amount of sediment, nutrients, pesticides, trash and other pollutants transported to surface waters in storm runoff.

Vision – The long-term desired future accomplishments of an organization or entity. Visions should help inspire and motivate.

Wastewater – The spent or used water of a community or industry containing dissolved and suspended matter.

Waterbody - Any body of surface water, such as a lake, river, or pond

Water table – The uppermost portion of the ground where water saturation occurs.

Water quality– A term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.

Water quantity –The volume or amount of water that is available in the water supply.

Water temperature – A physical water quality measurement of the temperature of water.

Waterbars – Compacted soil diversion berms angled across an inactive road surface, similar to speed bumps, that intercept, divert and drain runoff water to reduce erosion.

Waterbody – Any significant accumulation of water on earth such as a stream, lake/reservoir, sea or ocean.

Watershed – All of the land area that drains water into a particular stream, river or lake. It is a land feature that can be identified by tracing a line along the highest elevations between two areas on a map, often a ridge. Large watersheds like the Mississippi River basin contain thousands of smaller watersheds.

Watershed approach – A hydrologically-defined, geographically-focused and community-driven method of addressing watershed issues such as water quality. This is an inclusive process in which watershed stakeholders address water quality issues in a strategic way that uses sound science, collaboration, education, planning and best management practice use to improve water quality.

Watershed divide – The boundary between two distinct watersheds and usually the highest points within a watershed.

Watershed hydrology – The study of water as it interacts with various parts of the watershed, including the land, the sea and the atmosphere.

Watershed management plan (WMP) – A management plan that addresses complex water quality problems and provides solutions for improving and maintaining water quality within a watershed. WMP's are often community or stakeholder driven, and are very useful in maintaining unimpaired waterbodies and improving impaired waterbodies by utilizing a holistic process to address and prioritize all potential sources of impairments within a watershed.

Well management – Inspection, management and maintenance of established wells to prevent pollution.

Western doctrine – Also known as doctrine of prior appropriation is a water allocation system that developed in the Western United States and establishes water use based on first claim in time as first claim in right for water use.

Wetland – Land that is saturated with water, contains plants and animals that are adapted to living on, near or in water and exhibits hydric soils.

Wetlands Reserve Program (WRP) – A voluntary incentive program administered by the Natural Resources Conservation Service that provides technical and financial assistance to eligible landowners to address wetland, wildlife habitat, soil, water and related natural resource concerns on private land in an environmentally beneficial and cost-effective manner.

Wing ditches – A side ditch along main ditches that allows water to leave the main drainage ditch and disperses it into areas of stable geology and vegetation.

Waters of the State of Arkansas - all streams, lakes, marshes, ponds, watercourses, waterways, wells, springs, irrigation systems, drainage systems, and all other bodies or accumulations of water, surface and underground, natural or artificial, public or private, which are contained within, flow through, or border upon this state or any portion of the state

Waters of the United States - All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide; 2. All interstate waters including interstate wetlands; 3. All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce including any such waters: (I) Which are or could be used by interstate or foreign travelers for recreational or other purposes; or (ii)(From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or (iii) Which are used or could be used for industrial purposes by industries in interstate commerce; 4. All impoundments of waters otherwise defined as waters of the United States under this definition; 5. Tributaries of waters identified in paragraphs (s)(1) through (4) of this section; 6. The territorial sea; 7. Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (s)(1) through (6) of this section; waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA (other than cooling ponds as defined in 40 CFR 423.11(m) which also meet the criteria of this definition) are not waters of the United States. Waters of the United States do not include prior converted cropland. Notwithstanding the determination of an area's status as prior converted cropland by any other federal agency, for the purposes of the Clean Water Act, the final authority regarding Clean Water Act jurisdiction remains with EPA.

Appendices

Arkansas Watershed Steward Handbook

Appendix A

Water Quality and Quantity Agencies and Organizations

Federal Agencies

1. **United States Army Corps of Engineers (USACE)**. Provides vital public engineering services in peace and war to strengthen our Nation's security, energize the economy, and reduce risks from disasters.

Vicksburg address:	U.S. Army Corps of Engineers 4155 Clay St Vicksburg, MS 39183
Telephone:	(601) 631-5000
Memphis address:	U.S. Army Corps of Engineers 167 North Main, B202. Memphis, TN 38103-1894.
Telephone:	(901) 544-4390
Little Rock address:	U.S. Army Corps of Engineers 700 West Capitol, Room 7530 Little Rock, AR 72201
Telephone:	(501)-324-5551
Rogers address:	U.S. Army Corps of Engineers 2260 N. 2nd St. Rogers , AR 72756
Telephone:	(479) 636-1210
Main Website:	http://www.usace.army.mil/Locations.aspx.
Regulatory Permits:	http://www.swl.usace.army.mil/Missions/Regulatory/WhatistheRegulatoryProgram.aspx.

2. **United States Environmental Protection Agency (EPA).** The purpose of the EPA is to regulate pollution to the environment and its mission is to protect human health and the environment. Since 1970 the EPA has been working for a cleaner, healthier environment for the United States and its citizens.

Region 6 address: U.S. Environmental Protection Agency
1201 Elm Street
Dallas, Texas 75270

Telephone: (800) 887-6063 – Region 6 (Dallas, TX)

Main Website: http://www.epa.gov.

Other Links: ***How's my Waterway:*** https://www.epa.gov/waterdata/hows-my-waterway.
Environmental Topics: Water.
http://water.epa.gov/type/watersheds/index.cfm.

3. **United States Department of Agriculture**. Natural Resource Conservation Service (USDA-NRCS) The mission of the USDA-NRCS is to "Help people Help the Land". This is accomplished by providing products and technical and financial assistance to better enable people to be good stewards of the nation's soil, water and related natural resources on non-federal lands.

Main address: USDA-NRCS
Room 3416
Federal Building
700 W. Capitol Ave.
Little Rock, AR 72201

Telephone: (501) 301-3100

Main Website: http://www.ar.nrcs.usda.gov/.

Other Links: ***Water Conservation Programs:*** http://www.ar.nrcs.usda.gov/programs/.
Find Your Local Office: http://offices.sc.egov.usda.gov/locator/app.
Field Office Technical Guide: Includes BMP listings, descriptions and financial assistance info) Field Office Technical Guide (https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/fotg/.
National Water Quality Handbook: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1044775.pdf.
Stream Visual Assessment Protocol (SVAP) document used for field level use: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1043252.pdf.
National Engineering Handbook 654, Stream Restoration Design Stream Restoration Design (National Engineering Handbook 654) | NRCS: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/water/manage/restoration/?cid=stelprdb1044707.

4. **USDA Forest Service (USFS)**. The mission of the USFS is to sustain the health, diversity and productivity of the Nation's forests and grasslands to meet the needs of present and future generations.

Ouachita National Forest

Main address: United States Forest Service
100 Reserve Street
Federal Building
Hot Springs, AR 71902

Ozark-St. Francis National Forests

Main address: 605 West Main
Russellville, AR 72801

Telephone: (501)-321-5202 (Ouachita)
(479)-964-7200 (Ozark-St. Francis)

Main Links: http://www.fs.usda.gov/ouachita/. (Ouachita National Forest)
http://www.fs.usda.gov/osfnf/. (Ozark-St. Francis National Forest)

5. **USDA- National Institute of Food and Agriculture (USDA-NIFA)**. NIFA's mission is to advance knowledge for agriculture, the environment, human health and well-being, and communities by supporting research, education and extension programs in the Land-Grant University System and with other partner organizations.

Main address: USDA
NIFA
1400 Independence Ave. SW, Stop 2201
Washington, D.C. 20250-2201

United States Department of Agriculture
National Institute of Food and Agriculture

Telephone: (202) 720-2791
Main Website: https://nifa.usda.gov/.

Other links: ***National Water Quality Program:***
https://nifa.usda.gov/program/national-water-quality-program.

6. **USDA- National Park Service**. Takes care of the national parks and helps Americans take care of their communities.

Buffalo River address: Buffalo National River

Main address: 402 N. Walnut, Suite 136
Harrison, AR 72601

Telephone: (870) 365-2700

Main Website: http://www.nps.gov/buff/index.htm.

Hot Springs Address: Hot Springs National Park
101 Reserve St.
Hot Springs AR 71901

Telephone: 501-624-3383

Main Website: http://www.nps.gov/hosp/index.htm.

7. **United States Department of Commerce – National Oceanic and Atmospheric Administration.**
NOAA is an agency that enriches life through science. Our reach goes from the surface of the sun to the depths of the ocean floor as we work to keep citizens informed of the changing environment around them.

Main Address: National Oceanic and Atmospheric Administration

1401 Constitution Avenue, NW
Room 5128
Washington, DC 20230

Main website: http://www.noaa.gov/.

8. **United States Department of Interior - Fish and Wildlife Service (USFWS)**.
The USFWS is the primary federal agency responsible for conserving, protecting and enhancing fish, wildlife and plants and their habitats for the continuing benefit of the American people.

Main address: 110 S. Amity Road
Suite 300
Conway, AR 72032

Telephone: (501)-513-4470

Main Website: http://www.fws.gov/arkansas-es/.

9. **United States Geological Survey (USGS).** The USGS serves the nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.

Main address: Arkansas Water Science Center
401 Hardin Road
Little Rock, AR 72211

Telephone: (501) 228-3600

Main website: http://ar.water.usgs.gov.

Other links: ***Current Water Data:*** http://waterdata.usgs.gov/ar/nwis/rt.

State Agencies

1. **Arkansas Department of Energy and Environment - Department of Environmental Quality (DEQ)**. The mission of the ADEQ is to protect the air, water and land through programs of regulation, stream work permits, education and assistance.

Main address: 5301 Northshore Drive
North Little Rock, AR 72118

Telephone: (501)-682-0744

Main website: http://www.adeq.state.ar.us/.

Other links: ***Water Division:*** http://www.adeq.state.ar.us/.water/.
Regulations: http://www.adeq.state.ar.us/regs/default.htm.
Public Outreach: http://www.adeq.state.ar.us/poa/default.htm.

2. **Arkansas Association of Conservation Districts (AACD)**. The mission of the AACD is to assist in efforts to serve the soil and water conservation needs of the people of Arkansas.

Main address: Arkansas Association of Conservation Districts
4004 McCain Blvd, Ste. 201-B
North Little Rock, Arkansas 72116

Telephone: (501) 904-5575

Main website: http://aracd.org/default.htm.

Other links: ***Arkansaswater.org:*** http://www.arkansaswater.org/.

3. **Arkansas Department of Agriculture.** Natural Resources Division – The mission of the ANRC is to manage and protect our water and land resources for the health, safety and economic benefit of the State of Arkansas.

Main address: Arkansas Natural Resources Commission
10421 W. Markham St.,
Little Rock, AR 72205.

Telephone: (501) 682-1611
Main Website: http://www.anrc.arkansas.gov/.

4. **Arkansas Department of Health (ADH).** The ADH mission is to protect and improve the health and well-being of all Arkansans.

Main address: Arkansas Department of Health
4815 West Markham Street
Little Rock, AR 72205

Telephone: 501-661-2623

Main Website: https://www.healthy.arkansas.gov/.

Other Links: ***Drinking Water Safety:*** https://www.healthy.arkansas.gov/programs-services/topics/drinking-water.
Private Wells: https://www.healthy.arkansas.gov/programs-services/topics/milk-and-water-testing.
Onsite Wastewater: https://www.healthy.arkansas.gov/programs-services/topics/environmental-health.

5. **Arkansas Game and Fish Commission (AGFC).** The mission of the Arkansas Game and Fish Commission is to wisely manage all the fish and wildlife resources of Arkansas while providing maximum enjoyment for the people.

Main address: Arkansas Game and Fish Commission
2 Natural Resources Dr.
Little Rock, AR 72205

Telephone: (800)-364-4263

Main website: http://www.agfc.com/Pages/default.aspx.

6. **Arkansas Game and Fish Commission Stream Team.** Arkansas Stream Team enables concerned citizens to become involved in stream and watershed conservation. Efforts revolve around three primary aspects of stream conservation: education, advocacy and stewardship.

Main address:	State Stream Team Coordinator Arkansas Game and Fish Commission 2 Natural Resources Drive Little Rock, Arkansas 72205
Telephone:	(800)-364-4263
Main Website:	https://www.agfc.com/en/education/onthewater/streamteam/.

7. **Arkansas Division of Forestry (ADF).** The mission of the ADF is to serve urban and rural forest management needs of Arkansans.

Main address:	Arkansas Division of Forestry 1 Natural Resources Drive Little Rock, AR 72205
Telephone:	(501) 225-1598
Main Website:	https://www.agriculture.arkansas.gov/forestry.

8. **Arkansas Natural Heritage Commission.** The Arkansas Natural Heritage Commission (ANHC) was established in 1973 to identify and protect the state's remaining high-quality natural communities. To protect the "best of the last," ANHC manages a System of Natural Areas and maintains data on the status of rare species and natural communities.

Main address:	Arkansas Natural Heritage Commission 1100 N St Little Rock, Arkansas 72201
Telephone:	(501)-324-9619
Main website:	https://www.arkansasheritage.com/arkansas-natural-heritage/anhc-home.

9. **Arkansas Department of Energy and Environment - Oil and Gas Commission.** The purpose of the Arkansas Oil and Gas Commission is to serve the public regarding oil and gas matters, prevent waste, encourage conservation, and protect the correlative rights of ownership associated with the production of oil, natural gas and brine, while protecting the environment during the production process, through the regulation and enforcement of the laws of the State of Arkansas.

Main address: 5301 Northshore Dr
North Little Rock, AR 7218

Telephone: 501-683-5814

Main website: http://www.aogc.state.ar.us/.

10. **University of Arkansas - Division of Agriculture System-Cooperative Extension Service (UACES).** The mission of UACES is to deliver researched based information to the public of Arkansas in order to help uplift them and improve their lives.

Main address: UACES
2301 South University Avenue
Little Rock, Arkansas 72204

Telephone: (501)-682-0022

Main Website: www.uaex.edu.

Other links: ***Arkansas Water Resources Center:*** https://awrc.uada.edu/.
National Agricultural Law Center: https://nationalaglawcenter.org/.
Center for Community Design: http://uacdc.uark.edu/.
Arkansas Public Policy Center: https://www.uaex.edu/business-communities/public-policy-center/default.aspx.
Water in Arkansas: https://www.uaex.uada.edu/environment-nature/water/.

11. **Keep Arkansas Beautiful Commission.** The Keep Arkansas Beautiful Commission inspires and educates individuals to prevent litter, recycle and keep Arkansas beautiful.

Main address: Keep Arkansas Beautiful Commission
1 Capitol Mall
Little Rock, Arkansas 72201

Telephone: 501-682-3507

Main Website: http://www.keeparkansasbeautiful.com/.

Non-Profit Organizations

1. **Audubon Arkansas.** Assists Arkansans by promoting local voluntary approaches to watershed management and conservation.

Main address: 4500 Springer Boulevard
Little Rock, AR 72706

Telephone: 501-244-2229

Main Website: http://ar.audubon.org/.

2. **Ducks Unlimited.** Ducks Unlimited conserves, restores, and manages wetlands and associated habitats for North America's waterfowl. These habitats also benefit other wildlife and people.

Main Website: http://www.ducks.org/arkansas.

3. **The Nature Conservancy.** The mission of TNC is to provide technical and planning services for the protection, conservation, and restoration of watershed resources.

Main address: 601 North University Avenue
Little Rock, AR 72205

Telephone: 479-444-1916

Main Website: http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/arkansas/index.htm.

4. **Watershed Conservation Resource Center.** Provides technical and planning services for the protection, conservation, and restoration of watershed resources.

Main address: Watershed Conservation Resource Center
380 West Rock Street
Fayetteville, AR 72701

Telephone: 479-444-1916

Main Website: https://www.watershedconservation.org/.

College and University Resources in Arkansas

Arkansas State University Ecotoxicology Research Facility. The ASU ecotoxicology Research Facility is a multi-user laboratory facilitating intercollegiate research and collaboration with other universities, state and federal agencies, industry, and various other interest groups.

Main address: Ecotoxicology Research Facility
Arkansas State University
PO Box 847
State University, AR 72467

Telephone: 870-972-2570

Website: http://www.astate.edu/college/sciences-and-mathematics/ecotoxicology-research-facility/.

Arkansas Water Resource Center (AWRC). The mission of AWRC is to conduct water quality testing, train future scientists, and transfer water quality information to the public of Arkansas.

Main address: Arkansas Water Resources Center
203 Engineering Hall
University of Arkansas
Fayetteville, AR 72701

Telephone: (479)-502-9843

Main Website: https://awrc.uada.edu/.

University of Arkansas Pine Bluff Aquaculture/Fisheries Center. The Aquaculture/Fisheries Center works in partnership with the University of Arkansas Cooperative Extension Service to provide aquaculture and fisheries information, education and services to all Arkansans. With few exceptions, educational materials and services are provided free of charge.

Telephone: (870) 575-8123

Main Website: http://www.uapb.edu/academics/school_of_agriculture_fisheries_and_human_sciences/aquaculture_fisheries/aquaculture_fisheries.aspx.

Watershed Organizations in Arkansas

• Association for Beaver Lake Environment

• Beaver Watershed Alliance

• Buffalo River Foundation

• Friends of Fourche Creek

• Friends of the North Fork and White Rivers

• Friends of Little Sugar Creek

• Illinois River Watershed Partnership

• Kings River Watershed Partnership

• L'Anguille River Coalition

• Lake Fayetteville Watershed Partnership

• Lake Conway-Point Remove Watershed Alliance

• Lower Mississippi River Conservation Commission

• Lower White River Watershed Coalition

• Mulberry River Society

• Multi-Basin Regional Watershed Council

• Northwest Arkansas Land Trust

• Ozarks Water Watch

• Saline River Watershed Alliance

• Save Our Spring River

• Searcy County Agricultural Conservation Co-Op

• White River Water Keeper

Appendix B

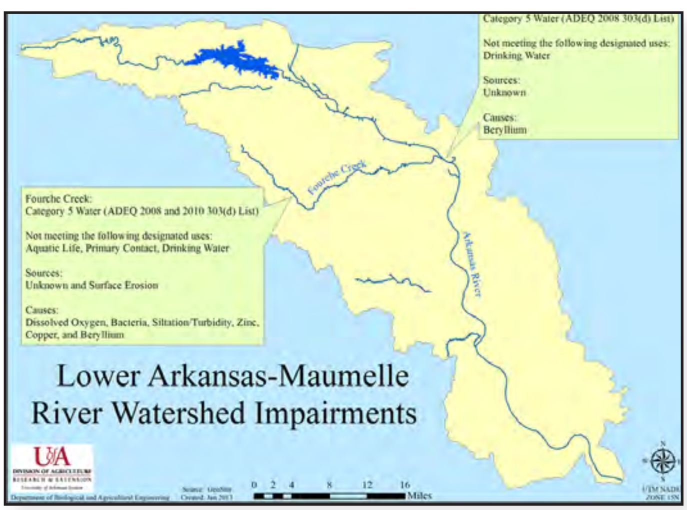
Community Activities for Your Watershed

As an Arkansas Watershed Steward, you now have an enhanced ability to make a difference in your local community, to raise awareness and increase education about issues in your watershed, and to participate in local watershed management and protection activities. The following is a list of activities (roughly arranged by "easiest" to "hardest" to participate in and organize that you can participate in or help organize as an individual or part of a watershed organization.

Learn About Your Watershed

Start by using EPA's Watershed Information Network at http://www.epa.gov/owow/watershed/ to find your watershed address and learn about its water quality issues. From here you can surf your watershed, adopt your watershed, and find other useful watershed information.

You can also learn more about the size, features, water quality issues, and funding opportunities for improving your watershed at the Arkansaswater.org website http://www.arkansaswater.org/.



Additionally, checking the 303(d) list, or the 305(b) integrated water assessment report of the ADEQ at their website https://www.adeq.state.ar.us/water/planning/integrated/ can be very helpful in learning more about your watershed.

For other types of information, such as real-time streamflow data and several types of water quality, water quantity, and aquatic biology reports for your watershed you can check out the Lower Mississippi Gulf Water Science Center USGS webpage http://ar.water.usgs.gov/.

Volunteer for Community Improvement Projects

Volunteering in an event like a creek cleanup, tree planting, or recycling event that other people organize is pretty easy. Doing the work may actually require some effort, but the organizing is left up to others. When you volunteer in community improvement events, you will be directly helping your community's watershed(s) and you will be able to network with other individuals and organizations that can likely assist you in learning about and taking care of your watershed.

Become a Volunteer Water Quality Monitor

Help collect water quality data and be a steward for one of your local water ways. There are a few different volunteer water quality monitoring programs in Arkansas, but the Arkansas Game and Fish Stream Team is the premier program for the state.

Join a Watershed Organization

After you have surfed or learned more about your watershed, you might have learned about some existing watershed organizations that are working to maintain or improve water quality already. If this is the case, check in with them to find out when and where they meet and how you can get involved.

Join or Create a Stream Team

Joining a stream team is as simple as contacting the Stream Team headquarters (800-364-4263) to find out about the other stream teams in your area. Creating a Stream Team of your own may be even easier since all you need to do is download the form at this link https://docs.google.com/forms/d/1nnxqFK6B9NZ-uwbUwG30JYb_qPhtxGFz55ymK3OZsl4/viewform?edit_requested=true fill it out, and mail it back in. Joining a Stream Team or starting you own can help you learn even more about your watershed, and gain access to materials that are helpful in monitoring, protecting or educating others about water quality.

Create a Watershed Display

A display can be an effective tool for engaging the public to raise awareness about issues, activities, and best management practices in your watershed when used in places where people gather – fairs, festivals, volunteer recruitment fairs and public facilities. The display can contain information about your watershed, pictures of volunteers working to improve the watershed, a map of your watershed, and any other information that you would like to share.

Give a Presentation to a School Class

Through teaching children about their watershed, it is possible to produce Watershed Stewards for tomorrow. Sometimes, the best way to reach adults is through their children.

Contacting and planning with teachers about providing aspects water quality education that meet curriculum requirements is a great way to get into schools. Once in the schools, you can carry out educational activities and hands on applications that convey the watershed concept and importance of good water quality. It is also possible to teach students about the steps they can take to help protect and improve water quality within their watershed.

There are many state and national water education programs for youth that can give you ideas:

- **Project Wet:** (http://projectwet.org/) Water Education Today (WET) is an award winning, nonprofit water education program and publisher. The program facilitates and promotes awareness, appreciation, knowledge and stewardship of water resources through the dissemination of classroom-ready teaching aids and the establishment of internationally sponsored project WET programs.
- **USGS Water Science School.** (http://water.usgs.gov/education.html) provides links to a variety of water education materials including maps, posters, glossaries and more.
- **EPA Resources for Students and Science Educators About Nonpoint Source.** Pollution https://www.epa.gov/nps/resources-students-and-educators-about-nonpoint-source-nps-pollution. Provides activities for students and other water science resources.
- **Watershed Science for Educators by the Cornell Cooperative Extension Service.** Develops skills and knowledge by using information to answer questions. http://www2.dnr.cornell.edu/ext/youth/sample%20watershed%20science.PDF.

Organize a Stream or River Walk

This is a great way to bring a group of citizens together to be outside and to make visual observations and assessments on the condition of a waterway. If problems or concerns like trash or other sorts of pollution are discovered, work with your local community and municipal government to organize a cleanup up for that waterway. It is also possible just to use this type of activity to get folks out into a waterway, so that you can help them understand more about the plants, wildlife, and scenic beauty that occur in these natural areas.

Start a Watershed Organization

Forming a watershed organization can range from fairly simple to complex. If a group is more informal in nature and is not a registered 501(c)3, then the startup is easier, but over the long term may be more difficult to sustain momentum. Likewise, becoming a registered non-profit is more difficult in the beginning, but makes a lot of things easier over the long term, such as obtaining grants, fundraising and establishing a stable group structure. Either way, forming a watershed organization in your watershed or community will help raise awareness and increase understanding of local watershed issues and help garner community buy-in to help maintain or improve water quality. https://www.irs.gov/charities-non-profits/charitable-organizations/exemption-requirements-501c3-organizations.

Organize a Community Cleanup or Recycle Event

Community cleanups, river cleanups, and recycle events all help to increase awareness about the importance of properly managing trash by disposing of it properly or recycling. You can get support for community cleanups from Keep Arkansas Beautiful, stream cleanups from Arkansas Stream Teams and E-waste recycling from the Department of Environmental Quality. In some cases you can organize these events with your local city or county governments.

Organize a Community Soil or Well Testing Campaign

This is a great way to increase the awareness about how important it is to soil test before fertilizing and that well water should be tested occasionally to ensure it is safe to drink. Both of these activities help participants learn more about the importance of properly managing their land to help protect water quality. Note: soil testing is free in Arkansas through the UACES.

Host a Watershed Workshop or Watershed Festival

You can organize a community watershed workshop or organize a watershed festival to raise awareness and increase education about watersheds or water quality issues in your watershed.

Organize a Storm Drain Stenciling/Painting or Reveal Project in Your Community

Storm drain stenciling and/or painting is a great way to teach and remind community members that storm drains lead directly to local waterbodies and are untreated discharges that can deliver a lot of pollutants. https://nwaupstreamart.com/.

Install Rain Barrels in Your Community

Install a rain barrel system to collect and store rainwater from roofs and other buildings that otherwise would runoff into storm drains and streams where it can cause erosion and carry pollutants with it. A rain barrel is used to harvest water from your rooftop, so that you can use that free water at a later date for watering plants. It is estimated that rain barrels can save homeowners an average of 1300 gallons of water during peak summer months and 5 gallons of water each day. http://www.uaex.edu/Other_Areas/publications/PDF/fsa-9534.pdf.

Create a Community Rain Garden

A rain garden is a landscaped depression created downslope of impervious surfaces like parking lots and rooftops. Rain gardens capture the runoff water created from places where rainfall does not soak in, and they filter pollutants like sediment, fertilizers and pesticides that may be contained within the water that flows into them.

Get Your Public Water System Involved in a Source Water Protection Program

The Arkansas Department of Health provides a Source Water Protection Program (SWAP) for community public water systems at no cost. All it takes to participate is to contact the ADH requesting their support for the program. Once ADH receives the letter, they will be able to work with the public water supply and other local partners necessary to get the program started.

Get Funding to Help Protect Your Watershed

Having money will greatly help to sustain water quality awareness and public education efforts and in doing some of the bigger tasks. Funding can be raised by conducting fundraisers, memberships, donations, sponsorships, contracts and grants. Be sure to check out federal grants available for watershed protection at the Funding Sources for Watershed Protection and Restoration EPA page https://www.epa.gov/nps/funding-resources-watershed-protection-and-restoration. Also, be sure to check out the Arkansas 319 grant program of the Arkansas Natural Resources Commission http://arkansaswater.org/index.php?option=com_content&view=article&id=13&Itemid=5 and the Environmental Education Grants Program http://www.epa.gov/education/grants/index.html. Be sure not to forget our state, county, and state-run grant programs.

Develop a Watershed Management Plan

A watershed management plan is a focused effort to bring together all of the different stakeholder groups (city, county, business, industry, homeowners, etc.) to work together to plan for the future of a watershed. It requires dedication of significant time, energy and money, but the end result is a shared plan that everyone can help implement with the goal of maintaining and improving water quality of a health watershed. If the plan is an EPA-accepted, nine-element plan, then you can more likely attain EPA funding for carrying out watershed improvements. Some examples of nine-element watershed management plans developed in Arkansas are the Beaver Lake Watershed Protection Strategy http://www.beaverwatershedalliance.org/strategy/watershed-protection-strategy.aspx and the Illinois River Watershed Management Plan. Additionally, EPA has several watershed management plan resources available on line as a public resource https://www.epa.gov/nps/resources-watershed-planning.

Appendix C

Water Quality on the Web

Arkansas Integrated Water Quality Monitoring and Assessment Report

- Arkansas Integrated Water Quality Monitoring Assessment Report for CWA sections 305(b) and 303(d): These reports describe the status of Arkansas waters based on historical data on surface water quality 305(b) and identifies Arkansas waters that are impaired 303(d). https://www.adeq.state.ar.us/water/planning/integrated/.

Best Management Practices (BMPs)

- California Stormwater Association Stormwater BMP Handbook: A great resource for construction, municipal, industrial and commercial, development and re-development related BMPs. https://www.casqa.org/resources/bmp-handbooks/municipal-bmp-handbook.
- EPA Green Infrastructure: A web page containing information about using principles of Green Infrastructure as BMPs in planning, growth, and development. http://water.epa.gov/infrastructure/greeninfrastructure/gi_why.cfm.
- International Stormwater Best Management Practices Database: Provides scientifically sound information regarding the design, selection, and performance of urban stormwater BMPs. http://www.bmpdatabase.org/.
- Irrigation Best Management Practices: An online information source for irrigation BMPs created by The Nationally Environmentally Sound Production Agriculture Laboratory (NESPAL) at the University of Georgia's College of Agricultural and Environmental Sciences. https://www.twdb.texas.gov/conservation/BMPs/Ag/doc/AgMiniGuide.pdf.
- NFIP Community Rating System Program: An incentive program that reduces flood insurance premiums in communities that go beyond the minimum standards for floodplain management. https://www.fema.gov/flood-insurance/rules-legislation/community-rating-system.
- National Menu of Stormwater Best Management Practices:
A great resource of the EPA that contains a large variety of stormwater BMPs. https://www.epa.gov/npdes/national-menu-best-management-practices-bmps-stormwater.
- NRCS Agricultural Field Technical Office Guide of BMPs: The Arkansas guide to agricultural BMPs complete with BMP listings and explanations. Field Office Technical Guide https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/fotg/.

Drinking Water

- Arkansas Department of Health: Public Drinking Water FAQs Field Office Technical Guide (usda.gov)
- Arkansas Department of Health: Source Water Protection Program: The ADH webpage containing information about the source water protection program in Arkansas. https://www.healthy.arkansas.gov/drinking-water-source-water-protection.
- Drinking Water Information for Arkansans: The best resource for drinking water information in Arkansas provided by the Arkansas Department of Health. https://www.healthy.arkansas.gov/programs-services/topics/drinking-water.
- EPA Drinking Water Regulations and Contaminants: Provides a list of drinking water contaminants and other MCLs. https://www.epa.gov/sdwa/drinking-water-regulations-and-contaminants.
- EPA Drinking Water Standards and Advisory Tables:
  Contains information regarding drinking water standards and health advisories.
  https://www.epa.gov/sdwa/2018-drinking-water-standards-and-advisory-tables.
- EPA Local Drinking Water Information: Provides drinking water information for each state, as well as links to safe drinking water organizations in the country.
  https://www.epa.gov/ground-water-and-drinking-water/local-drinking-water-information.
- Improving Home Water Quality: A University of Arkansas Cooperative Extension Service publication about investigating and improving home water quality for drinking and other purposes. http://www.uaex.edu/Other_Areas/publications/PDF/MP292.pdf.

Emergency Response

- Arkansas Department of Emergency Management Preparedness Training Programs.
  http://www.adem.arkansas.gov/ADEM/Divisions/Preparedness/Training/index.aspx.
- Flood: Post-Disaster Community Responsibilities; Mississippi Emergency Management Agency: a guide to prepare communities to respond to a flood event in compliance with the requirements of their flood damage prevention land use ordinance.
  https://silo.tips/download/mississippi-emergency-management-agency.

Environmental Facts

- EPA Envirofacts Data Warehouse: A national information system that provides a single point of access to data extracted from seven major EPA databases.
  http://www.epa.gov/enviro/.

Funding Sources

- Arkansas 319 Nonpoint Source Pollution Management Program
  https://www.epa.gov/education/grants.
- Grants.gov: A source to find and applu for federal grants. The U.S. Department of Health and Human Services is proud to be the managing partner for Grants.gov, an initiative that is having an unparalleled impact on the grant community.
  http://www.grants.gov/.
- EPA Funding Resources for Watershed Protection and Restoration: A collection of financial assistance sources (grants, loans, cost-sharing) available to fund a variety of watershed protection projects.
  https://www.epa.gov/nps/funding-resources-watershed-protection-and-restoration.
- FEMA Flood Hazard Mitigation Assistance Programs: These programs provide federal funds for cost-effective measures to reduce or eliminate the long-term risk of flood damage to structures insurable under the NFIP. Two types of grants are available under the program-planning and project. The planning grant is limited to funding activities that only develop or update the flood hazard component of the jurisdiction's Multi-Hazard Mitigation Plan. Project grants can be used for acquisition of insured structures and real property for open/green space; elevation, relocation or demolition of insured structures; and minor localized flood reduction projects.
  https://www.fema.gov/grants/mitigation#:~:text=Flood%20Mitigation%20Assistance%20(FMA)%20Program,the%20National%20Flood%20Insurance%20Program.

Glossaries

- EPA Terminology Services: A single resource of environmental terminology.
  https://iaspub.epa.gov/sor_internet/registry/termreg/searchandretrieve/termsandacronyms/search.do.
- USGS Water Resource Glossaries: A nearly comprehensive water terminology glossary page.
  https://water.usgs.gov/glossaries.html.

Groundwater Management

- USGS Lower Mississippi Gulf Science Center Groundwater Data Network:
  http://ar.water.usgs.gov/PROJECTS/GWData.html.
- Groundwater Management and Protection Program of the ADA-NRD:
  http://www.anrc.arkansas.gov/groundwater/groundwater.html.

Green Infrastructure and Low Impact Development

- EPA Green Infrastructure Webpage: A one stop shop for Green Infrastructure fact sheets, success stories, and programs.
  http://water.epa.gov/polwaste/green/index.cfm.
- University of Arkansas Community Design Center:
  A website with local and national low impact development resources
  http://uacdc.uark.edu/.

Mapping/Database Tools

- Arkansaswater.org: A one stop shop for Arkansas water resources related information.
  http://arkansaswater.org/.
- Arkansas Watershed Information System: The Arkansas Watershed Information System is a comprehensive statewide electronic watershed atlas consisting of a series of practical maps and reports for the 308 watershed units across the state.
  http://watersheds.cast.uark.edu/.
- EPA BASINS (Better Assessment Science Integrating Point & Nonpoint Sources): A multipurpose environmental analysis system that integrates a geographical information system (GIS), national watershed data, and state of the art environmental assessment and modeling tools into one convenient package.
  http://water.epa.gov/scitech/datait/models/basins/index.cfm.
- EPA Enviromapper: An integrated water quality database that dynamically displays snapshots of EPA Office of Water program data. MyWATERS Mapper depicts the status of NPDES permits for each State; summary information from the Clean Watershed Needs Survey; and water quality assessments.
  https://geopub.epa.gov/myem/efmap/index.html?ve=13,47.236778259277344,-122.35669708251953&pText=Fife,%20WA.
- EPA Water Quality Data (WQX): A national database for chemical, physical, and biological water quality information.
  https://www.epa.gov/waterdata/water-quality-data-wqx.
- EPA WATERS (Watershed Assessment, Tracking & Environmental Results): A powerful mapping tool that allows users to view data from many EPA databases and find geography-specific water quality information.
  http://www.epa.gov/waters/.
- FEMA Map Service Center: A directory of historic and current flood insurance rate maps, flood insurance studies, and additional community flood data.
  https://msc.fema.gov.

Nonpoint Source Pollution

- Arkansas Nonpoint Source Pollution Management Program: A program developed and implemented by the ANRC for the State of Arkansas. This program is a cooperative effort between many federal, state, local, and non-profit agencies and organizations. http://www.anrc.arkansas.gov/water%20resources%20management/nonpoint_source_management_program.html.
- Arkansas Nonpoint Source Pollution Management Plan: The most comprehensive literature about non-point source pollution in Arkansas and the plan containing milestones and objectives regarding nonpoint source pollution reduction. https://www.agriculture.arkansas.gov/wp-content/uploads/2020/05/Pages_from_2018-2023_NPS_Pollution_Management_Plan.compressed_1.pdf.
- Water in Arkansas: A website of the University of Arkansas System Division of Agriculture that features nonpoint pollution, stormwater, and other water conservation related information. https://www.uaex.edu/environment-nature/water/default.aspx.
- EPA Polluted Runoff: A website that provides information about non-point source pollution for youth and adult audiences, funding sources, publications, education and outreach ideas and materials. https://www.epa.gov/nps.
- EPA What is Nonpoint Source Pollution: A webpage of EPA that provides great information on nonpoint source pollution. http://water.epa.gov/polwaste/nps/whatis.cfm.
- FEMA Map Service Center: A directory of historic and current flood insurance rate maps, flood insurance studies, and additional community flood data. https://msc.fema.gov.

Nutrient Management in Arkansas

- An Overview of Nutrient Regulations of Nutrient Management on Livestock Farms in Arkansas. http://www.uaex.edu/Other_Areas/publications/PDF/FSA-9523.pdf.
- Arkansas Title XXII: Arkansas Natural Resources Commission Rules Governing the Soil Nutrient and Poultry Litter Application and Management Program Title 22. https://www.agriculture.arkansas.gov/wp-content/uploads/2020/05/Title_22.pdf.
- Nutrient Management in Arkansas: A webpage of the University of Arkansas System Division of Agriculture Cooperative Extension Service (UACES) with many nutrient management links. https://www.uaex.edu/environment-nature/water/quality/nutrient-applicators.aspx.
- Understanding Nutrient Management Laws for Turfgrass, Lawns and Landscaping: A fact sheet of the UACES about nutrient management for lawns and landscaping in Arkansas. http://www.uaex.edu/Other_Areas/publications/PDF/FSA-9532.pdf.

Partnerships

- Partnership Resource Center: Provides online resources to build vibrant partnerships and effective collaboration for the nation's forests, grasslands and other special places.
  http://www.fs.usda.gov/prc.
- Partners you can work with to protect water quality.
  https://www.epa.gov/standards-water-body-health/partners-you-can-work-protect-water-quality.

Point Source Pollution

- EPA National Pollutant Discharge Elimination System (NPDES): The site contains technical and regulatory information about the NPDES permit program.
  https://www.epa.gov/npdes.
- Arkansas Pollution Control and Ecology Commission Regulations.
  http://www.adeq.state.ar.us/regs/default.htm.

Septic Tanks

- Arkansas Department of Health website for septic/onsite wastewater treatment related information in Arkansas.
  https://www.healthy.arkansas.gov/programs-services/topics/onsite-wastewater.

Smart Growth

- EPA Smart Growth: A weblink of the EPA website that contains information about and links to Smart Growth concepts and funding sources.
  https://www.epa.gov/smartgrowth.

Stormwater

- EPA Stormwater Program: This website contains information relating to the National Pollution Discharge Elimination System (NPDES) for nonpoint source pollution relating to stormwater discharge.
  https://www.epa.gov/npdes/npdes-stormwater-program.

Total Maximum Daily Load (TMDL)

- ADEQ Arkansas TMDLs: An ADEQ weblink that contains information on draft and established TMDLs for waterbodies in Arkansas.
  https://www.adeq.state.ar.us/water/planning/integrated/tmdl/.
- EPA Impaired Waters Total Maximum Daily Loads: Clearinghouse for all things TMDL, including an introduction and access to policy/program documents, technical support documents, sample TMDLs, litigation status and more.
  https://www.epa.gov/tmdl.

Volunteer Water Quality Monitoring

- Arkansas Stream Team: An educational water quality program of the Arkansas Game and Fish Commission of which volunteer water quality monitoring is a part of the program. https://www.agfc.com/en/education/onthewater/streamteam/.
- EPA Volunteer Monitoring: Provides links to volunteer monitoring fact sheets, methods, newsletters, conferences, and events. https://www.epa.gov/wetlands/volunteer-stream-monitoring-methods-manual.

Water Conservation

- Water in Arkansas: A website of the University of Arkansas System Division of Agriculture that features water conservation related information. https://www.uaex.edu/environment-nature/water/default.aspx.

Watersheds

- Arkansaswater.org: A one stop shop for Arkansas water resources related information. http://arkansaswater.org/.
- Arkansas Watershed Information System: The Arkansas Watershed Information System is a comprehensive statewide electronic watershed atlas consisting of a series of practical maps and reports for the 308 watershed units across the state. http://watersheds.cast.uark.edu/.
- EPA Watersheds: The most comprehensive watershed information collection of EPA that has most of the watershed information you need to learn about and get others involved in your watershed(s) http://water.epa.gov/type/watersheds/.
- EPA Surf Your Watershed: An internet application to help you locate your watershed and collect watershed information that you can use and share with others in your community. https://www.epa.gov/waterdata/hows-my-waterway.
- EPA Watershed Academy: The Watershed Academy is a focal point in EPA's Office of Water for providing training and information on implementing watershed approaches. The Academy's self-paced training modules, webcast seminars and live training courses provide current information from national experts across a broad range of watershed topics. http://water.epa.gov/learn/training/wacademy/index.cfm.
- USGS Science in Your Watershed: A website to help you find scientific information organized on a watershed basis. This information, coupled with observations and measurements made by the watershed groups, provides a powerful foundation for characterizing, assessing, analyzing, and maintaining the status and health of a watershed. http://water.usgs.gov/wsc/.
- USGS Water Science for Schools: Information on many aspects of water, along with pictures, data, maps, and an interactive center where you can give opinions and test your water knowledge. http://ga.water.usgs.gov/edu/.

Watershed Hydrology

- EPA Urbanization and Streams: Studies of hydrologic modifications and impacts.
  http://water.epa.gov/polwaste/nps/urban/report.cfm.
- USGS Real Time Streamflow for Arkansas: A complete streamflow listing for all streams monitored by the U.S. Geological Survey in Arkansas.
  http://waterdata.usgs.gov/ar/nwis/current?type=flow&group_key=basin_cd&search_site_no_station_nm=.
- USGS Watershed and Surface Water Reports:
  https://www.usgs.gov/centers/lmg-water/.
- USGS Water Cycle: Contains information related to the water cycle.
  https://www.usgs.gov/special-topic/water-science-school/science/water-cycle?qt-science_center_objects=0#qt-science_center_objects.

Water Law

- ANRC Listing of Arkansas Water Laws, Policy, and Regulations.
  https://www.agriculture.arkansas.gov/natural-resources/rules/current-rules/.
- Arkansas River Compact:
  https://www.oscn.net/applications/OCISWeb/DeliverDocument.asp?CiteID=97776.
- EPA Laws, Regulations, Policy, Guidance and Legislation:
  Links to all kinds of information related to water law and policy.
  https://www.epa.gov/laws-regulations.
- National Agricultural Law Center:
  https://nationalaglawcenter.org/.
- Red River Compact:
  https://www.owrb.ok.gov/rrccommission/rrccommission.html.
- UACES Arkansas Water Primer Series: Water Rights in Arkansas.
  http://www.uaex.edu/Other_Areas/publications/PDF/FSPPC101.pdf.

Watershed Management Plans

- EPA Watershed Management Process: A webpage containing information on how to develop a watershed management plan. https://www.epa.gov/nps/handbook-developing-watershed-plans-restore-and-protect-our-waters.
- Illinois River Watershed Management Plan: The EPA accepted 9 element watershed management plan for the Illinois River Watershed.
- Beaver Reservoir Watershed Protection Strategy: The EPA accepted 9 element watershed management plan for the Beaver Reservoir. http://www.beaverwatershedalliance.org/strategy/watershed-protection-strategy.aspx.

Watershed Publications and Products

- EPA Getting In Step: A Guide for Conducting Watershed Outreach Campaigns: A handbook to help local and state agencies and watershed groups conduct effective watershed outreach campaigns. https://cfpub.epa.gov/npstbx/getinstep.html.
- EPA Handbook for Developing Watershed Plans to Restore and Protect Our Waters: This handbook is intended to help communities, watershed organizations and others develop and implement comprehensive watershed management plans. https://www.epa.gov/nps/handbook-developing-watershed-plans-restore-and-protect-our-waters.
- EPA Protecting Water Resources with Smart Growth: Documents 75 innovative approaches to help communities protect water resources and achieve smart growth. https://www.epa.gov/smartgrowth.

Water Quality Monitoring

- ADEQ Water Quality Studies in Arkansas: A collection of water quality reports about waterbodies in Arkansas. https://www.adeq.state.ar.us/water/planning/publications.aspx.
- EPA Water Quality Assessment Report for Arkansas: A website containing brief and specific information related to impairments and pollutants responsible for impairments of surface waters in Arkansas. http://ofmpub.epa.gov/waters10/attains_state.control?p_state=AR.
- USGS Real Time Water Quality Monitoring Data: http://waterdata.usgs.gov/ar/nwis/current/?type=qw.
- United States Geological Survey: A complete listing of water quality monitoring studies. https://www.usgs.gov/centers/lmg-water/.
- ADEQ 303(d) Report: List of Impaired Rivers in Arkansas. https://www.adeq.state.ar.us/water/planning/integrated/303d/list.aspx.

Water Quality Parameters

- Kentucky River Basin Assessment Report: WQ Parameters described.
  http://www.uky.edu/WaterResources/Watershed/KRB_AR/krww_parameters.htm.

Water Quality Standards

- Arkansas Department of Environmental Quality: Water quality standards and information about the review process for water quality standards.
  http://www.adeq.state.ar.us/water/branch_planning/wqs_review.htm.
- EPA Water Quality Standards Database: Provides access to EPA and state water quality standards.
  http://www.epa.gov/waterscience/standards/.
- EPA Water Quality Standards Database: Provides a summary of state-reported water quality information and allows the user to view assessments of individual water bodies.
  https://rb.gy/zjbdli.

Water Quantity

- Arkansas Drought Resources: A website of the University of Arkansas System Division of Agriculture that contains drought and drought mitigation in Arkansas.
  http://arkansasdroughtresourcecenter.wordpress.com/.
- Arkansas Natural Resources Commission Rules for the Protection and Management of Groundwater Title 4:
  https://www.agriculture.arkansas.gov/wp-content/uploads/2020/05/Title_4.pdf.
- Groundwater Reports for Arkansas: A comprehensive listing of groundwater reports.
  https://www.agriculture.arkansas.gov/natural-resources/news/annual-reports/.
- National Drought Mitigation Center (NMDC): Program based at the University of Nebraska-Lincoln to help people and institutions develop and implement measures to reduce societal vulnerability due to drought.
  http://www.drought.unl.edu/.
- National Oceanic and Atmospheric Administration (NOAA):
  http://www.noaa.gov/.
- U.S. Geological Survey Real-Time Streamflow for the Nation: Find real-time flow data for all streams in the United States.
  http://waterdata.usgs.gov/nwis/rt.
- United States Department of Agriculture Drought Monitor:
  http://droughtmonitor.unl.edu/.

Wells

- Arkansas Department of Health: Well Water Testing. The ADH webpage containing information about well water testing in Arkansas. https://www.healthy.arkansas.gov/programs-services/topics/milk-and-water-testing.
- Arkansas Water Well Commission: https://www.agriculture.arkansas.gov/arkansas- water-well-construction-commission/.
- EPA Private Drinking Water Wells: Helpful information about private drinking water wells, including basic information, human health information, and precautions to ensure the protection and maintenance of private drinking water supplies. http://www.epa.gov/safewater/privatewells/index2.html.
- NSF Well Water Website: Provides private well owners with general information on water quality and the special needs of well water users. http://www.nsf.org/consumer/drinking_water/dw_well.asp?program=WaterTre.
- USGS Lower Mississippi-Gulf Science Center: A helpful website containing current information and historic reports about groundwater in Arkansas. https://www.usgs.gov/centers/lmg-water/data-tools.

Wetlands

- Arkansas Multi-Agency Wetland Planning Team Website: An informative collection of wetland information about wetlands in Arkansas, including reports and maps. https://arkansaswater.org/23-uncategorised/241-interagency.
- EPA Wetlands: A website containing information on protecting, restoring and monitoring wetlands. http://www.epa.gov/owow/wetlands/.

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