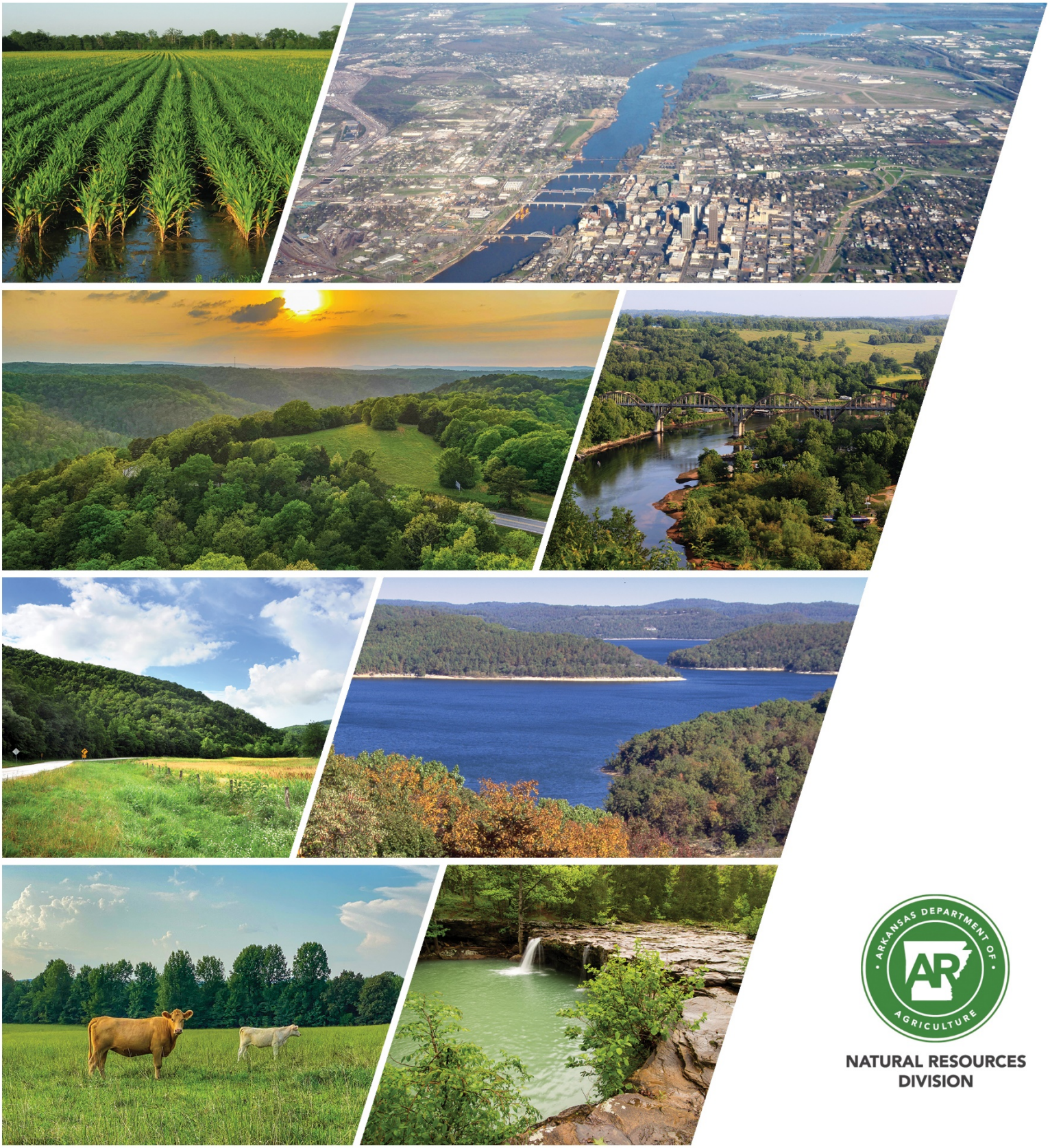
DRAFT

2022
Arkansas Nutrient Reduction Strategy (ANRS)



NATURAL RESOURCES DIVISION

Arkansas Department of Agriculture
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Acknowledgement

The Natural Resource Division gratefully acknowledges the planning and technical expertise provided by the coordinating team: Arkansas Department of Agriculture, Forestry Division (John Beasley, Joe Fox, Darren Spinks); Arkansas Department of Agriculture, Natural Resources Division (Ryan Benefield, Tate Wentz, Katie Mann, Kevin McGaughey); Arkansas Department of Energy and Environment, Division of Environmental Quality (Joe Martin); Arkansas Department of Health (Richard McMullen), Arkansas Game and Fish Commission (Bill Posey, Chris Racey, Ted Zawislak, Eric Brinkman); Arkansas Water Resource Center (Erin Grantz, Brian E. Haggard); Natural Resources Conservation Service (Roger Cousins, Amanda Mathis); and University of Arkansas, Division of Agriculture, Cooperative Extension Service (Mike Daniels).

Executive Summary

Nutrient pollution is one of America's most widespread, costly, and challenging environmental problems. It is caused by excess nitrogen and phosphorus entering America's waterways, usually from human activities. The primary sources of nutrient pollution are runoff of fertilizers, animal manure, and sewage. While plants and animals need nutrients to grow, excessive nutrients can cause harmful algal blooms in lakes and streams and contribute to the hypoxic zone in the Gulf of Mexico.

The Arkansas Nutrient Reduction Strategy (ANRS) was initiated by the 2014 Arkansas Water Plan update and is a response to federal initiatives to address the Gulf of Mexico Hypoxic Zone. The purpose of the ANRS is to reduce nutrient concentrations in Arkansas watersheds, providing local benefits and helping to shrink the Gulf of Mexico Hypoxic Zone. This is accomplished by working closely with stakeholders to adaptively manage and aggressively implement relevant practices and programs to safeguard state and regional economic prosperity, environmental quality, and recreational opportunities for current and future generations.

In 2021, the Natural Resources Division with the Arkansas Water Resource Center conducted a water quality analysis of all subbasin level watersheds (Appendix A). The goal was to prioritize watersheds based on extensive, statewide water quality monitoring data. All watersheds were classified into four Tiers. Tier 1 had the greatest potential for both nitrogen and phosphorus reduction based on sufficient data as outlined in Appendix A. Tier 2 had the greatest need for future monitoring investments due to demonstrated nutrient reduction needs, data limitations, or both. Tier 3 and Tier 4 did not have high demonstrated nutrient reduction needs. Tier 3 needed to expand on gathering more data, and Tier 4 focused on continuing statewide efforts.

The three main goals of the ANRS are:

- Goal 1: Increase or maintain downward trends for Tier 1 watersheds.
- Goal 2: Enhance water quality monitoring to inform nutrient trends for Tier 2 watersheds.
- Goal 3: Continue efforts in all watersheds.

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Acronyms

AACD	Arkansas Association of Conservation Districts
ACEP	Agricultural Conservation Easement Program
ACP	Arkansas Conservation Partnership
ACT	Avoiding, Controlling, and Trapping
ADA	Arkansas Department of Agriculture
ADH	Arkansas Department of Health
AFA	Arkansas Forestry Association
AFB	Arkansas Farm Bureau
AGFC	Arkansas Game and Fish Commission
ANRS	Arkansas Nutrient Reduction Strategy
API	Arkansas Phosphorus Index
ASU	Arkansas State University
AWRC	Arkansas Water Resource Center
BMP	best management practice
CAFO	concentrated animal feeding operation
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
CSP	Conservation Stewardship Program
CWA	Clean Water Act
DEQ	Arkansas Department of Energy and Environment, Division of Environmental Quality
EQIP	Environmental Quality Incentives Program
FD	Arkansas Department of Agriculture, Forestry Division
FSA	Farm Services Agency
GI	green infrastructure
HAB	harmful algal bloom
HTF	Hypoxia Task Force
HUC	hydrological unit code
IRWP	Illinois River Watershed Partnership
LID	low impact development
MARB	Mississippi/Atchafalaya River Basin
MRBI	Mississippi River Healthy Watersheds Basin Initiative
MS4	municipal separate storm sewer system
NPDES	National Pollutant Discharge Elimination System
NPS	nonpoint source
NRCS	Natural Resources Conservation Service
NRD	Arkansas Department of Agriculture, Natural Resources Division
NWQI	National Water Quality Initiative
POTWs	publicly owned treatment works
RC&D	Resource Conservation and Development Council
RCPP	Regional Conservation Partnership Program
TMDL	total maximum daily load
TNC	The Nature Conservancy
TN	total nitrogen
TP	total phosphorus
UADA	University of Arkansas, Division of Agriculture
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WMP	watershed management plans
WRP	Wetland Reserve Program
WWTP	wastewater treatment plant

Section 1. Introduction

Background

The Arkansas Nutrient Reduction Strategy (ANRS) was initiated by an update of the Arkansas Water Plan and Arkansas's participation on the Gulf of Mexico Hypoxia Task Force. The ANRS is a strategic framework that outlines opportunities, both regulatory and voluntary, that are available to improve water quality for the benefit of Arkansans and to reduce Arkansas's overall nutrient levels and exports. The strategy serves as an effort to encourage engagement, research, and education to partnerships and the public regarding the protection of Arkansas's waters. The ANRS is not a regulatory document and does not supersede existing water laws governing water quality issues in Arkansas. This document will guide the state in achieving nutrient reduction so local and downstream water quality goals are ultimately met.

Existing State Authority

The State of Arkansas has invested significant voluntary, incentive-based, and regulatory effort to address point and nonpoint source (NPS) pollution in Arkansas's streams, rivers, and lakes. These multi-agency efforts have been implemented through state and federal partnerships for the protection and maintenance of aquatic resource functions and the environmental benefits enjoyed by all citizens.

While affordable and good quality water is generally abundant throughout Arkansas for a multitude of purposes, impacts to beneficial uses caused by excessive nutrient loading exists in some of Arkansas's streams and lakes. The State of Arkansas, through the Arkansas Department of Health (ADH); Arkansas Department of Energy and Environment, Division of Environmental Quality (DEQ); and Arkansas Department of Agriculture, Natural Resources Division (NRD), exercises jurisdiction and management of water as it

relates to beneficial uses, i.e., environment, economy, public health. Through coordination of regulatory and voluntary programs, these agencies provide the foundation for implementing water quality improvement activities at the state level. In addition, partnership with other local, county, state, federal, nonprofit, academic, and private sector entities is essential to the protection, maintenance, and enhancement of all beneficial water uses in Arkansas.

Organizational Setting

Federal Level

There are many federal agencies that are involved in water quality. Federal agencies such as the Federal Emergency Management Agency, the National Oceanic Atmospheric Administration, the Department of Interior, and the U.S. Geological Survey (USGS) have a role in protecting water quality. However, the three main federal agencies that are highlighted in the ANRS are:

Environmental Protection Agency

The U.S. Environmental Protection Agency (USEPA) is an independent federal agency, created in 1970, that sets and enforces rules and standards that protect the environment and control pollution. USEPA enforces federal clean water and safe drinking water laws, provides support for municipal wastewater treatment plants, and takes part in pollution prevention efforts.

National Resource Conservation Service

The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) helps America's farmers, ranchers, and forest landowners conserve the nation's soil, water, air, and other natural resources. All programs are voluntary and offer science-based solutions that benefit both the landowner and the environment. NRCS conservationists provide technical expertise and conservation planning for farmers, ranchers, and forest landowners wanting to make conservation improvements to their land. Farmers, ranchers, and forest landowners can receive financial assistance from NRCS to make improvements to their land.

Farm Services Agency

The USDA Farm Services Agency (FSA) serves all farmers, ranchers, and agricultural partners through the delivery of effective, efficient agricultural programs for all Americans.

State Level

Arkansas's statutory authority to directly impact water quality resides primarily in three agencies: NRD, DEQ, and ADH. Other state agencies, including the Arkansas Department of Agriculture, Forestry Division (FD); Arkansas Game and Fish Commission (AGFC); Arkansas Natural Heritage Commission; and the University of Arkansas, Division of Agriculture (UADA), Cooperative Extension Service play an important role in state management of water resources.

Arkansas Department of Agriculture, Natural Resources Division

NRD manages Arkansas's NPS pollution program. The program includes voluntary implementation of NPS pollution abatement and management activities. Activities and projects are coordinated through local conservation districts whenever possible. NRD has authority to establish nutrient surplus watersheds (Arkansas Code Annotated § 15-20-1104). In nutrient surplus watersheds, special limitations govern poultry, livestock, forage, and crop production operations that involve land-application of litter, sewage sludge, and commercial fertilizer (Arkansas Administrative Rule 138.00.05-004).

Arkansas Department of Energy and Environment, Division of Environmental Quality

DEQ is Arkansas's main environmental protection agency, charged with protecting, enhancing, and restoring the environment for Arkansans. DEQ manages Arkansas's point source pollution programs. DEQ regulates municipal wastewater, industrial waste, some stormwater runoff, and liquid animal waste systems.

Arkansas Department of Health

ADH regulates the collection, treatment, and operation of domestic wastewater, excluding industrial discharge. On-site wastewater systems must be sited, planned, designed, constructed, and installed in accordance with the ADH's "Rules and Regulations Pertaining to General Sanitation" and the "Rules and Regulations Pertaining to Onsite Wastewater Systems." ADH is also the primacy agency for the Safe Drinking Water Act within the state, including source water protection.

Arkansas Department of Agriculture, Forestry Division

FD protects Arkansas's forests, and those who enjoy them, from wildland fire and natural hazards while promoting rural and urban forest health, stewardship, development, and conservation for all generations of Arkansans.

Arkansas Game and Fish Commission

AGFC conserves and enhances Arkansas's fish and wildlife and their habitats while promoting sustainable use, public understanding, and public support.

University of Arkansas, Division of Agriculture

UADA is a statewide, system-level entity to administer agricultural teaching, research, and extension programs. UADA includes the Agricultural Experiment Station, which is Arkansas's primary research agency for agriculture and related areas, and the Cooperative Extension Service, which delivers information and technology to the public. UADA strengthens agriculture, communities, and families by connecting trusted research to the adoption of best practices.

Local Level

Conservation Districts

Arkansas's conservation districts are the lifeblood of conservation activity at the watershed level. District board members are active leaders in the local community and are often pioneers in implementing innovative conservation practices. This "grassroots" connection is an important element in achieving sustainable nutrient reduction in priority watersheds. Conservation districts, along with many other watershed-level stakeholder groups and organizations, work with state and federal agencies to improve water quality through public policies, public outreach and education, project implementation, and water quality monitoring.

National Problem—Pollution

What is Point Source Pollution?

Point source pollution is defined as a discharge from a single, discrete point such as a pipe. The Clean Water Act (CWA) of 1972 defines a point source as any discernible, confined, and discrete conveyance, including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural stormwater discharges and return flow from irrigated agriculture.

What is Nonpoint Source Pollution?

NPS pollution is a type of water pollution that is not confined to an end-of-the-pipe discharge but is generated by surface water runoff during rain events. Total phosphorus (TP) and total nitrogen (TN) are the focus for the ANRS. Common sources of NPS pollution in Arkansas include:

- Animal production operations and feedlots
- Agricultural activities
- Timber harvesting
- Home sewage systems
- Land development
- Urban stormwater runoff
- Streambank and shoreline erosion
- Atmospheric deposition

What are HABs?

Harmful algal blooms (HABs) occur when colonies of cyanobacteria, also known as blue-green algae, grow rapidly in response to nutrient surpluses in water. Cyanobacteria can produce toxins that can be harmful to people, pets, livestock, fish, and other animals. Toxin exposure may cause rash, nausea, vomiting, diarrhea, or numerous other effects.

Exposure occurs when people have contact with contaminated water such as surface scum or water containing high levels of toxins. Routes of exposure include:

- Ingestion or swallowing water while drinking or recreating
- Inhalation or inhaling airborne water droplets while recreating
- Skin or eye contact while recreating

What is a Watershed?

A watershed is a land drainage area that channels rainfall and snowmelt to creeks, streams, and rivers, which eventually flow to reservoirs, bays, or the ocean. U.S. watersheds are divided and subdivided into successively smaller hydrologic units. Every hydrologic unit is identified by a unique hydrologic unit code (HUC) consisting of 2 to 12 digits based on the levels of classification in the hydrologic unit system (Figure 1):

- 2-digit HUC first-level (regional level)
- 4-digit HUC second-level (subregional level)
- 6-digit HUC third-level (basin level)
- 8-digit HUC fourth-level (subbasin level)
- 10-digit HUC fifth-level (watershed level)
- 12-digit HUC sixth-level (subwatershed level)

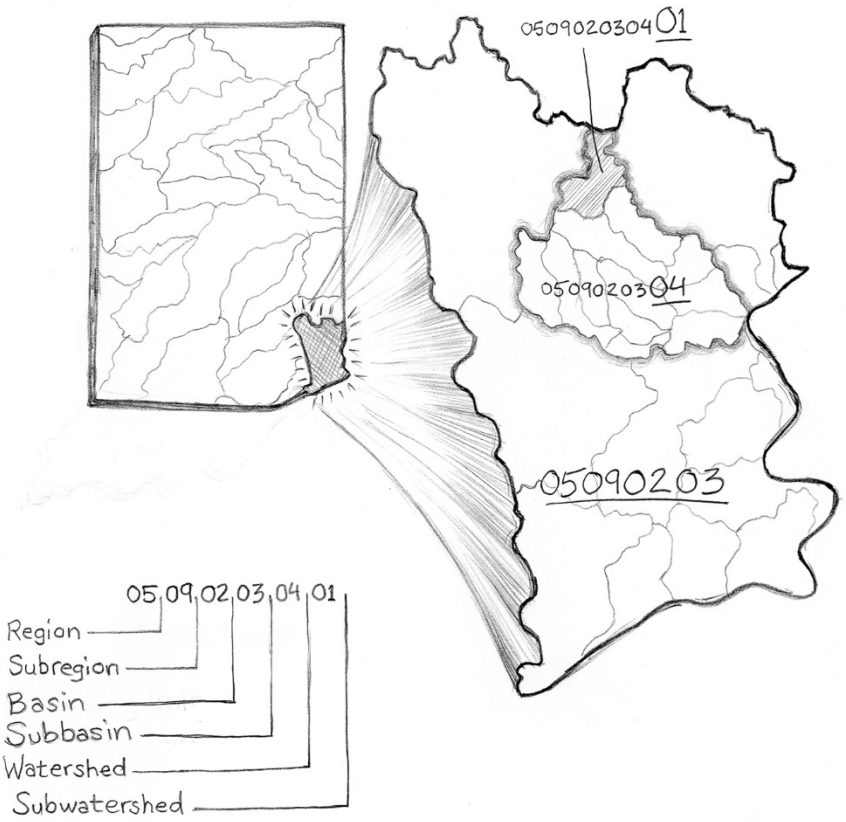


Figure 1. Hydrologic Unit System Classification.

Arkansas has fifty-eight HUC-8 subbasin level watersheds (Figure 2).

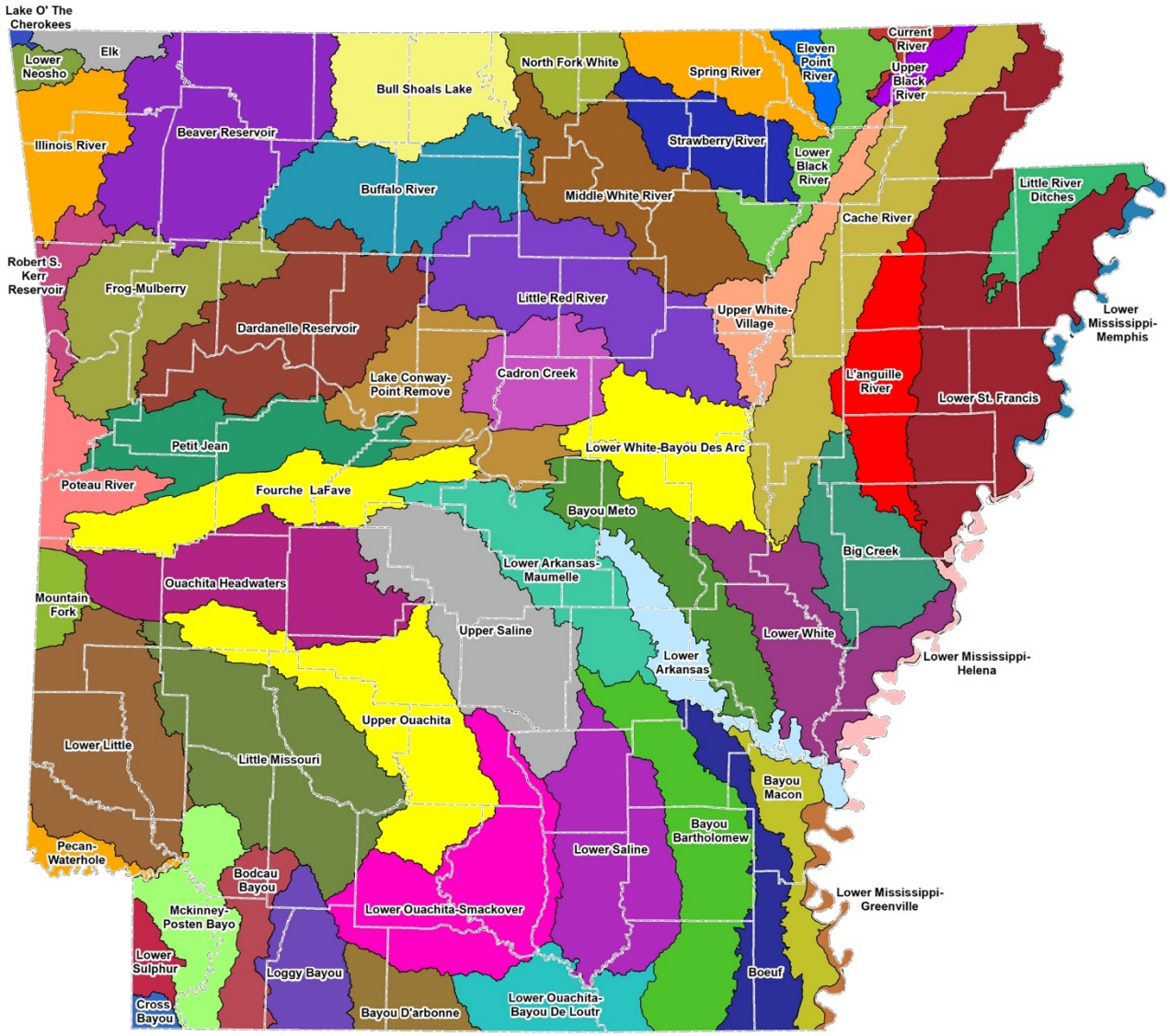


Figure 2. Arkansas Subbasin Level Watersheds.

What is the MARB?

The Mississippi/ Atchafalaya River Basin (MARB) is the third-largest river basin in the world. The Mississippi River originates in northern Minnesota (Figure 3). During a 2,350-mile journey south to the Gulf of Mexico, the Mississippi River is joined by hundreds of tributaries, including the Arkansas River. Water from 31 states drains into the Mississippi River and creates a drainage basin over 1,245,000 square miles (mi^2) in size. Before reaching the Gulf, the Mississippi meets up with the Atchafalaya River. This forms the MARB.

Figure 3. Mississippi/Atchafalaya River Basin.

What is Hypoxia?

Hypoxia means low oxygen and is a problem for freshwater, estuaries, and coastal waters. Hypoxic waters have dissolved oxygen concentrations of less than 2–3 milligrams per liter (mg/L). Hypoxia can be caused by a variety of factors, including excess nutrients, primarily nitrogen and phosphorus. These excess nutrients can promote algal overgrowth and lead to eutrophication. As dead algae sink to the bottom and decompose, oxygen is consumed in the process, resulting in low levels of oxygen in the water (Figure 4).

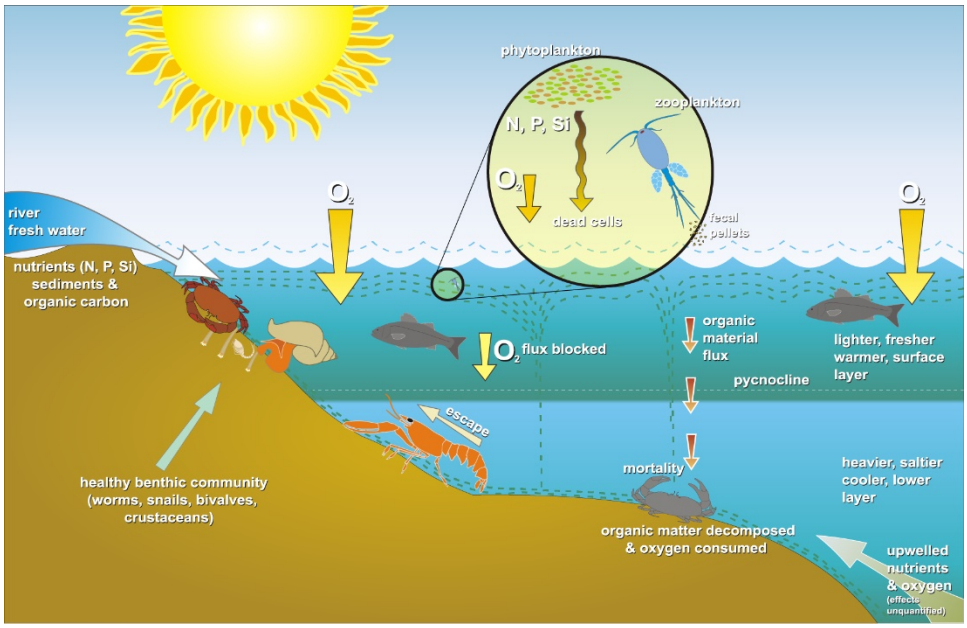


Figure 4. Hypoxia Process.

What is the Hypoxic Zone?

The Gulf of Mexico is experiencing water quality degradation in the form of hypoxia (low dissolved oxygen levels), which negatively affects aquatic communities and creates a hypoxic zone. The hypoxic zone in the Gulf of Mexico is caused by nutrient loadings from tributary streams and river basins that flow into the Mississippi River and subsequently to the Gulf of Mexico. Seasonal stratification (layering) of waters in the Gulf of Mexico prevents mixing of oxygen-rich surface water with oxygen-poor water on the bottom of the Gulf. Without mixing, oxygen in the bottom water is limited and a hypoxic condition exists. The hypoxic zone was mapped from July 25 to July 31, 2021 and estimated at 16,400 square kilometers (km^2) (6,334 mi^2) (Figure 5). The 2021 size is the 16th largest in 35 years of hypoxia data.

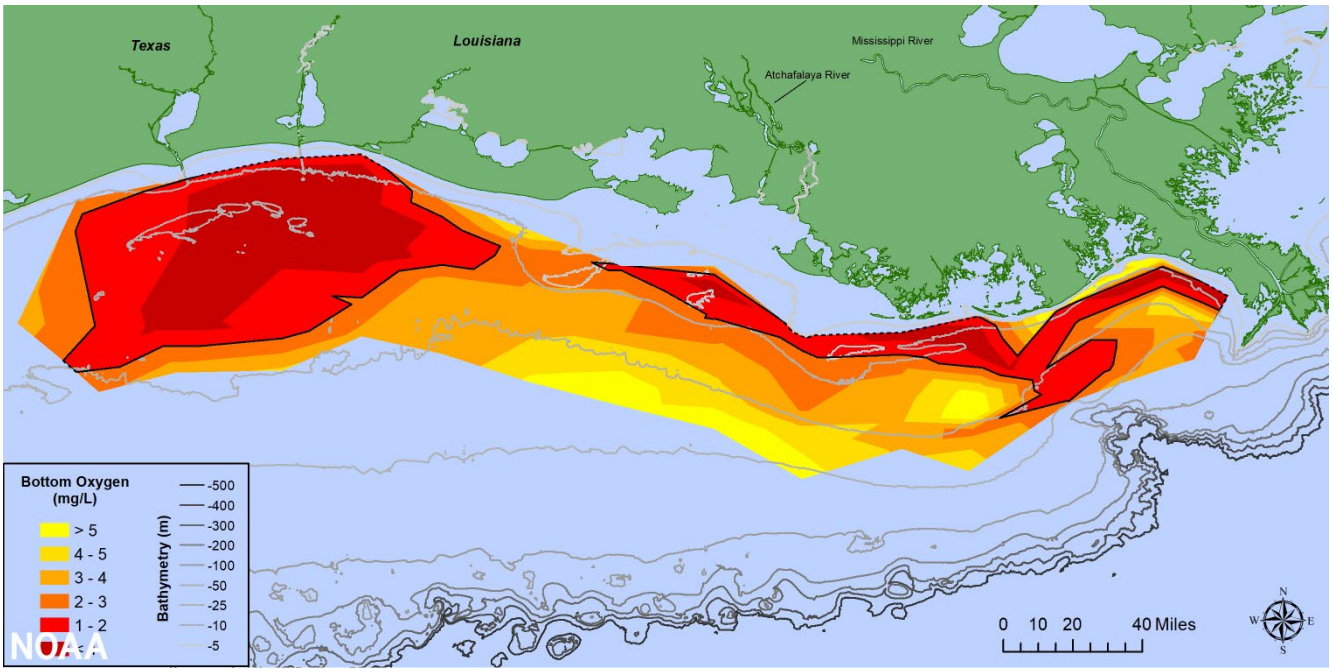


Figure 5. Hypoxic Zone: July 25 to July 31, 2021 (6,334 miles^2).

Hypoxia Task Force

What is the Hypoxia Task Force?

Established in 1997, the Hypoxia Task Force (HTF) brings together 12 upper and lower Mississippi River Basin states, tribes within the MARB, and five federal agencies to partner on local, state, and regional efforts to reduce nutrient pollution. The HTF convenes to discuss ongoing nutrient reduction activities that can potentially decrease Mississippi River nutrient concentrations and subsequent nutrient loadings to the Gulf of Mexico. It encourages a holistic approach that considers upstream sources and downstream impacts.

What is the Goal?

The HTF has set a goal of limiting the dead zone to a running 5-year average of 5,000 km^2 or 1,930 mi^2 (see Figure 5). Meeting this goal will depend on nutrient load reduction (both TN and TP) to the Gulf of Mexico from the MARB. It is estimated that reductions in TN and TP loads of 48% ± 21% are required to reach HTF goals (Fennel and Laurent 2017). The HTF has set a goal of reducing nutrients to the Gulf of Mexico by 45% of baseline levels (1980–1996) by 2035 with an interim goal of 20% by 2025. Arkansas will help the HTF meet those goals.

Section 2. Strategy Development

Gulf Hypoxia Action Plan 2008

The Gulf Hypoxia Action Plan of 2008 describes a national strategy for reducing, mitigating, and controlling hypoxia in the Gulf of Mexico and improving water quality in the MARB. It calls for states to complete and implement comprehensive nitrogen and phosphorus reduction strategies. The plan also reiterates goals first adopted by the HTF in 2001 (Figure 6).

Coastal	Within the Basin	Quality of Life
"…Strive to reduce or make significant progress toward reducing the five-year running average areal extent of the Gulf of Mexico hypoxic zone to less than 5,000 km^2 by 2035. Including an interim target of a 20% reduction of nitrogen and phosphorus by 2025."	**"To restore and protect the waters of the 31 States and Tribal lands within the MARB through implementation of nutrient and sediment reduction actions to protect the public health and aquatic life as well as reduce the negative impacts of water pollution on the Gulf of Mexico."**	**"To improve the communities and economic conditions across the MARB, in particular the agriculture, fisheries, and recreation sectors, through improved public and private land management and a cooperative, incentive-based approach."**

Figure 6. Goals of the 2008 Gulf Hypoxia Action Plan.

The 2008 plan also outlines the following overarching principles as guidance for reaching goals:

- Encourage actions that are voluntary, incentive-based, practical, and cost-effective
- Use existing programs, including existing state and federal regulatory mechanisms
- Follow adaptive management strategies
- Identify additional funding needs and sources during the annual agency budget processes
- Identify opportunities for, and potential barriers to, innovative and market-based solutions
- Provide measurable outcomes

The ANRS attempts to closely adhere to these same principles.

The 2008 plan estimates that significant reductions in nitrogen and phosphorus are needed to achieve the major goals of reducing the size of the hypoxic zone and improving water quality within the MARB.

Memo on State Nutrient Reduction Frameworks

The Recommended Elements of a State Framework for Nutrient Reduction memorandum was released to USEPA regional offices and states in 2011 by the USEPA Acting Assistant Administrator for the Office of Water, Nancy Stoner. The recommendations included:

- Prioritizing watersheds on a statewide basis for nitrate-nitrogen and TP loading reductions.
- Setting watershed load reduction goals based on the best information available.
- Ensuring the effectiveness of the National Pollutant Discharge Elimination System (NPDES) point source permits in targeted or priority watersheds.
- Addressing agricultural sources.
- Addressing stormwater and septic system sources.
- Establishing accountability and verification measures.
- Conducting annual reporting of implementation activities and biennial reporting of load reduction and environmental impacts associated with each management activity in targeted watersheds.
- Create a work plan and schedule for numeric criteria development.


Rice Fields in Arkansas

Arkansas's Role

State Nutrient Reduction Strategies are considered the cornerstone in reducing nutrient loads to the Gulf of Mexico. The State of Arkansas joined the HTF and initiated the ANRS as part of the 2014 Water Plan update. Arkansas's efforts specific to national nutrient loading and impairment of the Gulf of Mexico is participation on the Gulf of Mexico HTF, coordinated research, and implementation of nutrient reduction activities in Arkansas. There is also great local benefit by reducing nutrients to Arkansas's lakes and rivers.

The process for creating and updating the ANRS is a lengthy process (Figure 7). Some actions are continuous and ongoing like participating in the HTF and updating watershed management plans, while other actions happen less frequently like conducting a full water quality analysis every five years. The overview of the process is a two-year cycle where information is collected, analyzed, reviewed, and updated. The first year focuses on collecting and analyzing information, and the second year focuses on goals and strategies specifically looking into watersheds that have been identified as having nutrient or monitoring issues. The coordination team is engaged during this review which results with a stakeholder review and a public notice.

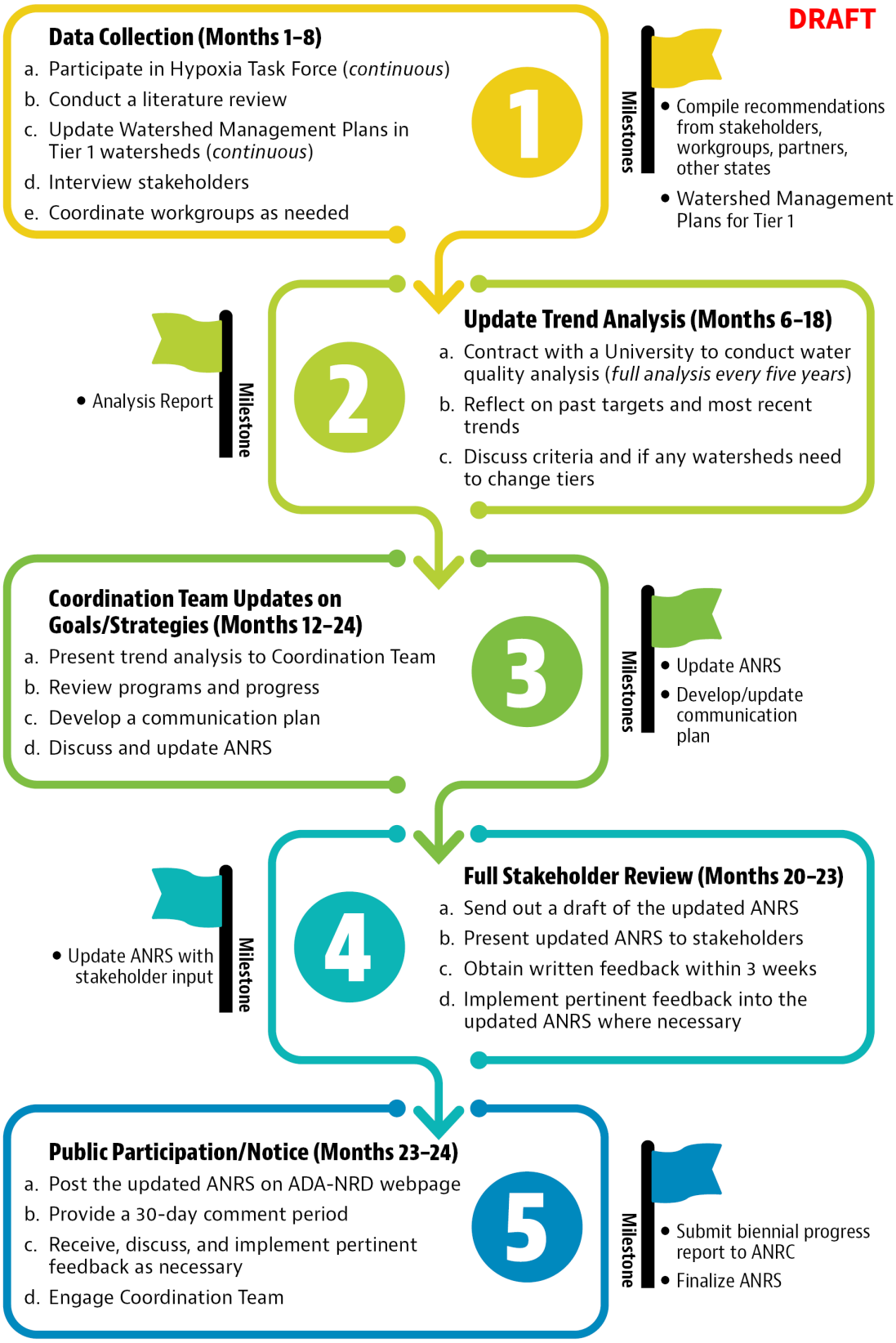


Figure 7. ANRS Development/Update Two-Year Cycle. (DRAFT)

Interagency Collaboration

Broad agency support, coordination, and collaboration is required for the successful implementation of the ANRS. Connecting multiple key partners can help foster an adaptive management approach by providing platforms for communication, relationship building, information sharing, and stakeholder engagement. The ANRS provides an opportunity to bridge multiple entities to apply a broad adaptive framework to facilitate nutrient reduction activities.

Coordination Team

A Nutrient Reduction Strategy Coordination Team is comprised of representatives from NRD, FD, DEQ, AGFC, UADA Cooperative Extension Service, and NRCS. The state agency members of the team are ultimately responsible for making final programmatic decisions for the ANRS, updating the strategy, and collecting both public and stakeholder comments.

Guiding Principles

Implementing changes in land use or increasing investment in wastewater treatment processes require clearly defined examples of effective and economically viable opportunities. Those opportunities should demonstrate measurable or assumed benefits to the individual and surrounding watershed community. The ANRS strategic framework recognizes that reaching water quality goals requires collaborative processes that when implemented over time result in incremental progress toward the desired improvement goal. Those processes must be adaptable to changing conditions and should adhere to the following set of guiding principles:

- Strengthening existing programs.
- Promoting voluntary, incentive-based, cost-effective conservation and protection measures.
- Incorporating adaptive management and flexible strategic planning.
- Leveraging available financial and technical resources.
- Pursuing market-based opportunities and solutions.

Public Participation

Implementation of the nutrient reduction practices are primarily voluntary, and thus, requires sustained public interest and support. Public and stakeholder support of these guiding principles and strategic opportunities referenced throughout the ANRS is crucial to nutrient reduction in Arkansas.

Stakeholder engagement and participatory management are key components for successful implementation of the ANRS. One of the intentions of the ANRS is to understand how the attitudes, beliefs, values, interests, and behaviors of stakeholders relate to nutrient pollution and nutrient reduction activities. It also encompasses incorporating that information into strategic decision-making. At the landscape scale,

processes to collect this type of information must be comprehensive, innovative, and flexible; enable integration of knowledge; and promote learning.

The ANRS framework promotes enhanced outreach and educational efforts to bolster engagement of local stakeholders in reduction activities, regular evaluation of reduction goals, and advancement of science-based technologies. This integrated approach represents a sustained multidiscipline, multisector effort to reduce point and nonpoint source nutrient loading and improve water quality through publicly supported strategies. This effort requires cooperation and communication on nutrient reduction between federal, state, and local agencies; stakeholders; and the public. Table 1 gives a list of identified stakeholders for the 2022 update of the ANRS.

Table 1. List of Identified Stakeholders

Agricultural Council of Arkansas	Arkansas Tech University	Peoples Company
American Biochar	Arkansas Wastewater Managers Association	Save Greers Ferry Lake
American Farmland Trust	Audubon Arkansas	Southeast Arkansas RC&D
Arkansas Association of Conservation Districts	Arkansas Water Works & Water Environment Association	Sierra Club – Arkansas Chapter
Arkansas Association of Conservation District employees	Bass Pro Shop	Southeast Aquatic Resources Partnership
Arkansas Cattlemen's Association	Bayou Meto Water Management District	Southwest Arkansas Economic Development District
Arkansas Chapter, Associated General Contractors	Beaver Water District	Southwest Arkansas RC&D Council
Arkansas Department of Health	Beaver Watershed Alliance	Southwest Arkansas Planning & Development District
Arkansas Department of Parks, Heritage, and Tourism	Central Arkansas RC&D	The KKAC Organization
Arkansas Department of Transportation	Central Arkansas Water	The Nature Conservancy
Arkansas Division of Environmental Quality	Circle K Angus Farm	The Poultry Federation
Arkansas Division of State Parks	Communities Unlimited	Trout Unlimited – Arkansas Chapter
Arkansas Environmental Federation	Conservation districts*	U.S. Army Corps of Engineers
Arkansas Farm Bureau	Delta Plastics of the South	USEPA
Arkansas Forestry Association	Ducks Unlimited	U.S. Fish and Wildlife Service
Arkansas Game and Fish Commission	East Arkansas Planning and Development District	U.S. Park Service
Arkansas Home Builders Association	Equilibrium	UADA Cooperative Extension Service
	Eureka Springs Parks and Recreation Commission	UADA Public Policy Center
	Farm Bureau Chapters	UADA Agricultural Experiment Stations
	Friends of North Fork/White River	UADA Research and Extension
	Friends of the Ouachita Trail	

Arkansas Land and Community Development Corp.	FTN Associates	UADA Water Resource Center
Arkansas League of Women Voters	Illinois River Watershed Partnership	University of Arkansas at Pine Bluff
Arkansas Municipal League	Kings River Watershed Group	University of Arkansas at Fayetteville
Arkansas Native Plant Society	L'Anguille River Watershed Coalition	University of Arkansas at Monticello
Arkansas Natural Heritage Commission	Lake Fayetteville Watershed Partnership	USA Rice
Arkansas Natural Resources Commission	Lakewood Property Owners' Association	USDA FSA
Arkansas Office of the Governor	Landcan	USDA NRCS
Arkansas Oil and Gas Commission	Little Red River Action Team	USGS
Arkansas Ozark Waterkeeper	Lower Mississippi River Conservation Committee	Watershed Conservation Resource Center
Arkansas Pork Producers Association	McGeorge Construction	West Center Arkansas Planning & Development District
Arkansas Poultry Federation	Mississippi River Network	West Central Arkansas RC&D
Arkansas Public Policy Panel	National Fish and Wildlife Foundation	West Fork – White River Watershed
Arkansas Recycling Coalition	National Weather Service	Western Arkansas Planning & Development District
Arkansas Resource Conservation and Development Council (RC&D)	Northeast Arkansas RC&D Council	Weyerhaeuser Company
Arkansas Rice Federation	Northwest Arkansas Land Trust	White Oak Bayou Wetlands Conservatory
Arkansas Rural Water Association	Northwest Arkansas RC&D Council	White River Planning & Development District
Arkansas State Plant Board	Ozark Land Trust	Witt Stephens Jr. Central
Arkansas State University	Ozark Society	
Arkansas Stream Heritage Partnership	Ozarks Water Watch	

* Arkansas County, Ashley County, Baxter County, Benton County, Boone County, Buffalo, Calhoun County, Carroll County, Chicot County, Clark County, Clay County, Cleburne County, Cleveland County, Columbia County, Conway County, Cossatot, Craighead County, Crawford County, Crittenden County, Crooked Creek, Cross County, Dallas County, Desha County, Drew County, Faulkner County, Franklin County, Fulton County, Garland County, Grant County, Greene County, Hempstead County, Hot Spring County, Independence County, Izard County, Jackson County, Jefferson County, Johnson County, Lafayette County, L'Aigle Creek, Lawrence County, Lee County, Lincoln County, Little River County, Logan County, Lonoke County, Madison County, Miller County, Mine Creek, Mississippi County, Monroe County, Montgomery County, Nevada County, Newton County, Ouachita County, Perry County, Phillips County, Pike County, Poinsett County, Pope County, Poteau River, Prairie County, Pulaski County, Randolph County, Rich Mountain, Saline County, Sebastian County, Sharp County, St. Francis County, Stone County, Union County, Van Buren County, Washington County, White County, Woodruff County, Yell County


I-40 Bridge over the Mississippi River

Section 3. Water Quality

Introduction

The ANRS aims to reduce TN and TP loading to the Gulf of Mexico by targeting watersheds with the greatest protentional for reduction. A water quality data analysis of all HUC-8 subbasin level watersheds was completed in 2021 by NRD through the Arkansas Water Resource Center (Appendix A). The goal was to prioritize watersheds based on extensive, statewide water quality monitoring data.

Sufficient data status indicated that all data availability requirements for both the magnitude assessment and trend analysis were met, including data collection at a minimum of three monitoring stations each year within a HUC-8. For the magnitude assessment, three of the last five years were required to qualify with at least three active stations, while trend analysis required a minimum of 10 qualifying years. Additionally for trend analysis, at least two-thirds of years from the first to last year of a HUC-8's data record was required to meet the three active stations requirement.

Nutrient Trends by Watershed

Nutrient concentrations have mostly declined or remained stable across Arkansas watersheds in the last three decades. Previous efforts over the last 30 years to reduce nutrient concentrations seem to be successful, but many watersheds do not have enough data due mainly to a shortage of water quality monitoring sites.

Only one HUC-8 subbasin-level watershed showed increases in TN: the Spring River watershed (HUC 11010010) in northern Arkansas (Figure 8). No changes in TN were detected for five HUC-8s. The rest of the HUC-8s analyzed were decreasing in TN. There were no HUC-8 watersheds that were increasing for TP (Figure 9). Seven HUC-8s remained the same for TP. All other qualifying HUC-8s show a decreasing TP trend.

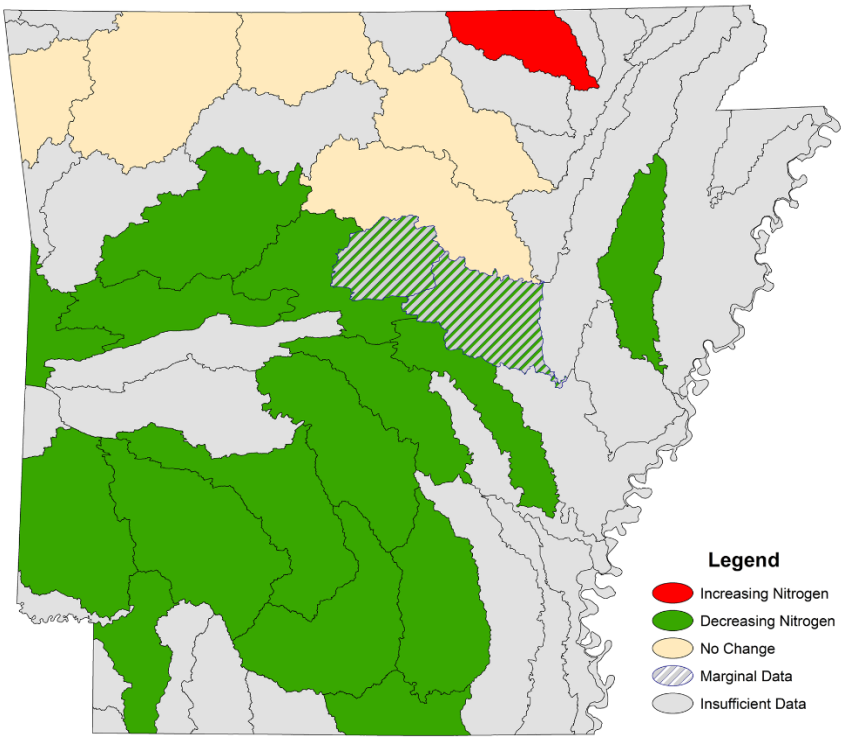


Figure 8. Trends in Watershed Total Nitrogen Concentrations, as the 75th Percentile of Annual Station Medians, 1990–2019.

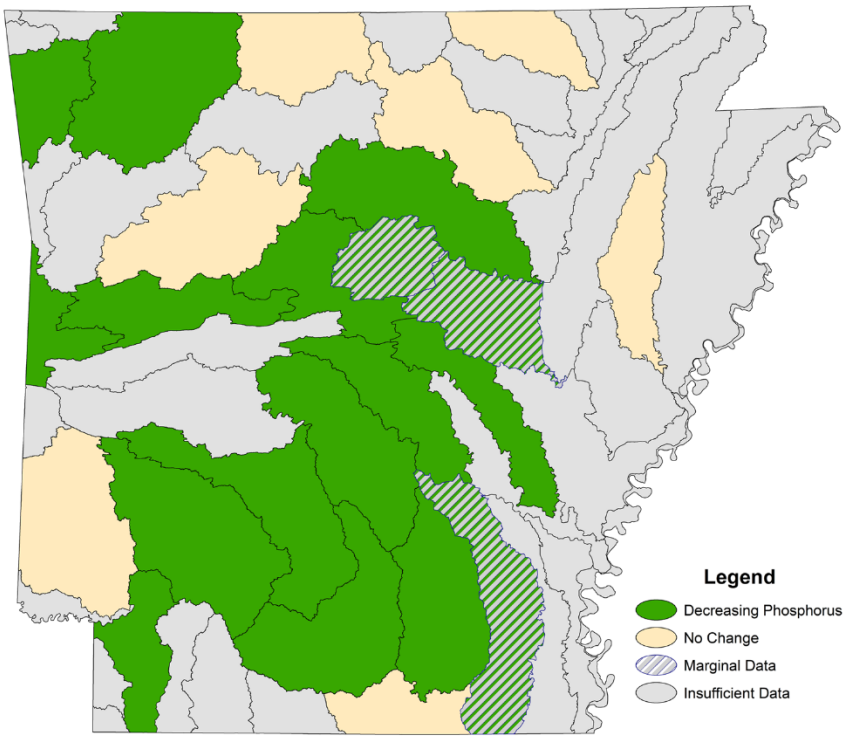


Figure 9. Trends in Watershed Total Phosphorus Concentrations, as the 75th Percentile of Annual Station Medians, 1990–2019.

HUC-8 Tiers

Arkansas's 58 watersheds were classified into four tiers (Figure 10). A four-tier framework was developed based on magnitude and trend results and data availability to assign all Arkansas's HUC-8s to following tiers:

- Tier 1 – Maximum focus for nutrient reduction activities, sufficient data
- Tier 2 – Focus for nutrient reduction activities, needs more monitoring
- Tier 3 – Less focus for nutrient reduction activities, needs more monitoring
- Tier 4 – Least focus for nutrient reduction activities, sufficient monitoring

See Appendix A for more information.

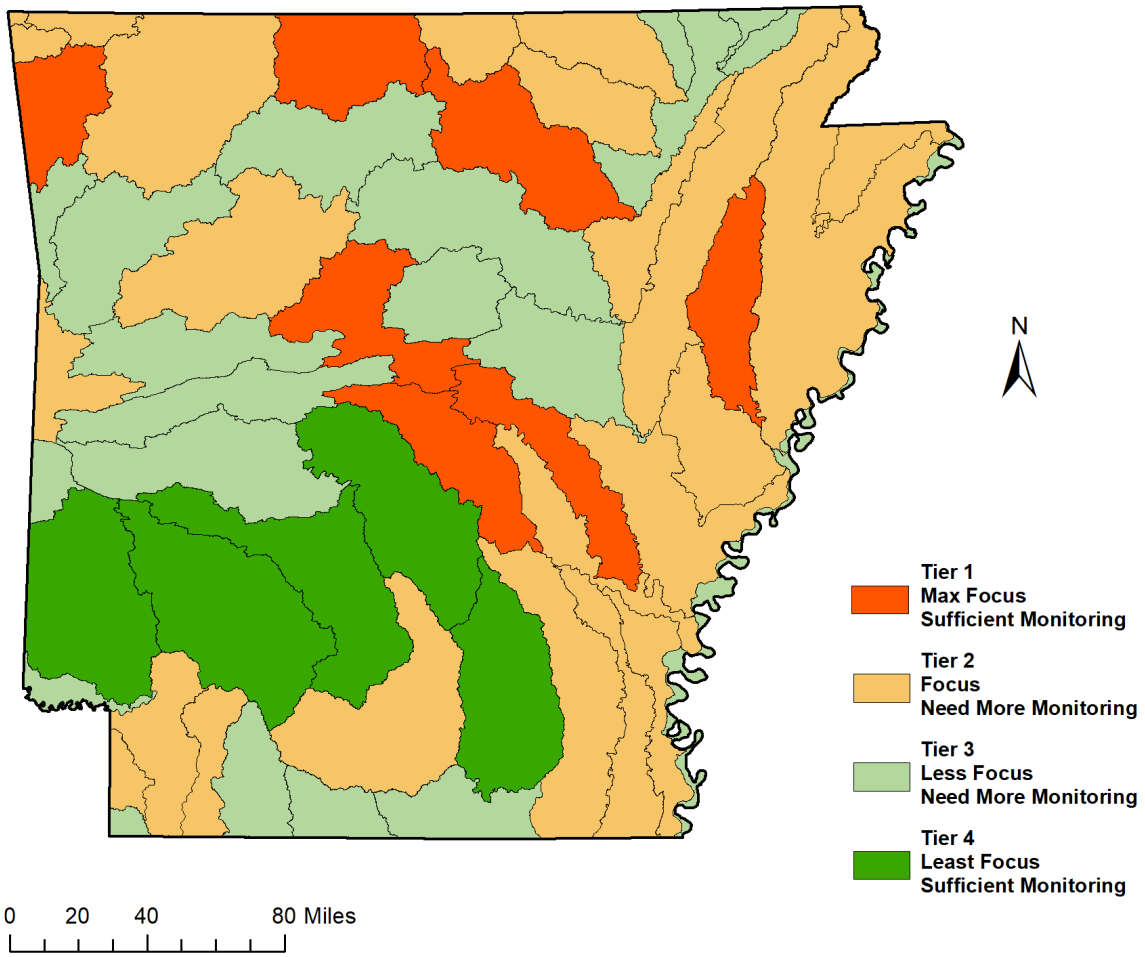


Figure 10. Four Tiers of HUC-8 Watersheds.

Tier 1 Designation

The prioritization framework identified seven Tier 1 HUC-8 watersheds for maximum focus with enough to guide a nutrient reduction strategy (Table 2; see Figure 10). Tier 1 watersheds have sufficient data and have a great potential for both TN and TP reduction. Total nutrient magnitudes (years 2015–2019) were the primary driver (see Appendix A).

Table 2. Tier 1 Watersheds

11110203 – Lake Conway-Point Remove
11110103 – Illinois
08020205 – L'Anguille
08020402 – Bayou Meto
11010004 – Middle White
1110207 – Lower Arkansas-Maumelle
11010003 – Bull Shoals Lake

Most of these watersheds had other substantiating factors for prioritization, including nutrient levels that were not changing at the HUC-8 level (11010004 – Middle White, 11010004 – Bull Shoals Lake, and 11110103 – Illinois), a majority of sites with increasing nutrients (11010004 – Bull Shoals Lake), NRCS Mississippi River Healthy Watersheds Basin Initiative (MRBI) priority watershed (08020205 – L'Anguille, 08020402 – Bayou Meto), nutrient surplus area priority watershed (11010003 – Bull Shoals Lake and 11110103 – Illinois), or prioritization under Arkansas's 2018–2023 Nonpoint Source Pollution Management Plan (08020205 – L'Anguille, 11110103 – Illinois, 11110203 – Lake Conway-Point Remove).

Tier 1 strategies will be implemented under Goal 1.

Tier 2 Designation

Twenty-three HUC-8s were assigned to Tier 2 focus status. Tier 2 focuses on future monitoring program investments due to demonstrated nutrient reduction needs, data limitations, or both. Tier 2 HUC-8s were grouped by four subcategories that summarize the level of nutrient reduction need suggested by the data analysis, data availability, and partner priority status (Table 2). Subcategories are: (2a) equivalent evidence for nutrient reduction need to Tier 1, but with insufficient data for quantitative assessment and goal setting; (2b) evidence of nutrient reduction need, but less than qualifying criteria for Tier 1, with sufficient data; (2c) evidence of nutrient reduction need, with limited data; and (2d) a partner priority (MRBI or nutrient surplus area) for nutrient reduction focus, but with insufficient data for assessment in any component of the data analysis (Table 3).

Tier 2 strategies will be implemented under Goal 2.

Table 3. Tier 2 Subcategories

Tier 2a: Max. Focus, Enhance Monitoring	Tier 2b: Focus, Continue Monitoring	Tier 2c: Focus, Enhance Monitoring	Tier 2d: Likely Focus, Design Monitoring
Lower St. Francis	Lower Ouachita-Smackover	Dardanelle Reservoir	Lake O' The Cherokees

Tier 2a: Max. Focus, Enhance Monitoring	Tier 2b: Focus, Continue Monitoring	Tier 2c: Focus, Enhance Monitoring	Tier 2d: Likely Focus, Design Monitoring
Lower Sulphur	Beaver Reservoir	Little River Ditches	Lower Neosho
Mckinney-Posten Bayous	Spring	North Fork White	Upper White-Village
Bodcau Bayou	Poteau	Cache	Big
Bayou Bartholomew		Strawberry	Lower White
Elk			Lower Arkansas
			Boeuf
			Bayou Macon

Tiers 3 and 4 Designation

Tiers 3 and 4 were designed to encompass HUC-8s with the fewest lines of evidence suggesting nutrient reduction need, acknowledging that data-limited HUC-8s merit greater prioritization in Tier 3 from the perspective of investment in future data collection efforts. All HUC-8s that did not qualify for Tier 1 or Tier 2 status were assigned to Tier 3 or Tier 4 based on data availability, with data-limited HUC-8s assigned to Tier 3 and HUC-8s with sufficient data assigned to Tier 4.

Tier 3 and Tier 4 strategies will be implemented under Goal 3.

Challenges to a Statewide Prioritization Framework

Uneven coverage in the state's ambient water quality monitoring data sets was the primary challenge to a statewide HUC-8 prioritization framework. Approximately one-third of Arkansas HUC-8s did not qualify for analysis. In many cases, data-deficient HUC-8s may not represent the appropriate scale for ANRS prioritization. Some are data-limited because only a small area is in Arkansas—most notably 11140105 – Kiamichi, of which only 0.13 mi^2 lies within Arkansas.

Section 4. Measuring Environmental Impacts

Water Quality Monitoring

Water quality monitoring provides data to support decision-making on health and environmental issues like nutrient pollution. Monitoring is used to inform us about current, ongoing, and emerging problems within Arkansas's waters. Several agencies and organizations are collecting data that can be incorporated into the strategic framework outlined here in the ANRS.

Challenges of Water Quality Monitoring

The monitoring of ecosystems poses several scientific, technical, and policy challenges. Challenges must be minimized or overcome for monitoring to be successful and to provide the information necessary to address questions the study was designed to answer.

The effectiveness of best management practices (BMPs) can vary greatly within and among watersheds, and the cumulative effects of combinations of practices can produce results that are different than the sum of their individual reductions (Sharpley et al. 2009; Francesconi et al. 2014). A report prepared by the Northeast-Midwest Institute in collaboration with the USGS (Betanzo et al. 2015) lists and discuss the following challenges:

- It takes time for management practices to be implemented at the watershed scale with a density that results in water quality change.
- Land management practices and land use are constantly changing.
- Legacy nutrients, specifically phosphorus, in soil and sediment can continue to be released after conservation practices have been implemented.
- Precipitation and streamflow vary from year-to-year, which can affect the length of time required to measure water quality change.

- The lack of long-term monitoring or the challenge of maintaining an adequate and appropriate long-term monitoring program to document results.
- Data on BMP and conservation practice implementation and maintenance are sometimes not available.

Ambient Water Quality Monitoring Network

DEQ monitors Arkansas's surface water in streams and lakes by collecting samples. Chemical, physical, and biological data obtained from the samples are used for water quality assessments, designated use attainment decisions, and special projects. DEQ currently monitors around 175 permanent, ambient monitoring stations (Figure 11). The ambient monitoring stations are sampled twice a quarter and analyzed for selected parameters. Nutrient data typically collected includes TP, orthophosphate, nitrate-nitrogen, TN, ammonia nitrogen, and total Kjeldahl nitrogen on selected waterbodies.

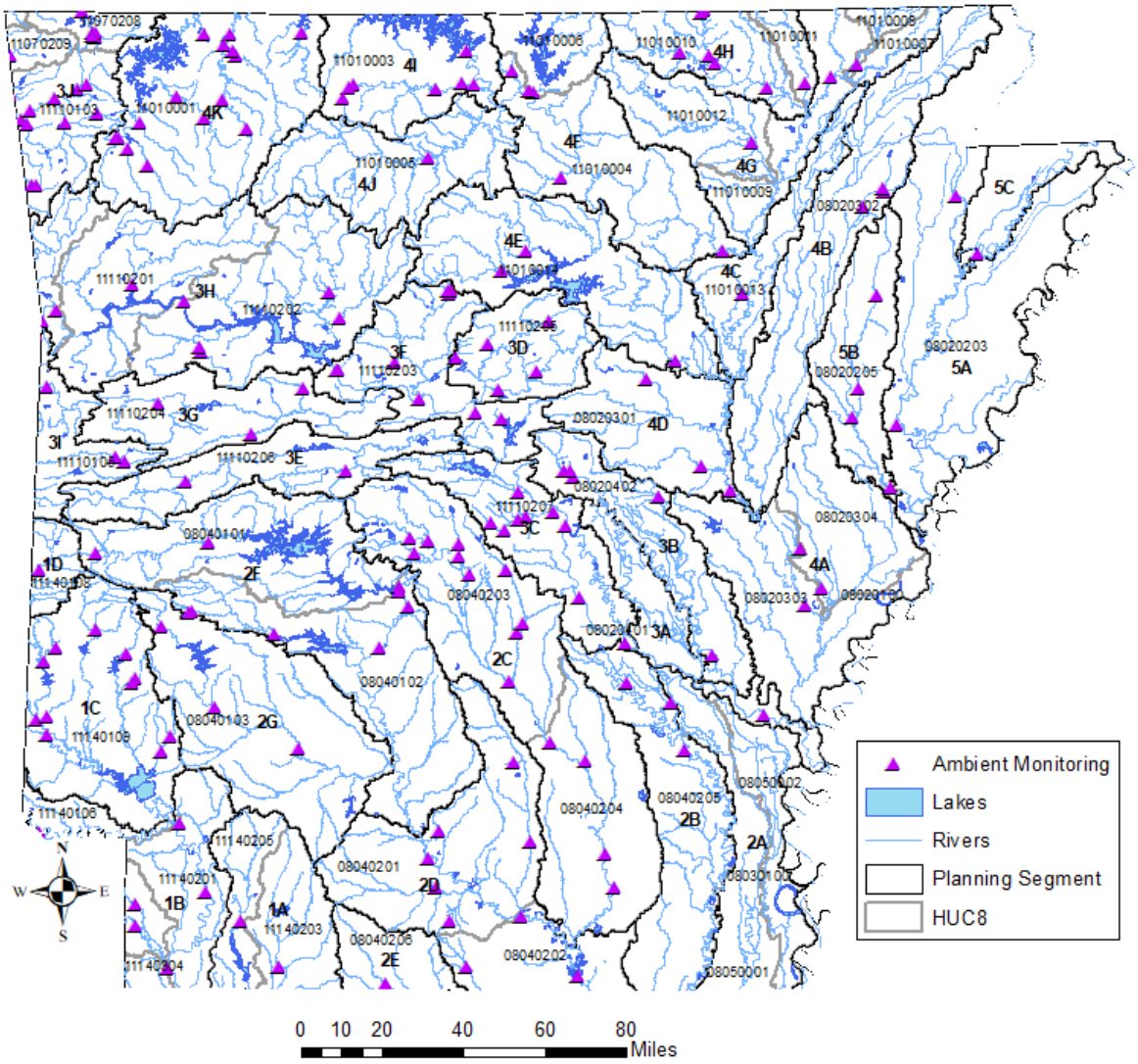


Figure 11. DEQ Water Quality Monitoring Stations.

Lake Water Quality Monitoring Program

The DEQ monitors the water quality of 23 of Arkansas's public lakes for designated use assessment and trend analysis. Lakes are sampled quarterly, and water samples are collected for ambient monitoring parameters.

Ground Water Quality Monitoring

DEQ operates the Ground Water Quality Monitoring Network, which currently uses a network of approximately 250 water supply wells and springs in 11 designated areas. Samples taken for laboratory analyses differ for each location, but nutrients include constituents like that of the ambient monitoring stations.

NRD works closely with other state and federal agencies to monitor a water well network of over 1,200 sites for water level and quantity information. Each spring, approximately 400 wells are monitored in the Alluvial aquifer and approximately 200–300 wells are monitored in the Sparta/Memphis aquifer. The number of wells monitored vary from year to year depending on the resources available, well accessibility, and other factors.

Arkansas Masterwell Program

The USGS maintains the Arkansas Masterwell Program, which supplies long-term groundwater quality monitoring.

Source Water Quality Monitoring

ADH monitors approximately 62 drinking water sources in Arkansas. Most sites are lakes, with some rivers and a few springs. Samples are taken on a quarterly basis, and laboratory analysis includes several constituents, but parameters associated with nutrients include TN and TP. The ADH also provides technical assistance to public water systems to enable their own monitoring for nutrients.

Water Quality Standards

Designated Uses

The CWA requires states to develop water quality standards to protect surface waters for aquatic life, recreation, human health, and other uses. DEQ develops proposed water quality standards for Arkansas that are published in Arkansas Pollution Control and Ecology Commission Rule 2. Water quality standards are designed to enhance the quality, value, and beneficial uses of the surface waters of Arkansas. They aid in the prevention, control, and abatement of water pollution. Water quality standards provide for the protection and propagation of fish and wildlife, while ensuring that water recreation is safe. Standards must consist of three elements: designated uses, criteria to protect those uses, and an anti-degradation policy.

Designated uses, also referred to as beneficial uses, are appropriate water uses to be achieved and protected for specific water bodies. Water quality standards are ecoregion-based. Water within each of the six ecoregions of the state has standards that were developed from data from the least-disturbed streams within each ecoregion.

List of Designated Uses

- **Extraordinary Resource Waters:** This beneficial use is a combination of the chemical, physical, and biological characteristics of a waterbody and its watershed that is characterized by scenic beauty, aesthetics, scientific values, broad scope recreation potential, and intangible social values.
- **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 semi-aquatic life forms.
- **Natural and Scenic Waterways:** This beneficial use identifies segments that have been legislatively adopted into a state or federal system.
- **Primary Contact Recreation:** This beneficial use designates waters where full body contact is involved.
- **Secondary Contact Recreation:** This beneficial use designates waters where secondary activities like boating, fishing, or wading are involved.
- **Aquatic Life:** This beneficial use designates waters which provide for the protection and propagation of fish, shellfish, and other forms of aquatic life.
- **Domestic Water Supply:** This beneficial use designates water that will be protected for use in public and private water supplies.
- **Industrial Water Supply:** This beneficial use designates water that will be protected for use as process or cooling water.
- **Agricultural Water Supply:** This beneficial use designates waters that will be protected for irrigation of crops and/or consumption by livestock.
- **Other Uses:** This category of beneficial use is generally used to designate uses that are not dependent upon water quality, such as hydroelectric power generation and navigation.

Impaired Waters

Section 303(d) of the CWA requires states to identify waters where current pollution control technologies alone cannot meet the water quality standards set for that waterbody. DEQ maintains a list of impaired waters—those water bodies that are not meeting water quality standards and/or designated uses based on DEQ assessments.

Impairment of a waterbody from excess nutrients is dependent on natural characteristics such as stream flow, residence time, stream slope, substrate type, canopy, riparian vegetation, primary use, season of the year, and ecoregion water chemistry. Because nutrient water column concentrations do not always

correlate directly with stream impairments, impairments are assessed by a combination of factors such as water clarity, periphyton or phytoplankton production, dissolved oxygen values, dissolved oxygen saturation, diurnal dissolved oxygen fluctuations, pH values, aquatic-life community structure, or other factors as identified by DEQ. Point source discharges into the watersheds containing DEQ's CWA section 303(d)-listed waters (due to phosphorus) shall be governed by the limits listed in Table 4.

For discharges from point sources that are greater than 15 million gallons per day (mgd), reduction of phosphorus below 1 mg/L may be required based on the magnitude of the phosphorus load (mass) and the type of downstream waterbodies (e.g., reservoirs, Extraordinary Resource Waters). Additionally, any discharge limits listed in Table 4 may be further reduced if it is determined that these values are causing impairments to special waters such as domestic water supplies, lakes or reservoirs, or Extraordinary Resource Waters.

Table 4. Point Source Phosphorus Discharge Limits

Facility Design Flow	Total Phosphorus Discharge Limit
Equal or greater than 15 mgd	Case by case
3 to less than 15 mgd	1.0 mg/L
1 to less than 3 mgd	2.0 mg/L
0.5 to less than 1 mgd	5.0 mg/L
Less than 0.5 mgd	Case by case

DEQ establishes minimum qualifications, standards, and procedures for issuance of permits for concentrated animal feeding operations (CAFOs) using liquid animal waste management systems within Arkansas and for the issuance of permits for land application sites within the state. An individual permitting program (site-specific permits) exists to regulate the operation of hog, poultry, or dairy farms or other confined animal operations using liquid animal waste management systems. Facility management, operation, and maintenance are managed through a waste and nutrient management plan developed in consideration of type of waste, on-site soils, and geological surveys. Both state NPDES and CAFO regulations stipulate additional nutrient management planning and certification requirements in nutrient surplus watersheds. Continual monitoring and reporting are necessary to ensure individual permit conditions are being met.

Nutrient Surplus Area

Three laws were enacted in 2003 in Arkansas that affect Arkansas's agricultural producers located within watersheds of concern. The goal of this legislation is to preserve water quality in Arkansas without creating

an unnecessary burden on agricultural interests. Arkansas's commercial poultry farmers, as well as any livestock, forage, and crop production operations utilizing poultry litter, are required to follow provisions of these laws:

- Act 1059, AN ACT TO CERTIFY SOIL NUTRIENT MANAGEMENT PLANNERS AND SOIL NUTRIENT APPLICATOR. Microsoft Word – ACT1059.doc (state.ar.us)
- Act 1060, ARKANSAS POULTRY REGISTRATION ACT. Microsoft Word – ACT1060.doc (state.ar.us)
- Act 1061, ARKANSAS SOIL NUTRIENT APPLICATION AND POULTRY LITTER UTILIZATION ACT. Microsoft Word – ACT1061.doc (state.ar.us)

Others impacted by the regulations are agricultural operators and landowners of more than 2.5 acres operating in nutrient surplus areas and any agricultural producers using state or federal funds for creating or implementing nutrient management plans, whether they are within designated nutrient surplus areas. Specifically, the new regulations require:

- Certifying all those who apply nutrients to crops or pastureland.
- Certifying nutrient management plan writers.
- Registering all poultry feeding operations.
- Developing and implementing nutrient and poultry litter management plans for those operating in nutrient surplus areas.

Designated nutrient surplus areas as identified in the enabling Arkansas legislation include the following watersheds (Arkansas Code Annotated § 15-20-1104; Figure 12):

- Illinois River
- Spavinaw Creek
- Honey Creek
- Little Sugar Creek
- Poteau River
- Mountain Fork of the Little River
- Upper Arkansas River, including Lee Creek and Massard Creek
- Upper White River, above its confluence with the Crooked Creek

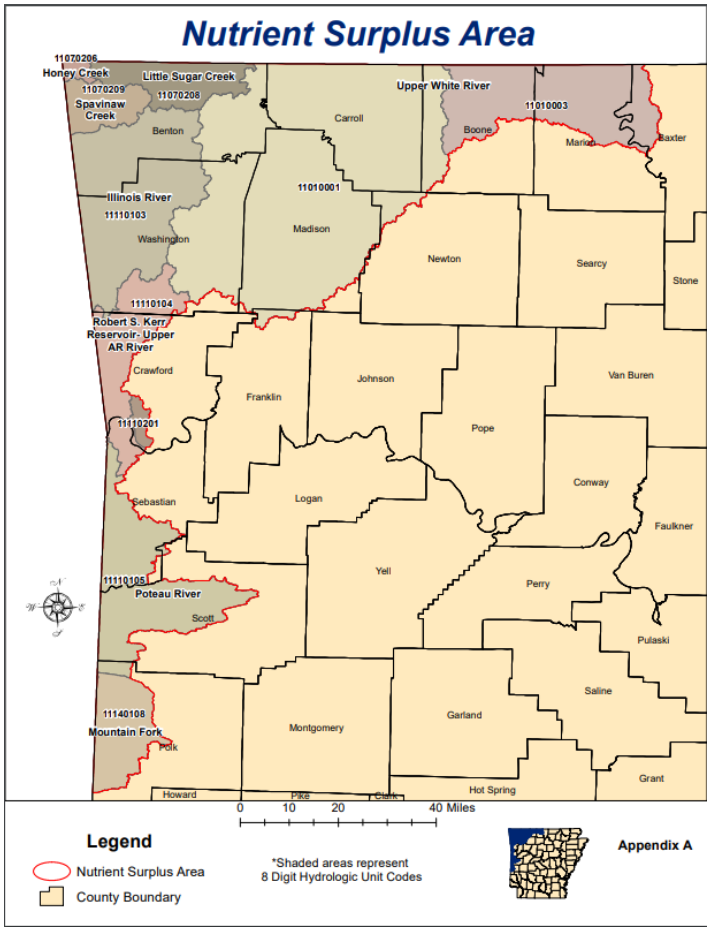


Figure 12. Nutrient Surplus Areas in Arkansas.

Waters in existing or subsequently designated nutrient surplus watersheds may be included if activities provide a significant phosphorus contribution in the nutrient surplus watersheds.

Urban stormwater runoff has been identified as a source of contamination in DEQ's most current (2018) List of Impaired Waterbodies. DEQ regulates this runoff through issuance of: (1) NPDES General Permits for construction, industrial, and municipal separate storm sewer systems (MS4); (2) Non-Stormwater NPDES General Permits for car washes, water treatment; and (3) No-Discharge Permits for land application and oil and gas activities. All permitted MS4s must develop and implement stormwater management plans that address these minimum control measures:

(1) Public education and outreach

(2) Public participation/ involvement

(3) Illicit discharge detection and elimination

(4) Construction site runoff control

(5) Post construction stormwater management and pollution prevention

(6) Pollution prevention/ good housekeeping for municipal operations

For urban areas, development and landscaping techniques that reduce or slow rates of runoff are well publicized and documented. These techniques and practices help mitigate the effects of impermeable surfaces by incorporating filtration and retention capacities within the urban setting. Urban pollution prevention programs can become more effective by incorporating initiatives that:

- Advance planning and establishment of runoff pollution prevention goals
- Increase government and community interaction
- Prioritize pollution prevention over source treatment
- Establish sustainable funding sources
- Increase public education, monitoring and reporting, and enforcement participation
- Develop strategies relevant to local issues
- Adapt policies and programs as needed to improve pollution prevention

Nutrient Trends by Source Category

In order to understand and identify the sources of nutrients that are contributing to the HABs in our local waterbodies and the Gulf of Mexico Hypoxic Zone, we used the USGS SPARROW model. The SPARROW (Spatially Referenced Regression on Watershed attributes) model is a popular watershed modeling technique that integrates water quality data with landscaped information. As seen in Figure 13 the biggest contributing source of nitrogen is atmospheric deposition followed by manure, nitrogen fixing crops, and farm fertilizer. While urban land and municipal wastewater treatment discharge are both a source of nitrogen and phosphorus, they are a much smaller contributor than other sources. The main source of phosphorus is contributed to farm fertilizer followed by manure and natural sources. Knowing the sources of nutrients will help to guide conservation practices and ultimately, help to reduce nutrients in our waters.

Placeholder for graphic

Figure 13. Nutrient Trends by Source Category.

Monitoring Nutrients

Financial support for comprehensive monitoring is sometimes inadequate and in direct competition for limited monies available for "on-the-ground" reduction practices. How much monitoring is needed should be based on watershed-specific characteristics, water quality data, observation, and professional judgment. Data policies should be adopted that allow aggregation of monitoring and program data and that can be made available for use by resource professionals without compromising the integrity of personal information.

On the agricultural landscape, implementation of individual edge-of-field or farm-scale reduction practices may not translate to immediate and measurable water quality improvements downstream. The larger the watershed, the greater the potential for localized reduction effects to become distorted (immeasurable) downstream. Potential lag times between initial implementation of reduction practices and improvement of water quality downstream, along with the environment's capacity to assimilate the nutrient load, must be understood when evaluating reduction progress. To fully evaluate and document reduction progress requires a network of monitoring locations determined by analyses of conditions in the watershed. A comprehensive monitoring network should include edge-of-field, subwatershed, watershed, and basin level sampling locations. However, financial support for such comprehensive monitoring is often inadequate and can be in competition with the limited funding available for implementation of "on-the-ground" reduction practices. The amount of monitoring effort adequate to document impacts and reduction progress will be based on watershed characteristics, water quality data, previous observation, and professional judgment from water quality and natural resource professionals.

Landscape features (e.g., land use, land cover, soils, hydrography and inundation, wetlands, geology, geomorphic setting, conservation practices) influence lag time, assimilation capacity, and overall reduction. Demonstration projects and technical studies can provide valuable insight regarding lag time and the chemical and biological processes that are influencing nutrient uptake and assimilation. Similarly, geographic information system (GIS) decision-support programs and watershed models can identify landscape influences beyond the individual farm level and can serve as powerful tools for resource managers and regulators. These tools should be fully utilized wherever possible to establish realistic and achievable reduction goals and to track the progress of implementation and nutrient-reduction efforts.

Data on local, state, and federal programs involving permitting and incentive-based, voluntary activities are not always readily available or easily transferred to a compatible format for use. In some instances, policies designed to protect private landowner information prevents the sharing of data related to the location and extent of "on-the-ground" changes resulting from regulatory and voluntary conservation programs. Lack of data on these changes can severely limit the scope of watershed planning. Data policies should be adopted that allow aggregation of program information for use by resource managers without compromising the privacy of individual personal information.

Total Maximum Daily Load

A total maximum daily load (TMDL) is a calculation developed for some waters that are not meeting or are at risk of not attaining water quality standards. The TMDL calculates the maximum amount of constituent a waterbody can receive and still meet the standards. When establishing TMDLs, the DEQ considers all point and nonpoint sources of a pollutant, existing scientific uncertainty, potential community growth, and the effects of seasonal variation.

Nutrient Criteria Development

In 2001, USEPA published recommended water quality criteria for nutrients under section 304(a) of the CWA (USEPA 2001). This document was to serve as a starting point for states, tribes, interstate commissions, and others to develop refined nutrient criteria (USEPA 2001). According to USEPA, nutrients cause adverse effects on humans and domestic animals; impairment to aesthetics; interference with human use; negatively effects on aquatic life; and impacts to downstream systems. The challenge with USEPA's 1998 National Strategy for the Development of Regional Nutrient Criteria is that the strategy is a "one number fits all" approach. The Regional Nutrient Criteria does not consider the dynamic characteristics of streams and rivers and their ability to assimilate nutrient impacts. These characteristics include, but are not limited to, flow, gradient, canopy cover, substrate type, water clarity, pH, dissolved oxygen, channel stability, temperature, season, trophic status, and other factors. In addition, large, generalized data sets, such as USEPA's Nutrient Ecoregions Approach, do not account for the natural state of streams and rivers, nor do they determine levels for predicting excessive levels of benthic algae.

In response to USEPA's guidance, DEQ has adopted the following approaches to nutrient criteria development:

- Develop nutrient criteria that fully recognize localized conditions and protect specific designated uses, using the process outlined in the USEPA technical guidance manuals.
- Use other scientifically defensible methods and appropriate water quality data to develop criteria protective of designated uses.

The Upper Saline watershed was used as a pilot study by DEQ to test methods for developing and utilizing a three-level nutrient criteria development approach for Arkansas's rivers/streams. The Level I Assessment was performed to screen sites for potential nutrient impairment. The Level II and Level III Assessments were performed at sites where potential nutrient impairment exists. It was intended that, after completion of the pilot study and verification of assessment methodology, the approach derived from the Upper Saline Watershed pilot project would transfer to other rivers/streams in Arkansas. Completion of the Upper Saline River Pilot Study brought forth intrinsic study design flaws. During the pilot study, lack of severely nutrient impacted reaches and modified calculation of 25th and 75th percentiles, macroinvertebrate assemblages exhibited little spatial or temporal differences, while fish assemblages among groups were highly variable.

The small sample size of the Upper Saline Pilot Study prevented identification of nutrient concentration thresholds among biotic assemblages using regression modeling.

Beaver Reservoir, a large drinking water source for Northwest Arkansas, was a pilot study area for the development of nutrient criteria for Arkansas's lakes/reservoirs. It was intended that, after completion of the pilot study and verification of assessment methodology, the tools and processes derived for the Beaver Reservoir pilot project would be transferable to other lakes/reservoirs in Arkansas. Completed in 2008 and based on weight-of-evidence approach, findings from the study recommend effects based numeric water criteria for Hickory Creek on Beaver Lake for growing season geometric mean chlorophyll a concentration of 8 micrograms per liter (µg/L), annual average Secchi depth of 1.1 meters (m), and nutrient targets for TP and TN of 0.04 mg/L and 0.4 mg/L, respectively.

Lake criteria have been developed for Beaver Lake only (Table 5). This criterion was adopted in February 2014 into Regulation #2 by the Arkansas Pollution Control and Ecology Commission. Data collection is ongoing for potential future use in nutrient criteria development.

Table 5. Lake Site-Specific Nutrient Standard

Lake	Chlorophyll a (µg/L) **	Secchi Transparency (m) ***
Beaver Lake *	8	1.1

** These standards are for measurement at the Hickory Creek site over the old thalweg, below the confluence of War Eagle Creek and the White River in Beaver Lake.*

*** Growing season geometric mean (May–October)*

**** Annual Average*

Currently, Arkansas maintains the following narrative nutrient standard, Reg. 2.509 in Rule # 2, Regulation Establishing Water Quality Standards for Surface Waters of the State of Arkansas:

> "Materials stimulating algal growth shall not be present in concentrations sufficient to cause objectionable algal densities or other nuisance aquatic vegetation or otherwise impair any designated use of the waterbody."

Section 5: Nutrient Reduction Practices

Point Source Management

Point source nutrient loading is small relative to statewide NPS contributions. However, during low streamflow conditions, loadings from point sources can be a significant portion of the total nutrient load. Depending on location and specific conditions, a point source may be the primary contributor to nutrient impairment on a seasonal or year-round basis. Point source nutrient loading can be reduced in influent to treatment facilities, in wastewater effluent, in stormwater discharges, or in other concentrated discharge sources.

Point source loadings and associated impairments are assessed regularly through stream and effluent water quality data. Additional watershed and hydrologic modeling, water quality and mass balance analysis, and other assessments may be necessary to understand the stream and lake environments where improvement efforts are ongoing or being considered. The assessments for point source loading should be led by state water quality regulators in cooperation with other water resource agencies involved in nutrient reduction. Where nutrient impairment is present, the necessary level of water quality monitoring should be determined on an individual watershed basis and may vary based on site-specific conditions. Monitoring may be appropriate at both the discharge point (end of pipe) and further downstream to assess overall nutrient effects on the aquatic environment from the point source(s). Locations of existing stream flow and water quality monitoring stations should be evaluated to take advantage of opportunities to add water quality sampling at stream flow stations and to leverage multiple sources of funding.

In nutrient surplus area watersheds, NPDES permitting requirements for phosphorus removal have been strengthened. DEQ bases regulations on the design flow (treatment capacity) of facilities in nutrient surplus area watersheds. NPDES phosphorus limits are referenced in Table 4 of this report. Treatment costs for phosphorus removal can be costly and prohibitive in some cases. Smaller wastewater treatment systems

that do not have adequate nutrient reduction treatment or revenue sufficient to support expensive nutrient removal processes may benefit from regionalization of treatment capacity.

The potential for multisystem collection and waste flow to regionally operated treatment facilities should be analyzed where there is little opportunity for smaller, individual treatment facilities to meet NPDES requirements and nutrient-reduction goals. New wastewater treatment facilities, whether partially or fully financed through state-funded, low-interest loan and grant programs, must be approved and receive certification of compliance with the Arkansas Water Plan. This certification process provides an opportunity to review factors that can affect nutrient reduction, environmental, and economic needs on a regional basis.

General Practices

There are many point source implementation practices that agencies can implement and coordinate to reduce nutrients in aquatic systems (Table 6). Leveraging financial support and resources from multiple programs where beneficial opportunities exist is basic to the state's multidiscipline, multiagency strategic approach to nutrient reduction.

The long-term reduction goal in priority watersheds is to remove impairment risks caused by nutrient point sources and maintain beneficial uses. Potential interim target or percent reduction goals are to be evaluated on a watershed-by-watershed basis.

DEQ encourages potential new or expanding facilities to request an evaluation of preliminary NPDES permit limits during the design of the treatment system. The preliminary limit evaluation provides an opportunity for new or expanding facilities to design nutrient reduction to consistently meet any preliminary nutrient limits. DEQ normally responds to preliminary limits requests in a response letter sent to the facility and/or consulting engineer.

Table 6. Point Source Implementation Practices

Adopt effective, innovative, and economical treatment technologies
Monitor and assess watershed impacts from point sources
Incorporate NPDES nutrient limits for major treatment facilities in priority watersheds
Increase the knowledge of available treatment processes and reduction effectiveness
Expand watershed-based monitoring networks where possible
Enhance reporting and analysis of trends in nutrient loading and reduction
Increase public participation in urban nutrient-reduction programs and practices
Improve nutrient assimilation and uptake capacities in riparian, lake, and wetland areas
Incorporate regional planning when developing new or upgraded treatment systems
Promote and increase implementation of effective urban stormwater management programs

Nonpoint Source Management

Nutrient Management

Nutrient management is the science and practice that links soil, crop, weather, and hydrologic factors with BMPs and conservation practices to achieve optimal nutrient use efficiency while protecting aquatic environments. Nonpoint sources of nutrients can originate from commercial fertilizers, animal manure and litter, urban stormwater runoff, home sewage, sediment, or other contributing sources. Managing nutrient inputs (e.g., fertilizer, manure, litter application) and potential runoff, as well as increasing the assimilation capacity of land and aquatic environments (e.g., riparian buffers, wetlands), is necessary to affect measurable reduction at the watershed-level scale.

Landscapes have undergone modifications that change the way water moves across the land. Examples of these changes include subsurface drainage; removal of wetlands, riparian corridors, and floodplains; construction of roads, buildings, and other impervious surfaces; and stream channelization, dredging, and relocation. As large flow events occur more frequently and local drought and flood cycles are intensified, it can result in increased nutrient loading, more sedimentation, increased water temperatures, lower dissolved oxygen, and degradation of aquatic ecosystems in Arkansas's water bodies. Restoring landscapes to a more natural hydrology by encouraging drainage water management is recommended.

Arkansas Phosphorus Index

The Arkansas Phosphorus Index (API) was developed as part of farm nutrient management planning process (Sharpley et al. 2010). The term phosphorus index is used to describe the level of risk for potential movement of phosphorus across the landscape. The API assesses the risk of phosphorus loss in runoff from pastures and hayland as a function of source potential (phosphorus from the soil and manure application), transport potential (risk of phosphorus movement offsite as affected by runoff and erosion, field slope, grazing intensity and proximity to streams) and any additional BMPs implemented between the application site and potential receiving waters.

For a specific set of field conditions, the index associates a phosphorus runoff risk value to a specific manure or biosolids application rate. The classification of this value into a risk range determines if the application is environmentally acceptable. If acceptable, the nutrient management plan specifies this application rate as the maximum rate for the combination of phosphorus source and field in question. During the implementation of a nutrient management plan, application rates up to the specified maximum can be applied. Lower application rates are generally assumed to have lower environmental phosphorus runoff risk and therefore also acceptable. UADA's publication, Using the 2010 Arkansas Phosphorus Index, describes the API and how to interpret the assigned risk, and it provides example calculations. The API addresses seven site characteristics that are grouped into either Source Factors or Transport Factors. The first two site characteristics are Phosphorus Source Factors: (1) soil test phosphorus and (2) soluble phosphorus application rate. The other five site characteristics are Phosphorus Transport Factors: (3) soil erosion, (4) soil

runoff class, (5) flooding frequency, (6) application method, and (7) timing of phosphorus application. In addition to management practices that influence site characteristics, there are additional BMPs that can be considered to reduce phosphorus runoff risk (Table 7). Currently, the API is also being updated to integrate the risk of phosphorus runoff from row crops.

Table 7. Approved BMPs for Use in the Arkansas Phosphorus Index

Diversion
Fencing
Field borders
Filter strip and/or fenced filter strip
Grassed waterway
Pond and/or fenced pond
Riparian forest buffer and/or fenced riparian forest buffer
Riparian herbaceous cover and/or fenced riparian herbaceous cover

NRD adopted the revised API and requires that it be used when preparing nutrient management plans in designated nutrient surplus watersheds (Figure 12). NRCS has also adopted the API as part of its nutrient management conservation practice standards (NRCS Practice Code 590).

Agricultural Practices

In Arkansas, nonpoint sources of pollution are primarily addressed through the application of BMPs and conservation practices. BMPs and conservation practices can often be specified as individual practices or as suites of practices that best address the resource of concern.

Agricultural landscapes provide the greatest opportunity for significant NPS nutrient and sediment reduction. NRCS defines several management techniques and practices. NRCS recommends a systems approach to NPS pollution management that targets core and supporting conservation practices and BMPs to address water quality concerns due to nutrient and sediment runoff. The systems approach concept is referred to as Avoiding, Controlling, and Trapping (ACT). Primarily agriculture-based, ACT provides an approach to help producers avoid pollution by reducing the amount of agricultural nutrients available in runoff or leaching into water bodies; to control pollution by preventing the loss of pollutants; and to trap pollution as a last line of defense against potential pollutants at edge-of-field or in facilities that capture and assimilate nutrients before entering water bodies.

It is known that implementing single reduction practices alone may not yield the desired reductions at the watershed or basin-level scale. Proving to be more effective are advanced farm planning and land management techniques that avoid, control, and trap nutrients by using combinations of practices to sustain long-term reduction. Whole-farm planning, which encourages farmers to identify long-term farm, environmental, and production goals, is helping to focus on longer-term planning objectives. The 4R nutrient stewardship concept advocates the use of the right fertilizer, at the right rate, at the right time, and in the right place (Figure 14). When the 4R principles are combined with BMPs on the land, maximum nutrient reduction is achieved while also meeting crop requirements.

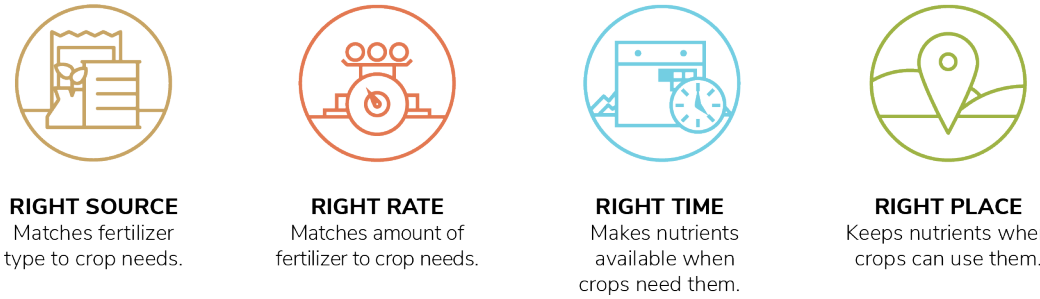


Figure 14. 4R Principles of Nutrient Stewardship. (Source: The Fertilizer Institute)

Knowledge gained from implementing these types of farm planning strategies and reduction practices should be used to guide future incentives and reduction activities while protecting the economic livelihood of local stakeholders whose voluntary actions over time are critical to successful nutrient reduction. Innovative methods and technologies that optimize nutrient reduction and water efficiencies should be promoted and incorporated wherever possible (Table 8). Refer to Appendix B for more information on conservation cropping systems.

Table 8. Nonpoint Source Implementation Practices

Promote research of innovative and effective market-based nutrient reduction practices
Demonstrate farming practices that increase reduction effectiveness and economic viability
Increase participation in nutrient reduction practices and programs
Expand the use of nutrient-inhibiting supplements
Increase adoption of improved grazing and pasture management practices
Explore the feasibility and viability of nutrient trading programs
Increase riparian buffer zones and functioning wetland areas
Enhance watershed assessment and modeling tools, web-based information, and reporting
Establish regular reporting on nutrient-reduction activities and progress
Promote public and private sector partnerships
Promote LID and other nutrient reduction strategies and programs in urban areas

Expected Nutrient Reduction Efficiencies

In late 2018 and early 2019, an expert panel consisting of 25 people with expertise in nutrient management met multiple times to identify nutrient reduction practices in Arkansas row crop and animal production systems. The panel's goal was to reach a consensus on expected reduction efficiencies for identified practices. The panel was made up of representatives from federal agencies (USEPA, USDA NRCS, USDA Agricultural Research Service); state agencies (NRD, DEQ); state universities (UADA Cooperative Extension Service; University of Arkansas, Department of Crop, Soil, and Environmental Sciences; Arkansas State University); and nongovernment natural resources organizations (Illinois River Watershed Partnership, The Nature Conservancy, Arkansas Farm Bureau). Practice suites and individual practices are listed along with their expected nutrient reduction efficiencies in Table 9 and Table 10, respectively. All nutrient reduction efficiencies represent expected annual reductions in TP or TN loads.

Table 9. Expected Nutrient Reduction Efficiencies for Practice Suites

Practice Suite	TP Reduction (%)	TN Reduction (%)
Irrigation Water Management Practices Suite	40	55
Tailwater Recovery Practices Suite	35	50
Reduced Irrigation Water Use Practices Suite	5	5
Row Crop Soil Nutrient Management Practices Suite	25	15
Conservation Tillage and Cover Crop Suite	55	50
Pasture Management Practices Suite	65	45

Table 10. Expected Nutrient Reduction Efficiencies for Individual Practices

Individual Management Practice	USDA Practice Code	TP Reduction (%)	TN Reduction (%)
No-till/conservation tillage	329/345	20	10
Cover crops	340	30	25
Nutrient management plan	104	15	10
Tailwater recovery system	447	20	25
Forested riparian buffer – cropland	391	45	30
Forested riparian buffer – pasture	391	35	35
Grassed riparian buffer – cropland	390	45	20
Grassed riparian buffer – pasture	390	35	35
Prescribed grazing	528	15	10
Stream exclusion/access control	472	15	10
Watering facility	614	15	10
Heavy use area protection	561	15	10

The expected nutrient reduction efficiencies will help inform the Arkansas Nutrient Reduction Reporting/ Tracking Framework that is being developed in 2022. The Arkansas Nutrient Reduction Reporting/ Tracking Framework will inventory the implementation of practices (and suites of practices) and measure NPS nutrient reduction in Arkansas.

Forestry Practices

Forestry BMPs

Forestry practices can help safeguard water quality during forestry operations from forestry landowners, logging contractors, and forest industry. Forestry BMPs include structural and nonstructural controls, operations, and maintenance procedures that can be applied before, during, and after silvicultural activities (AFC 2018). FD, in collaboration with the NRD, DEQ, the Sustainable Forest Initiative, and others, have developed and endorsed voluntary BMPs to effectively protect water quality. Example BMPs for forestry operations include, but are not limited to, streamside management zones, active road planning to minimize stream crossings, inactive road revegetation and/or stabilization, soil stabilization, and preparing sites with methods that minimize the disturbance of soil while meeting desired objectives.

FD conducts surveys on the voluntary implementation of BMPs for water quality protection in Arkansas. The most recent results from 2017–2018 found the BMP implementation rate on sites monitored was 93% (AFC 2018). Implementation of BMPs was highest on public and forestry land sites and lowest on private nonindustrial sites. See the State Forest Action Plan for more information.

Homeowners and Businesses

At the individual level, homeowners and businesses can use fertilizer responsibly, refrain from overwatering gardens and yards, and landscape with native plants that promote nutrient absorption. Limiting fertilizer use is key to reducing nutrient loading in runoff. When fertilizer is needed, reach for phosphorus-free lawn fertilizer by only buying fertilizer in which the center number is '0'. A free soil test is the best way to decide what the soil needs. Homeowners can reduce nutrient use both outdoors and indoors.

Outdoor Nutrient Reduction

- Test soil**.** Arkansans are able to get a free soil test. It is important to limit nutrients, especially phosphorus.

- Disconnect downspouts and install rain barrels to catch water collected from the roof to reduce runoff. This water can be used to water plants and gardens during non-rainy weather.

- Plant rain gardens**.** Rain gardens increase soil porosity and the ground's capacity to absorb rainwater. Using rain gardens has proven to reduce overall water runoff into our sewers.

- Plant native plants**.** To combat nutrient runoff, using native plants in your garden is the most effective method of reducing need for fertilizers. Native plants are naturally adapted to the native climate and, once established, can be grown without the need to fertilize or water.

- Plant trees**.** Trees are increasingly recognized for their importance in managing runoff. Their leaf canopies help reduce erosion caused by falling rain. They also provide surface area where rainwater lands and evaporates. Roots take up water and help create conditions in the soil that promote infiltration.

Indoor Nutrient Reduction

- Inside your home, be sure to double check that your liquid dish soap, laundry detergent, and dishwater detergents are all phosphate free.

- Excessive private water usage can keep sewage treatment plants from operating most efficiently. To reduce your indoor water use, consider the following to help you save money along with Earth's most precious resource: (1) purchase low-flow shower heads, (2) use shower timers, (3) turn off faucets when brushing teeth, and (4) check your indoor pipes for leaks.

Low Impact Development and Green Infrastructure

There are a variety of ways to address urban stormwater runoff at the city, local, and individual levels.

In urban and suburban parts of Arkansas, much of the land surface is covered by buildings and pavement, which does not allow rain and snowmelt to absorb into the ground. These impervious surfaces make it easier for stormwater to pick up, absorb, and carry pollutants directly to Arkansas's waterways where they can harm water quality. Pollutants in stormwater may include:

- Fertilizers, pesticides, and other chemicals from gardens, homes, and businesses
- Nutrients and bacteria from pet waste and failing septic systems
- Sediment from construction areas
- Grease, oil, and heavy metals from cars

One of these solutions is to utilize low impact development (LID). LID is a term to describe systems and practices that use natural processes that result in infiltration, evapotranspiration, or use of stormwater to protect water quality. LID tries to manage stormwater as close to the source as possible. The most common examples of LID are rain gardens, bioretention gardens, bioswales, pervious pavement, green roofs, and rain harvesting.

Green infrastructure (GI) is an approach to water management that protects, restores, or mimics the natural cycle. At both the site and regional scale, LID/GI practices aim to preserve, restore, and create green space using soils, vegetation, and rainwater harvest techniques. Although the terms LID and GI can sometimes be used interchangeably, LID is often considered to be a subset of GI.

Outreach and Education

Public education and support are vital to long-term NPS nutrient reduction. Local participation and involvement in urban pollution prevention activities such as LID (e.g., rain gardens, infiltration and open space areas, riparian buffers, residential and subdivision stormwater management, local ordinances), should be fostered through public workshops and educational training, field days, advertisements, restoration, and demonstration projects.

Local watershed groups should be supported and encouraged as they can positively influence public participation and interest in pollution prevention activities. Opportunities to involve youth in local pollution prevention projects and education programs should be promoted to local administrators and program managers as a necessary component for long-term nutrient reduction success.

Organized Arkansas Watershed Community Efforts

Community-based watershed groups come together around water issues. They may coordinate projects, educate residents, and promote stewardship of their watershed. On-the-ground projects encompass a wide variety of issues but often include a strong education and outreach component. Projects may include water quality monitoring, habitat restoration, stormwater management, and rain gardens. Example Arkansas watershed groups include:

- Beaver Watershed Alliance
- Friends of the Mulberry River Watershed
- Friends of the North Fork and White Rivers
- Illinois River Watershed Partnership
- Kings River Watershed Partnership
- Lake Fayetteville Watershed Partnership
- Little Red River Action Team
- Lower Mississippi River Conservation Committee
- Ozarks Water Watch
- Save Greers Ferry Lake
- White Oak Bayou Wetlands Conservancy

Other Nonprofit Groups

Arkansas Soil Health Alliance

The Arkansas Soil Health Alliance (ASHA) is a nonprofit 501(c)3, led by farmers to drive adoption of soil health practices through educating farmers on the benefits of soil health. The alliance is supported by NRCS, Arkansas Association of Conservation Districts, Arkansas Grazing Lands Coalition, University of Arkansas, Arkansas State University, and the Soil Health Institute.

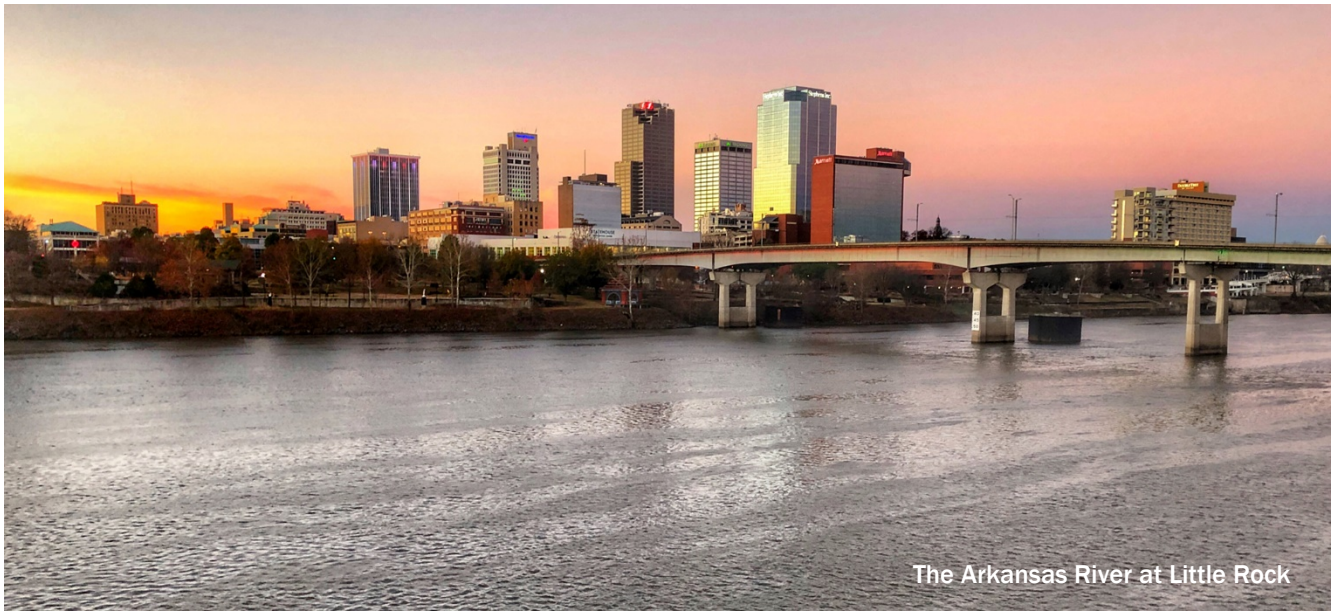
Individual Home Sewage Systems

Septic systems are intended to treat and dispose of relatively small volumes of wastewater effluent produced by homes and small businesses in areas not served by centralized sewer systems. There are a variety of individual and cluster treatment systems that process home and commercial sewage including,

but not limited to, traditional septic tanks, chamber treatment systems, drip distribution systems, and aerobic treatment systems. These systems are regulated by ADH.

Properly managed septic systems can protect human health and preserve water quality. However, old; undersized; or poorly designed, installed, operated, or maintained systems can have adverse health and environmental impacts.

Documented issues with compromised septic systems include contamination of surface waters and ground water with disease-causing pathogens (i.e., Escherichia coli) and nutrients (i.e., nitrogen and phosphorus). NRD and partner organizations are exploring a program that coordinates resources to remediate failing individual home sewage systems in prioritized watersheds.



Section 6: Programs, Projects, and Initiatives Supporting Nutrient Reduction

Point Source Pollution Management

National Pollutant Discharge Elimination System Program

Federal and state laws require permits and place limits on businesses, cities, and industries that discharge water containing pollutants that may flow to a river, stream, or lake. Limits are set at levels protective of both human health and aquatic ecosystems. Point source discharges in Arkansas are managed through NPDES permits regulated by DEQ.

The NPDES permit program helps address water pollution by regulating point sources that discharge pollutants to water bodies. In Arkansas, wastewater, construction, stormwater, and pretreatment are managed through the NPDES permit program. DEQ also operates NPDES compliance inspections. This is to verify compliance with effluent limitations and to evaluate the permittee self-monitoring program. The DEQ has authority from USEPA to issue permits that control the discharge of treated wastewater into Arkansas waterways. Active NPDES sites are shown in Figure 15.

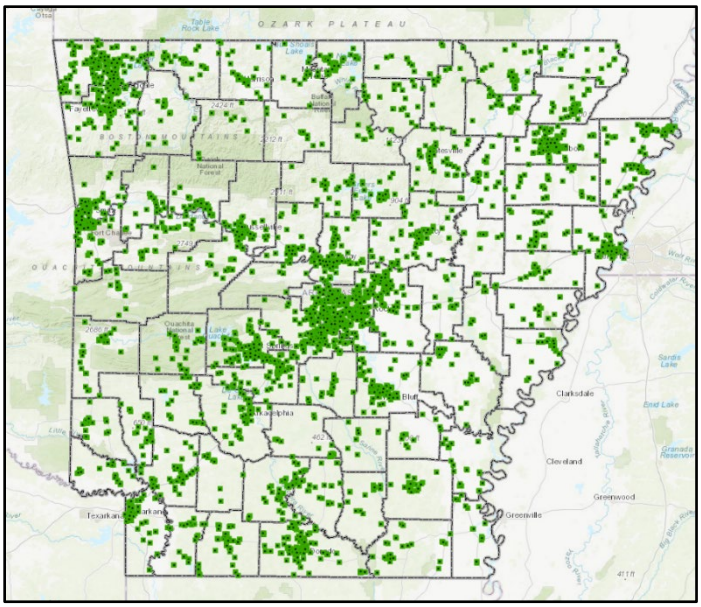


Figure 15. Active NPDES Sites.

DEQ can prepare two different types of permits within the discharge permit program: individual and general. An individual permit is prepared for a specific facility with unique permit limits and general permits are used for those facilities with similar operations. DEQ organizes its general permits as stormwater and non-stormwater. General stormwater permits may cover activities associated with construction, industry, and MS4s. General non-stormwater permits may cover operations related to sanitary landfill ponds; noncontact cooling water, cooling tower blowdown, and boiler; aggregate facilities; nonindustrial individual treatment systems; filter backwash wastewater from municipal drinking water supply plants; hydrostatic testing; car/truck wash; groundwater cleanup; and pesticide coverage.

DEQ also has a pretreatment program as a component of the NPDES program. DEQ works with closely with municipalities to protect water quality from potential pollutants discharged into publicly owned treatment works (POTWs). POTWs may be designed to treat domestic sewage, but treatment plants also have industrial customers that may be discharging harmful pollutants.

Nonpoint Source Pollution Management

NRD is responsible for developing and implementing the state's NPS Pollution Management Program. This program is a cooperative effort of many local, state, and federal agencies. Each year the NPS Management Section receives federal monies from USEPA to fund projects associated with the abatement, reduction, or control of NPS pollutants. Projects may include implementation of BMPs, demonstrations of effective techniques, technical assistance, education, and monitoring. The NPS program uses the federal CWA section 319 guidance and their NPS Program Management Plan as part of the criteria for selecting grant recipients. Recipients must provide a minimum of 43% nonfederal match (in-kind or cash). Recipients eligible for funding must be nonprofit (documented and recognized), state/local government agencies, or academic institutions.

Nutrient reduction often involves changing historic land use practices, and the value of these changes may or may not be initially understood or embraced by local communities. For this reason, benefits of nutrient reduction must be clearly defined and demonstrable. Showcasing successful projects and programs can be an effective way to promote reduction benefits and increase participation in reduction activities. Universities and research centers should not only study those factors that impact reduction and reduction effectiveness, but also the economic consequences to individuals participating in reduction activities. The economic livelihood of stakeholders must be protected because they are part of the local economy, and their voluntary actions over time are critical to successful nutrient reduction.

Because nutrients can be transported in a dissolved form, proper application combined with water management can reduce loading and increase water efficiency—outcomes that are supported by many local, state, and federal programs. Capture, storage, and reuse of surface water and retention of sediment is a priority component of comprehensive water resources planning efforts ongoing in agriculture areas of east

Arkansas. The most current and innovative technologies that optimize nutrient reduction and water efficiencies should be widely promoted and incorporated into normal agricultural practices wherever possible.

Arkansas can be described in terms of regional nutrient causes and impacts. In northwest, north, and southwest Arkansas, excess nutrients (phosphorus) from animal agriculture and increased sediment loading from urbanization are the primary sources of loading. Throughout east Arkansas, nutrient loads are the result of increased sediment and runoff from row-crop agricultural areas.

The 2018–2023 Nonpoint Source Pollution Management Plan

The Arkansas Natural Resource Commission names 11 priority watersheds in the 2018–2023 Nonpoint Source Pollution Management Plan (Figure 16). The priority watersheds were designated using a risk assessment matrix process. Most of the funding goes toward those priority watersheds.

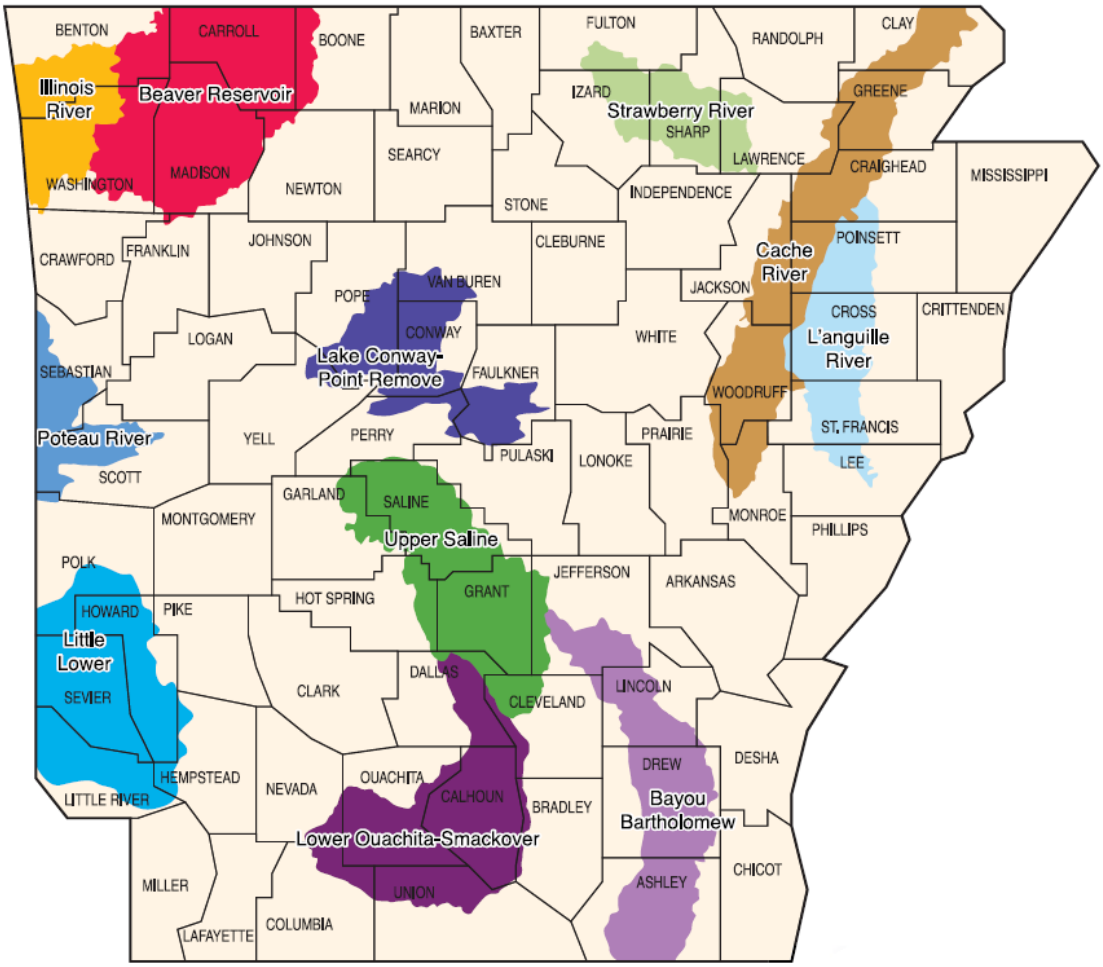


Figure 16. NPS Management Program Priority Watersheds.

Federal Management Programs, Projects, and Initiatives

USDA Farm Bill

The Farm Bill provides support, certainty, and stability to a variety of Arkansas's sectors by enhancing farm support programs and promoting and supporting voluntary conservation. The USDA offers a variety of programs to support operations. NRCS and FSA implement Farm Bill programs related to conservation and improving water, including:

- Environmental Quality Incentives Program (EQIP) – EQIP provides financial and technical assistance to agricultural producers to address natural resource concerns and deliver environmental benefits such as improved water and air quality, conserved ground and surface water, reduced soil erosion and sedimentation, and improved or created wildlife habitat.

- Conservation Stewardship Program (CSP) – CSP helps agricultural and forestry producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resources concerns. Participants earn CSP payments for conservation performance—the higher the performance, the higher the payment.

- Agricultural Conservation Easement Program (ACEP) – ACEP helps landowners, land trusts, and other entities protect, restore, and enhance wetlands, grasslands, and working farms and ranches through conservation easements.

- Regional Conservation Partnership Program (RCPP) – RCPP promotes coordination between NRCS and its partners to deliver conservation assistance to producers and landowners. NRCS aids producers through partnership agreements and RCPP conservation program contracts (Figure 17).

- Conservation Reserve Program (CRP) – CRP is a land conservation program administered by FSA. In exchange for a yearly rental payment, farmers enrolled in the program agree to remove environmentally sensitive land from agricultural production and plant species that will improve environmental health and quality.

- Agricultural Conservation Easement Program (ACEP) – ACEP provides financial and technical assistance to help conserve agricultural lands and wetlands. Under the Agricultural Land Easements component, NRCS helps Indian tribes, state and local governments, and nongovernmental organizations protect working agricultural lands and limit nonagricultural uses of the land. Under the Wetlands Reserve Easements component, NRCS helps to restore, protect, and enhance enrolled wetlands.

- Mississippi River Basin Healthy Watersheds Initiative – Launched by NRCS in 2009, the 13-state MRBI uses several Farm Bill programs, including EQIP, CSP, and ACEP. These programs help landowners sustain natural resources through voluntary conservation. MRBI funding is made available in small

priority watersheds (HUC-12s) and is delivered through multiyear implementation plans for individual projects in priority watersheds. These implementation plans are developed by NRCS and local partners. Implementation plans document annual targets for conservation treatments and must be informed by watershed assessments that identify critical source areas related to nutrient and sediment loss. Implementation plans must also contain quantifiable interim metrics for each watershed related to the primary water quality concerns that can be reported annually. The overall goals of MRBI are to improve water quality, restore wetlands, and enhance wildlife habitat while ensuring economic viability of agricultural lands. There are numerous MRBI projects ongoing in Arkansas (see Figure 18).

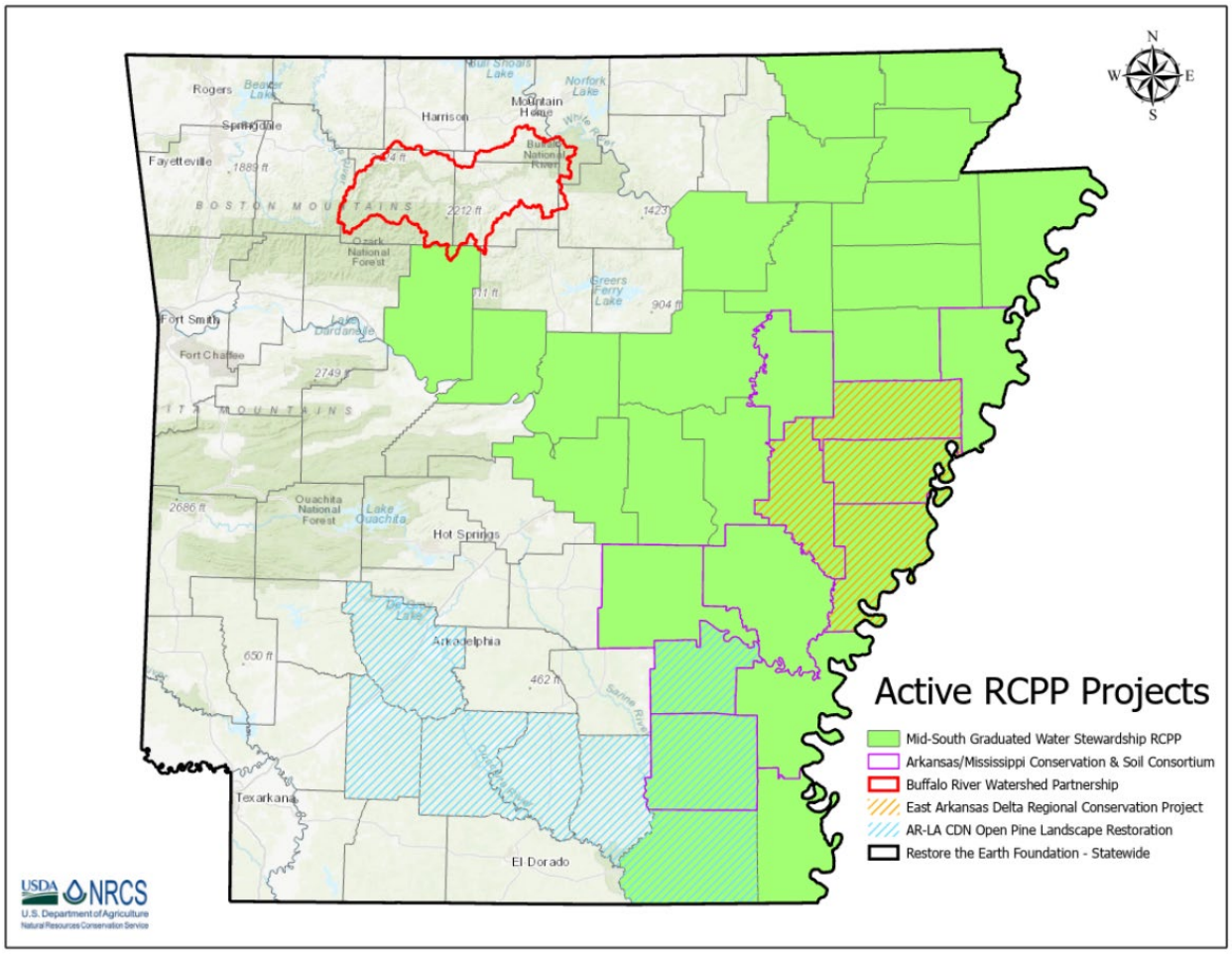


Figure 17. Regional Conservation Partnership Program Priority Areas Map.

National Water Quality Initiative

Launched in 2012, the National Water Quality Initiative (NWQI) is a partnership among NRCS, state water quality agencies, and USEPA to identify and address impaired water bodies through voluntary conservation. Arkansas has several NWQI projects (Figure 18). NRCS provides targeted funding for financial and technical assistance in small watersheds most in need and where farmers can use conservation practices to make a

difference. Conservation systems include practices that promote soil health, reduce erosion, and lessen nutrient runoff, such as filter strips, cover crops, reduced tillage, and manure management. These practices not only benefit natural resources but also enhance agricultural productivity and profitability by improving soil health and optimizing the use of agricultural inputs.

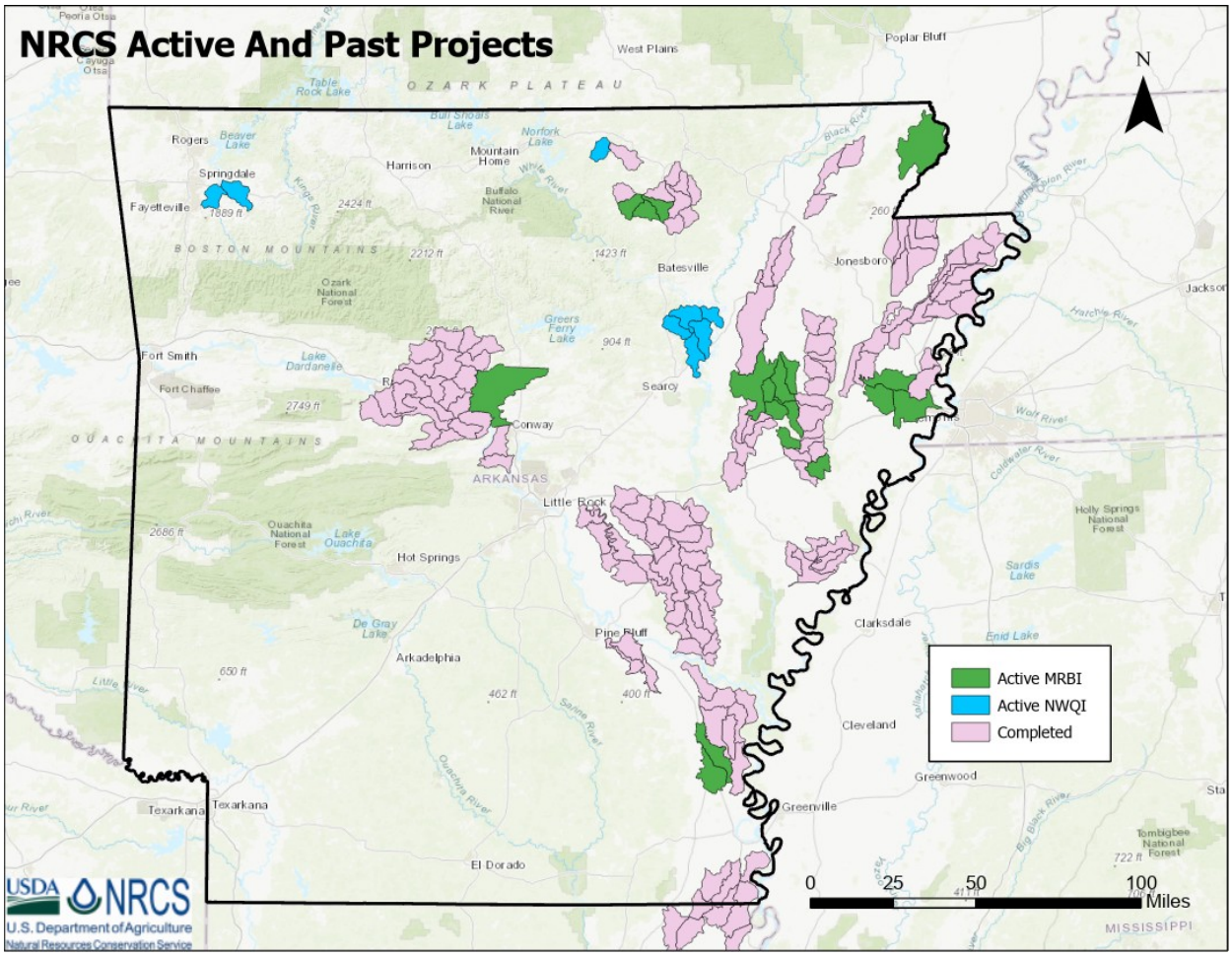


Figure 18. Natural Resource Conservation Services Initiatives.

Joint Chiefs' Landscape Restoration Partnership

The USDA Forest Service and NRCS are working together to improve the health of forests where public forests and grasslands connect to privately owned lands. Through the Joint Chiefs' Landscape Restoration Partnership, the two USDA agencies are restoring landscapes, reducing wildfire threats to communities and landowners, protecting water quality, and enhancing wildlife habitat.

Conservation Lands Program

Ducks Unlimited, acting primarily through its land-holding subsidiary, Wetlands America Trust, works with willing landowners to protect land through several means, including acquisitions, conservation easements,

and planned gifts. Conservation easements are a valuable tool in estate planning for landowners wanting to preserve the land/habitat they have spent their life managing for future generations. Ducks Unlimited also maintains a Habitat Revolving Fund accessible for target acquisitions and purchases of development rights within their Landscape Conservation Priority Areas.

Measuring Conservation Practices

Edge-of-field water quality monitoring on agricultural lands in targeted watersheds throughout Arkansas is available through MRBI and NWQI. Producers can use the data from water quality monitoring and evaluation to measure the effectiveness of conservation practices and systems such as nutrient management, cover crop, and irrigation water management. Evaluation of conservation practice effectiveness through edge-of-field monitoring will lead to a better understanding of nutrient and sediment loading and will assist NRCS and participants in adapting or validating the application of conservation measures.

State Programs

Nutrient Management Program

NRD operates the Nutrient Management Program, which includes certification programs for consultants, compliance activities, and education programs necessary to implement state nutrient law. The certification programs include the Nutrient Management Planner Certification and the Nutrient Management Applicator Certification. Planners prepare nutrient management plans to indicate how nutrients should be applied to fields and other land for crop production while protecting ground water and surface water from excessive nutrient enrichment. Applicators apply nutrients from litter or commercial fertilizer to land within nutrient surplus areas (see Figure 12).

The program also requires poultry feeding operations where 2,500 or more poultries are housed or confined on any given day to register annually with the NRD. The NRD administers the registration program for the purpose of collecting information on the number of poultry, type of poultry, and practices of poultry feeding operations in Arkansas. It is designed to preserve Arkansas's economy and water quality through registration, training, and research.

Arkansas and federal partners fund water quality technicians to help facilitate the development and the implementation of nutrient management plans within nutrient surplus watersheds. The technicians also develop voluntary nutrient management plans outside of nutrient surplus watersheds. In 2021, there were more than 1,000 nutrient management plans written or updated throughout Arkansas.

Arkansas Unpaved Roads Program

The Arkansas Unpaved Roads Grant Program was established in 2015 by Act 898 of the 90th General Assembly of Arkansas. The program will fund more than $300,000 worth of projects annually in Arkansas counties. The goals of the program are to: (1) fund safe, efficient, and environmentally sound projects for the

maintenance of dirt and gravel roads that have been identified as sources of sediment or dust, (2) provide training to road maintenance professionals on techniques of dirt and gravel road maintenance that minimizes negative impacts to water and air quality, and (3) conduct demonstrations of new and innovative techniques of dirt and gravel road construction and maintenance to assist in training of road crews and to more broadly share BMPs.

Nonpoint Source Cost Share Program

NRD administers the voluntary Nonpoint Source Cost Share Program for the State of Arkansas. NRD cooperates with conservation districts, other state agencies, academic institutions, nonprofit organizations, and local watershed groups to implement BMPs to help reduce NPS pollution. Common BMPs include:

- Brush management
- Cover crop
- Cross fencing
- Firebreak
- Forage and biomass planting
- Forest stand improvement
- Heavy use area protection
- Herbaceous weed treatment
- Irrigation and livestock pipeline
- Pond (certain sizes may require specifications)
- Prescribed burning
- Silvopasture
- Tree/shrub establishment
- Watering facility

Wetlands and Riparian Zone Tax Credit

Wetlands and riparian zones provide significant benefits to Arkansans, including flood control, water quality enhancement, fish and wildlife habitat, recreational opportunities, and groundwater recharge. Arkansas Code Annotated §26-51-1501 et seq., the "Arkansas Wetland and Riparian Zone Creation, Restoration, and Conservation Tax Credits Act," allows a state income tax credit to be taken by taxpayers who engage in the development, restoration, or conservation of wetland and riparian zones through projects approved by the Private Lands Restoration Committee. The program promotes an increase in biological and ecological integrity through voluntary restoration or conservation of Arkansas' important environmental landscapes.

Projects that restore and improve riparian zones, create wetlands, or conserve riparian habitat are generally determined to be eligible for the program by the Private Lands Restoration Committee. Project applications must be approved by the Private Lands Restoration Committee before project activities occur to qualify for the tax credit program. Some project activities that qualify for tax credits are:

- Procuring professional services for site development and project maintenance
- Preparing the site
- Establishing permanent vegetation
- Stabilizing stream banks and controlling erosion
- Constructing berms
- Installing water control structures

Specific criteria for eligibility are included in Title XIII rules governing this program.

Groundwater Protection and Management Program

The Arkansas Natural Resources Commission (ANRC) is Arkansas's water resources planning and management agency. ANRC is responsible for state level planning, management, and protection of our groundwater resources. This is accomplished through monitoring of aquifer water levels and water quality, the implementation of BMPs, conservation, enforcement of the proper construction of water wells, and education.

Water and Wastewater Funding

NRD has available funding for water and wastewater projects from both state and federally funded programs. Each of these programs has its own requirements and limitations. Our purpose here is to provide an overview of what can be done without getting into specifics of each program.

Types of projects ANRC funds:

- Public water supply, treatment, and distribution systems
- Sewer collection and treatment systems
- Solid waste collection or disposal
- Irrigation (water conservation)
- Flood control and drainage
- Erosion and sediment control
- Agricultural BMPs (NPS pollution prevention)

Eligible entities:

- Cities
- Towns
- Counties
- Rural development authorities
- Public facilities boards
- Water associations
- Improvement districts

- Regional water distribution districts
- Levee and drainage districts
- Conservation districts
- Regional solid waste authorities
- Regional wastewater treatment districts

Funds may be used for new or existing systems. Generally, funds must be used for capital improvement projects and not maintenance projects. ANRC has funded projects for $5,000–$60,000,000.

Agricultural Water Quality Loan Program

The NRD, in conjunction with conservation districts and participating banks, provides low-interest loan money to agricultural landowners for installing conservation practices that reduce NPS pollution impacts to water quality. Approved applicants are eligible to have up to $250,000 in outstanding loan balance. Eligible practices include constructing tail water recovery systems, irrigation reservoirs, stacking sheds, ponds, and livestock fencing; purchasing no-till drills; and leveling land areas.

Arkansas Water Plan

The Arkansas Water Plan is the state's policy for long-term water management. The plan includes all previous plan updates and is a dynamic framework updated to meet the state's changing needs. The Arkansas Water Plan brings data, science, and public input together to define water demands, water supplies, issues, and potential solutions to meet future needs.

Forest Legacy Program

The purpose of the Forest Legacy Program is to protect forest areas that are threatened by conversion to non-forest uses. The protection is accomplished through fee simple title or conservation easement purchases. The conservation easement allows the seller to retain the right to manage the forest and sell timber while protecting the forest from conversion to non-forest uses. The Forest Legacy Program provides federal funding for up to 75% of the cost of conservation easements or fee acquisition.

Forest Stewardship Program

The Forest Stewardship Program recognizes and rewards landowners that are managing their forestlands according to a multiple-use concept. The Forest Stewardship Program is also a means by which a landowner has access to resource professionals to assist them in obtaining a written forest management plan addressing multiple-use management.

Private Lands Program

Many federal, state, and nongovernmental programs are available for private lands. AGFC offers many programs, technical assistance, and advice on managing wildlife on private lands.

Arkansas Discovery Farm Program

There are currently 14 Discovery Farm sites around the state (Figure 19). Production systems selected for study are crop and livestock-based, representing the diversity of operations in Arkansas. Knowledge gained from the Arkansas Discovery Farm Project will help farmers, natural resource managers, and decision-makers develop more effective science-based practices to address water resources issues. The Arkansas Discovery Farm Program is supported by a host of sponsors and industry stakeholders who ensure research addresses the needs of Arkansas farmers in a proactive manner. Several Discovery Farm sites are in Tier 1 watersheds.

The objectives of the Arkansas Discovery Farm Program are to:

- Conduct on-farm research and monitoring to assess the need for and effectiveness of BMPs.
- Provide on-farm verification and documentation of conservation practices to ensure sound environmental land stewardship.
- Develop and deliver educational programs from data collected on-farm to help producers achieve both production and environmental goals, thus increasing the overall sustainability of Arkansas's farming enterprises.

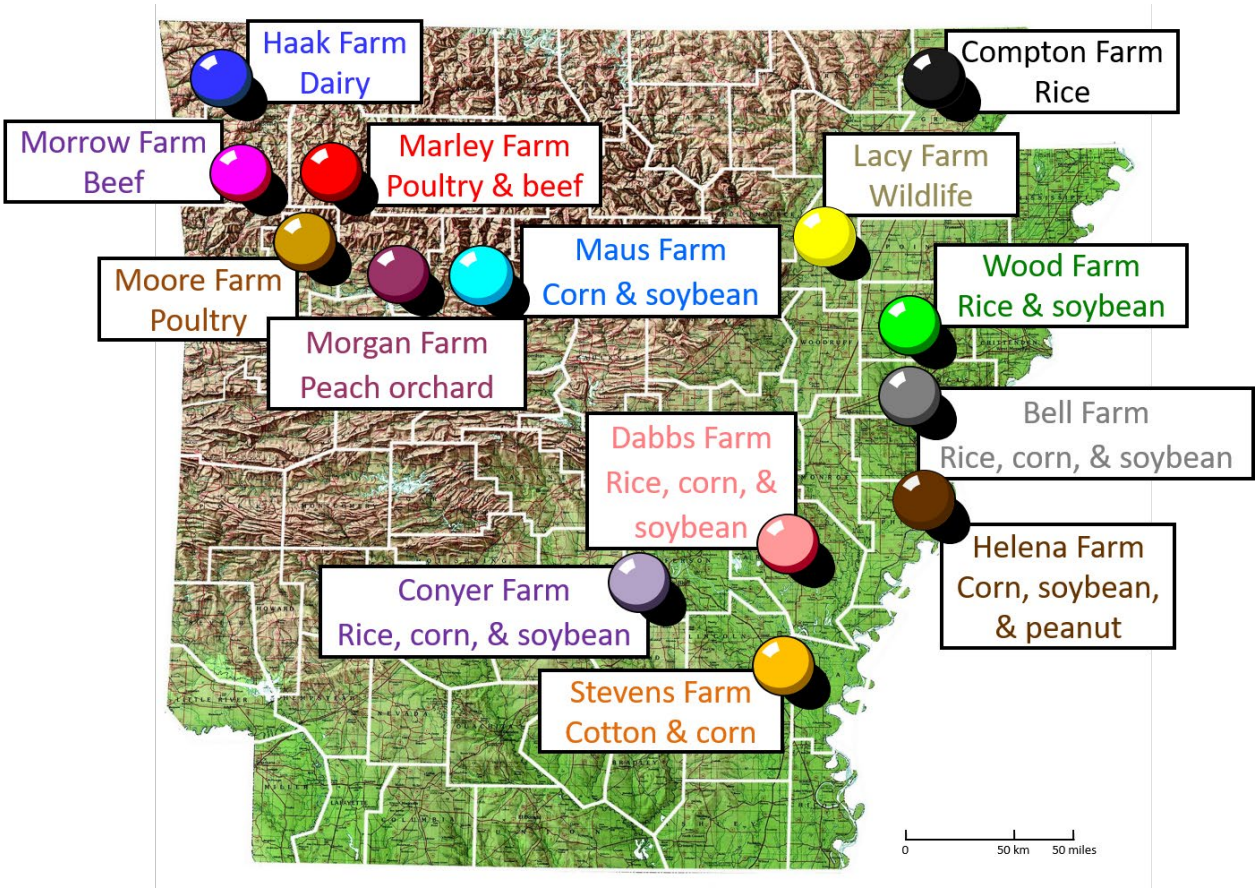


Figure 19. Discovery Farm Sites.

Pilot Project – Septic Remediation

In many rural areas throughout Arkansas, residential wastewater is treated using septic systems. Inadequate or poorly maintained septic systems are often ineffective and can leak nutrients such as nitrogen and phosphorus. Arkansas has a pilot project to help homeowners replace old, failing septic systems in two targeted watersheds: the Beaver Reservoir Watershed and the Illinois River Watershed. These watersheds in northwest Arkansas are a priority for the State of Arkansas. They are both in the nutrient surplus area and are on the priority list for the 2018–2023 Nonpoint Source Pollution Management Plan.

The septic remediation pilot project offers financial assistance in the form of a grant and/ or loan to qualifying homeowners in the two targeted watersheds. Funding is only for repair or replacement of an existing septic system as determined by the ADH. Grant assistance is based on a sliding income scale of the homeowner. Grants are usually paired with a no-interest 10-year loan. For instance, an income level less than $20,828 receives 90% grant funding and a 10% loan, and an income level of $62,486–$83,314 receives 10% grant funding and a 90% loan. A 0% interest loan for all income levels above $83,315 is also available. Financial assistance to homeowners does not exceed $30,000, with funding usually between $5,000 and $10,000 per failing septic tank.

The pilot project began in 2021. It will run for three years and will then be evaluated. Local watershed managing organizations oversee the septic remediation pilot project. The managing organization is responsible for determining eligibility, reviewing applications, and ensuring the projects are implemented correctly.


Brier Creek, Ouachita National Forest

Section 7: Strategic Framework

The Framework

The strategic framework lays out the specific actions and strategies to take to achieve the overall goals and purpose of the ANRS. The strategic framework identifies potential opportunities for nutrient reduction and water quality improvement. It is a coordinated and adaptive management strategies that leverage collaborative, integrated approaches to nutrient reduction and goal setting.

The ultimate desired goal is to remove nutrient impairment from all waterbodies. The purpose of the ANRS is to reduce nutrient concentrations in Arkansas's watersheds, providing local benefits and helping to shrink the Gulf Hypoxic Zone. This goal will be accomplished by working closely with our stakeholders to adaptively manage and implement relevant practices and programs to safeguard state and regional economic prosperity, environmental quality, and recreational opportunities for current and future generations.

The three main goals of ANRS are:

1. Increase or maintain downward nutrient trends in Tier I watersheds.
2. Enhance water quality monitoring and increase or maintain downward nutrient trends in Tier 2 watersheds.
3. Continue efforts to reduce nutrients in all watersheds.

Overview of Goals

Interim target reduction levels for Tier 1 watersheds will be identified on a watershed-specific basis but must be based on sufficient data (i.e., physical, chemical, and biological); existing policies, regulations, and public support; watershed planning; and any other factors appropriate for establishing a reduction goal. If numeric

nutrient reduction goals cannot be established at present or are undeterminable due to insufficient data, qualitative goals that describe implementation of nutrient reduction activities and water quality improvements will be used to track incremental progress resulting from reduction efforts.

Technical and nontechnical factors affecting nutrient goals are to be fully discussed and disclosed to all local stakeholders. Protecting the economic and environmental benefits for land and water users should be a priority for all entities involved in nutrient-reduction efforts and activities. Focusing on the protection of these benefits provides the opportunity to better understand conditions within individual watersheds and the stressors that are most affecting those conditions. Increased understanding of land uses and water quality relationships in the watershed will help identify solutions that more effectively reduce nutrient loading and leverage limited financial resources. Learn more about how the ANRS goals and strategic framework work together (Figure 20).

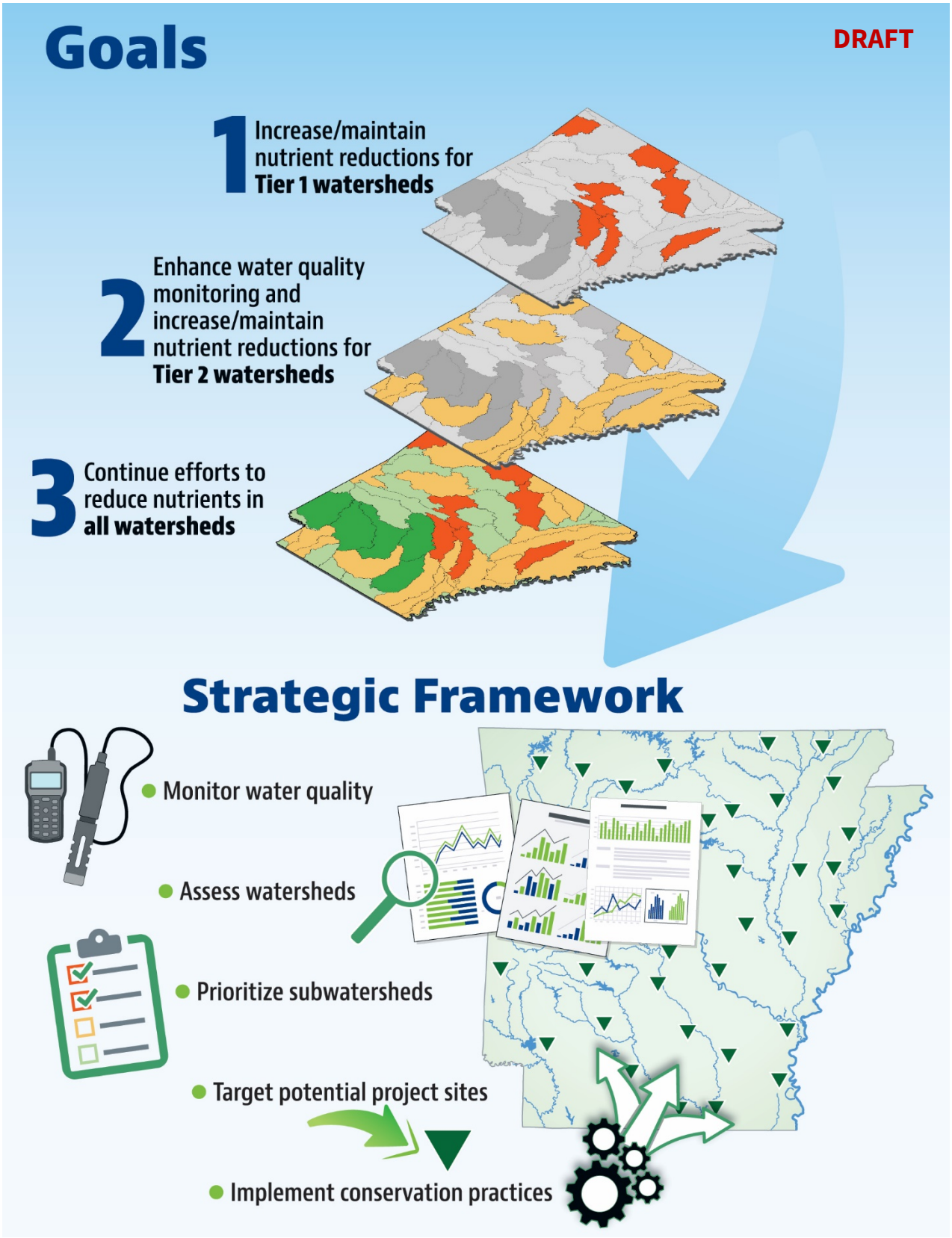


Figure 20. ANRS Goals and Strategic Framework. (DRAFT)

Goal 1: Increase or Maintain Downward Trends for Tier 1 Watersheds

Objective A. By 2029, NRD will update watershed management plans for all Tier 1 watersheds.

1. By 2023, NRD will update, review, and compare strategies for Tier 1 Watershed Management Plans for Middle White and Lake Conway-Point Remove.
2. NRD will update watershed management plans for Tier 1 watersheds by the following dates:
    a. By 2024: Illinois River watershed
    b. By 2025: L'Anguille
    c. By 2026: Bayou Meto
    d. By 2027: Bull Shoals Lake
    e. By 2028: Lower Arkansas-Maumelle
    f. By 2029: Middle White
3. Maintain current watershed management plans by updating the plans for Tier 1 watersheds every seven years.

Objective B. By 2025, NRCS will reduce nutrients by implementing conservation practices on agricultural and forest lands within Tier 1 watersheds.

1. Implement Farm Bill programs, federal water quality-based initiatives, and state-level programs within watersheds by providing conservation technical assistance to operators and landowners as well as offering the opportunity to compete for financial assistance dollars.
    a. Identify nutrient resource concerns present on individual farms when working with operators and landowners.
    b. Determine the objectives of the operators and landowners to develop the strategy for implementation to reduce nutrients at a field-scale level as well as watershed level.
    c. Develop conservation plans, nutrient management plans, irrigation water management plans, and forestry plans to help landowners meet conservation goals on their operations while reducing nutrients.
    d. Implement those plans at the field scale with landowners to reduce nutrients.
    e. Evaluate results of conservation practice implementation in reducing nutrient loads.

Objective C. By 2025, NRD will review the pilot Septic Tank Removal Program.

1. Gather information from Illinois River Watershed Partnership (IRWP) and Ozark Water Watch (OWW) about lessons learned.
2. In conjunction with IRWP and OWW, perform a strengths, weaknesses, opportunities, and threats (SWOT) analysis of Septic Tank Removal Program. Based on the outcome of the SWOT analysis, develop strategic planning implementation for future Tier 1 watersheds.
3. Present findings to the ANRC in a report on or before the ANRC's November 2024 meeting.

Objective D. By 2023, NRD will develop and implement a communication plan to engage partners and stakeholders in Tier 1 watersheds.

1. Send out Draft of the ANRS (approved by the ANRS team) to stakeholders and make changes as needed.
2. Put the finalized ANRS on the NRD website.
3. Issue a statewide news release to inform public of Tier 1 watersheds and the ANRS.
4. Inform those Tier 1 conservation districts that have most of their district in a Tier 1 watershed about the ANRS and begin working with them.
5. Develop a communication plan for each individual Tier 1 watershed during watershed management plan updates.
6. Accumulate knowledge on the communication practices that are most effective and review these with the ANRS team.

Goal 2: Enhance Water Quality Monitoring to Inform Nutrient Trends for Tier 2 Watersheds

Objective A. By 2023, NRD, DEQ, and ADH will improve communication among water quality monitoring agencies to reduce overlap and enhance spatial coverage.

1. DEQ will review Arkansas's water quality monitoring efforts during development of the state's Integrated Report to:
    a. Identify agency monitoring data objectives.
    b. Determine if improvements are needed.
    c. Implement improvements as needed.
2. By 2023, the ANRS team will prioritize water quality monitoring efforts in data-limited watersheds.
    a. Use the following Tier 2 subcategories to help prioritize areas of need:
        i. Tier 2a: insufficient data for quantitative assessment and goal setting
        ii. Tier 2b: low priority because has sufficient data
        iii. Tier 2c: limited data
        iv. Tier 2d: insufficient data for assessment in any component of the data analysis, but a partner priority (MRBI or nutrient surplus area)
    b. Evaluate strategic development of monitoring networks and new station placement on a case-by-case basis:
        i. Evaluate spatial extent of Tier 2 watersheds to determine monitoring scale.
        ii. Develop clear thresholds for data analysis needs per watershed and per Tiers 2a, 2c, and 2d.

Objective B. By 2025, NRCS and NRD will reduce nutrients by implementing conservation practices on agricultural and forest lands within Tier 2 watersheds with HTF or CWA section 319 funds.

1. Implement Farm Bill programs, federal water quality-based initiatives, and state-level programs within watersheds by providing conservation technical assistance to operators and landowners as well as offering the opportunity to compete for financial assistance dollars.
    a. Identify nutrient resource concerns present on individual farms when working with operators and landowners.
    b. Determine the objectives of the operators and landowners to develop the strategy for implementation to reduce nutrients at a field-scale level as well as watershed level.
    c. Develop conservation plans, nutrient management plans, irrigation water management plans, and forestry plans to help landowners meet conservation goals on their operations while reducing nutrients.
    d. Implement those plans at the field scale with landowners to reduce nutrients.
    e. Evaluate results of conservation practice implementation in reducing nutrient loads.

Goal 3: Continue Efforts in all Watersheds

Objective A. By 2023, NRD will develop the nutrient reduction reporting/ tracking framework to quantify reductions from adopted BMPs across the state and communicate results to public.

Objective B. By 2024, NRD will incorporate data and analysis into biennial progress reports as needed when sufficient data is obtained.

Objective C. By 2024, NRD will issue a report on the ANRS to the ANRC by or in November every other year.

1. The update will include implementation of strategic actions from the previous 24 months.
2. The update will include a summary of the outcomes of the current programs that support nutrient-reduction activities.
3. Comments and feedback will be solicited to improve implementation, strengthen collaborative partnerships, and identify additional opportunities for promoting effective nutrient-reduction activities.

Objective D. By 2028, NRD will perform a full analysis of nutrient concentrations for all Tiers.

1. Have a contractor analyze water quality data and produce a report.
2. Present data to the ANRC on or by November 2028.
3. Increase data by prioritizing monitoring site locations.

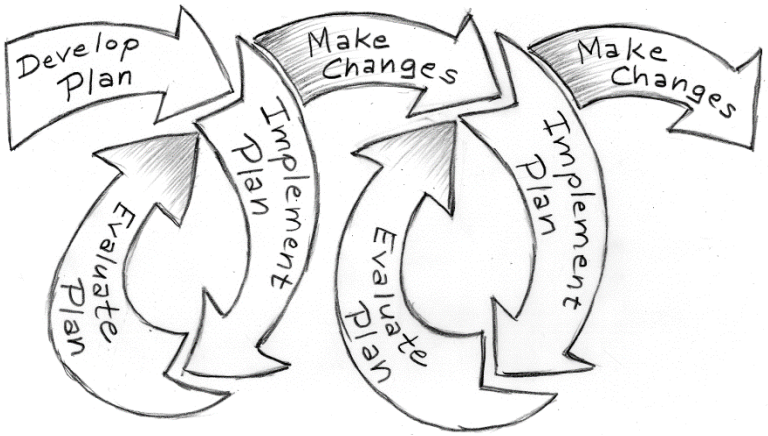
Objective E. By 2028, NRD and a team of scientists will update and analyze expected nutrient reduction efficiencies from practice suites and individual practices.


Red River near Lewisville

Section 8. Measuring Progress

Adaptive Management

The ANRS is based on scientific analysis with input from the public and governmental agencies. However, the ANRS will need to continually be improved and refined based on new information and input from stakeholders, scientists, and key partners. The ANRS will be evaluated and periodically updated every two years using a process of planning, implementing, assessing, and adapting the plan. This is referred to as accountability and explicitness. The adaptive management approach assumes that knowledge will be gained through implementation and observation of nutrient reduction strategies, projects, and programs.



These activities are evaluated on a watershed-by-watershed basis to determine what can be achieved and maintained through regulatory processes and with voluntary grassroots participation and support. Reduction goals for Tier 1 watersheds are attained through individual watershed management plans. Plans are regularly assessed to determine what is working, what improvements should be made, and what policies are supported by the public. These factors will change over time as technology and programs evolve to improve nutrient management and adapt to social, political, and economic changes in the future.

Coordinated and adaptive management strategies that leverage collaborative, integrated approaches to nutrient reduction and goal setting will help the ANRS to evolve to continually meet the nutrient reduction requirements needed in Arkansas. The ANRS is a framework that identifies potential opportunities for nutrient reduction and water quality improvement.

A key to long-term water quality improvement is commitment from both public and private sectors. This commitment can be realized through a variety of means such as:

- Mobilization and coordination of available resources.
- Consistent interpretation and implementation of water management policies.
- Long-term support at local, state, and national levels.
- Improvement in science-based assessment of nutrient reduction techniques and practices.

To maximize benefits from these commitments necessitates that limited resources be targeted for water quality improvement activities that provide the most environmental, social, and economic "bang-for-the-buck."

Nutrient Reduction Tracking

The ANRS defines success based in terms of improved environmental indicators; more specifically, by observing decreasing trends in nutrient concentrations at the HUC-8 scale. Nutrient-reduction activities and initiatives must contribute to the achievement of on-the-ground water quality objectives and need to demonstrate progress toward Arkansas's water quality goals.

Analysis may be performed every two years and incorporated into biennial progress reports. This project will provide a continued assessment of water quality trends across the State of Arkansas, as well as help the state decide which HUC-8 watersheds need targeted for nutrient-reduction efforts.

Reporting Progress

Reporting the progress of nutrient-reduction efforts is an important component of the strategic framework. Communication among entities involved in reduction activities and the public is essential to maintaining transparency of program implementation and to evaluating and reporting progress toward reaching reduction goals.

Biennial reporting that compiles the implementation of strategic actions from the previous 24 months will be developed by the date of the November board meeting of the ANRC every other year. The outcomes of the current programs that support nutrient-reduction activities will be summarized in general for the state and by Tier 1 watershed management plans. The report will be presented every other year by or in the November meeting of the ANRC, as well as posted on the ANRD website. Comments and feedback will be

solicited to improve implementation, strengthen collaborative partnerships, and identify additional opportunities for promoting effective nutrient reduction activities.

Future Efforts

Research and demonstration projects provide insight on the economics and effectiveness of nutrient reduction activities and programs. Such organizations as the UADA, the USDA Agricultural Research Service, the Arkansas Water Resources Center, the Center for Advanced Spatial Technologies, and others contribute invaluable knowledge through research and demonstration of agricultural practices, watershed modeling, economic and GIS analysis. These efforts will continue to inform nutrient-reduction work in the future. Education is provided to landowners and public officials by many levels of government. However, the local conservation districts are and should remain the primary network for coordination of outreach efforts.

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