Watershed-Based Management Plan for the

Upper Illinois River Watershed, Northwest Arkansas

Prepared for

Illinois River Watershed Partnership
and
Arkansas Natural Resources Commission

Prepared by

FTN Associates, Ltd.
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Executive Summary

The Upper Illinois River Watershed lies in Benton and Washington counties, as well as a small portion of Crawford County, in northwest Arkansas. The Illinois River originates near Hogeye, Arkansas, approximately 15 miles southwest of Fayetteville. The river flows westerly, crossing the Ozarks of northwest Arkansas and into Oklahoma, 5 miles south of Siloam Springs, Arkansas, near Watts, Oklahoma. Land use in the UIRW is diverse with about 46% pasture, 41% forest, and 13% urban. The watershed is characterized by rapidly growing urban centers from south Fayetteville to Rogers and Bentonville, Arkansas, in the headwaters, with more rural areas to the west, along the Oklahoma border. The Illinois River and its major tributaries in Arkansas (Osage Creek, Clear Creek, Baron Fork, and the Muddy Fork) exhibit a range of conditions, from areas with dense riparian forest buffers illustrating exceptional beauty and ecological value, to areas of exposed and eroding stream banks with no vegetated buffers.

The Illinois River and its tributaries have many designated uses set forth by the Arkansas Pollution Control and Ecology Commission (APCEC), including fisheries, primary and secondary contact recreation, drinking water supply, and agricultural and industrial water supply. However, portions of the Illinois River and its tributaries have been cited as not meeting these designated uses due to impairment from bacteria, sediment, and/or nutrients. The goal of this watershed-based plan is to improve water quality in the Illinois River and its tributaries so that all waters meet their designated uses both now and in the future.

The watershed-based management strategy described within this document considers watershed land use, current water quality conditions, and existing and potential pollutant sources. The management strategies for the Upper Illinois River Watershed were developed based on water quality conditions at the sub-watershed level. Based on the identified priorities, recommended best management practices specific to each priority sub-watershed should be implemented to improve water and watershed environmental quality. Since no single management option can "fix" the watershed, a suite of practices is recommended. Since watershed processes and systems are dynamic, adaptive management is the best means of achieving sustainable watershed management. Stakeholders should expect the implementation of this management plan to be a cooperative, evolving, ongoing process.

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Glossary of Terms and Acronyms

303(d)	Identification of impaired waters or waters not meeting designated uses
ADEQ	Arkansas Department of Environmental Quality
ADH	Arkansas Department of Health
AFC	Arkansas Forestry Commission
AHTD	Arkansas State Highway and Transportation Department
ALPC	Arkansas Livestock and Poultry Commission
ANRC	Arkansas Natural Resources Commission
AWRC	Arkansas Water Resources Center
BMP	best management practice
CAFO	confined animal feeding operation
CAST	Center for Advanced Spatial Technology
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
EPA	Environmental Protection Agency
ERW	Extraordinary Resource Waters
FEMA	Federal Emergency Management Agency
FSA	Farm Services Agency
GIS	geographic information systems
HUC	hydrologic unit code; code used by USGS to identify watersheds in the United States
HUC 8	hydrologic unit code, level 8; a larger watershed identified by 8 digits, e.g., the Illinois River Watershed
HUC12	hydrologic unit code, level 12; a smaller watershed identified by 12 digits, e.g., the subwatersheds of the Upper Illinois River Watershed
IRWP	Illinois River Watershed Partnership
KGA	Knowledge Gap Assessment
MGD	million gallons per day; a measure of water flow or discharge
mg/L	milligrams per liter; a measure of concentration
MS4	municipal separate storm sewer system
NACA	Northwest Arkansas Conservation Authority
NALMS	North American Lake Management Society
NASS	National Agricultural Statistics Service
NAWQA	National Water Quality Assessment Data Warehouse
NFIP	National Flood Insurance Program
NMP	Nutrient Management Plan
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service

Glossary of Terms (continued)

NSW	Natural and Scenic Waterway
NTU	Nephelometric turbidity unit; a measure of turbidity or the cloudiness of water
ROW	right-of-way
Section 319	Nonpoint Source Pollution Program (Section 319 of the Clean Water Act)
SRF	State Revolving Fund
SSURGO	Soil Survey Geographic Database
STEP	septic tank effluent pump
SWAT	Soil and Water Assessment Tool
TN	total nitrogen; the amount of dissolved inorganic and organic nitrogen and particulate organic and inorganic nitrogen in water
TNC	The Nature Conservancy
TP	total phosphorus; the amount of dissolved and particulate phosphorus in water
UA	University of Arkansas
USDA	United States Department of Agriculture
USFS	United States Forest Service
USGS	United States Geological Survey
UIRW	Upper Illinois River Watershed
WWTP	wastewater treatment plant

Plan Guidance 1

1.1 A Vision for the Upper Illinois River Watershed

The Upper Illinois River Watershed (UIRW) is a special place where the threads of private, public and non-profit partnerships are woven into the regional fabric of economic vitality, environmental stability, and social responsibility. Through its cultural heritage, the legacy of land stewardship, integrated with respect for personal property rights, continues. Natural resources are restored and sustained within a healthy mosaic of fields, forests, farms, woodlands, wetland prairies, pastures, cities, and naturally flowing streams. It is an incubator for green energy, entrepreneurial, educational, and environmental initiatives.

The vision for the UIRW was developed by the Illinois River Watershed partnership (IRWP) Board of Directors at a retreat in 2009. The make-up of the IRWP Board of Directors is a microcosm of the UIRW community, with representatives from business, agriculture, government, academics, conservation, construction, and technical research and education.

1.2 Watershed Based Plan Funding Sources and Management

The IRWP was awarded a grant to oversee the development of a watershed-based plan for the UIRW (i.e., the Arkansas portion of the UIRW). This grant was funded in part by US Environmental Protection Agency (EPA) Section 319 funds through the Arkansas Natural Resources Commission (ANRC) Section 319 program. The Walton Family Foundation provided an equal match of funds.

The mission of the IRWP is to improve the integrity of the Illinois River through public education and community outreach, water quality monitoring, and the implementation of conservation and restoration practices throughout the Illinois River Watershed.

The IRWP is a not-for-profit, membership-based organization working to protect and restore the Illinois River and its tributaries throughout Arkansas and Oklahoma. Current information about this group and its members is available at www.irwp.org.

1.3 Development Team

The IRWP hired several technical experts to develop a watershed-based plan for the Arkansas portion of the UIRW. This watershed-based plan, prepared by FTN Associates, Ltd., incorporates work by Tetra Tech, of Pasadena, California; the University of Arkansas (UA) Division of Agriculture Arkansas Water Resources Center (AWRC); Foth Infrastructure & Environment, LLC; and the UA Division of Agriculture Cooperative Extension Service (UAEX).

1.4 Nine Elements of the Watershed-Based Management Plan

The objective of this watershed-based management plan is to restore the impaired 303(d)-listed streams and for streams in the UIRW to attain water quality standards. While phosphorus has received considerable attention in this watershed, phosphorus is not addressed in this plan for two reasons. First, numeric water-quality criteria for phosphorus have not been implemented in the UIRW. Second, EPA is currently preparing a total maximum daily load (TMDL) for phosphorus in the Illinois River Watershed that will establish phosphorus loads for different stream segments in the watershed.

Watershed-based management plans developed using Clean Water Act Section 319 funding must address nine planning elements required by EPA to manage and protect against nonpoint source pollution. Table 1.1 provides a roadmap for where the required planning elements are addressed in this plan.

1.5 Implementation Process

This watershed-based management plan recommends voluntary, non-regulatory practices that can be implemented to protect and improve the quality of the water and the landscape throughout the UIRW. The IRWP has established partnerships with organizations that have authority and resources for managing the condition of the watershed. The IRWP mission embodies watershed-based management through a stakeholder-driven, participatory process. The IRWP has been an active force for improving water quality and quality of life throughout the Illinois River Watershed since 2005. Therefore, the IRWP is suited to oversee the administration and implementation of the actions recommended in this plan and will continue to invite and encourage public participation in restoration and service activities. Multiple organizations, including the IRWP, the UA Division of Agriculture, the Nature Conservancy (TNC), Audubon Arkansas, Watershed Conservation Resource Center, Northwest Arkansas Conservation Authority (NACA), and municipalities, are suited to seek funding to implement parts of this watershed-based plan. In addition, the IRWP has worked extensively with Oklahoma organizations to implement a holistic management approach for the Illinois River basin.

Table 1.1. The required nine planning elements to manage and protect against nonpoint source pollution, and the location of the elements within this plan.

Required Watershed Plan Elements	Location in this Plan
1. The identification of causes, sources of pollution, and extent of water quality impairment	Chapter 4
2. Expected load reductions once management actions are implemented	Chapter 6
3. A description of nonpoint source pollution management actions that stakeholders can participate in and help to implement, especially in critical areas	Chapter 5
4. An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon	Chapter 8
5. Education and outreach strategies to encourage stakeholders to learn more about selecting, designing and implementing management actions	Chapter 7
6. A schedule for implementing identified management measures	Chapter 10
7. A description of measureable milestones along the way to a fully implemented vision	Chapter 10
8. A set of criteria that can be used to determine if water quality is improving towards attaining water quality standards	Chapter 9
9. A monitoring component to determine if implemented management actions are really improving water quality	Chapter 11

1.6 Adaptive Watershed Management

This Watershed-Based Plan for the UIRW was developed to include the adaptive management concept. Adaptive management is an iterative process of optimal decision-making through evaluating results and adjusting actions based on what has been learned. Watershed processes and systems are dynamic; therefore, adaptive management is the best means of achieving sustainable watershed management.

Utilizing an adaptive management approach means that periodic assessments must be made to evaluate water quality in the UIRW. Watershed conditions will be re-evaluated during the state biennial water quality review. The success of the plan will be evaluated, and the plan adapted, as needed, in 2017. The IRWP will take the lead to make sure a current, relevant plan is available for the watershed at all times.

Watershed Description 2

A Summary of the Upper Illinois River Watershed

Area:	758 square miles (484,947 acres)
Location:	Benton County (40%), Washington County (60%), and Crawford County (<0.5%) in northwest Arkansas
Population:	Approximately 210,700[1]
Land Use:	46% Pasture, 41% Forest, 13% Urban, and <1% Water
Agriculture:	♦ Arkansas is the second-largest producer of broiler chickens in the United States; Benton and Washington counties are the largest producers in the state. ♦ The main type of agricultural lands are pastures and forage fields; there are minimal row crops in the watershed.
Industry:	♦ Northwest Arkansas is home to the Walmart corporate headquarters, currently the second largest public corporation in the world, and Tyson Foods, the largest meat producer in the world. ♦ UIRW is home to 25 federally regulated food processing facilities (identified in EPA data systems). ♦ The most common industries include poultry processing, and prepared feeds and feed ingredients for animals and poultry.
Municipalities:	♦ Northwest Arkansas is one of the fastest growing metropolitan areas in the state the United States. ♦ The Fayetteville-Springdale-Rogers Metropolitan Statistical Area (MSA) grew over 13 times faster than the state of Arkansas from 1990 to 2000. ♦ There are multiple federally regulated municipal wastewater treatment facilities in the UIRW, with five designated as "major" facilities under the National Pollutant Discharge Elimination System (NPDES) program.

[1] 2010. census.gov/2010census/popmap/:pmtext.php?fl=05

2.1 Geography

Figure 2.1. Location of the Illinois River Watershed in northwest Arkansas and northeast Oklahoma.

The Illinois River headwaters originate near Hogeye, Arkansas, approximately 15 miles southwest of Fayetteville. The river flows westerly, crossing the Ozarks of northwest Arkansas and into Oklahoma approximately 5 miles south of Siloam Springs, Arkansas, near Watts, Oklahoma. The river continues southwesterly in Oklahoma to Lake Tenkiller and eventually flows into the Arkansas River near Gore, Oklahoma. The Illinois River is about 145 miles long and drains approximately 1,645 square miles in Arkansas and Oklahoma (Figure 2.1).

The UIRW, which is the focus for this plan, lies in Benton, Washington, and Crawford counties in northwest Arkansas and totals about 758 square miles, or 484,947 acres. The UIRW is contained within the Ozark Plateaus Province and lies mostly in the Springfield Plateau physiographic region, with a small part of the southeast corner in the Boston Mountains physiographic region (Figure 2.2). The Springfield Plateau is gently rolling for the most part, with land surface relief rarely exceeding 200 to 300 feet. The Boston Mountains area is more rugged, with greater topographic relief and steep-sided valleys.

2.2 Geology

The Springfield Plateau is underlain by karst limestone and cherty limestone of the Mississippian age, while the Boston Mountains are underlain by sandstone, shale, and limestone of the Pennsylvanian age (Adamski et al. 1995, Freiwald 1987). Both the Springfield Plateau and the Boston Mountains are underlain by the Boone Formation, which is characterized as an immature karst system (Brahana 2005). Karst topography is the landscape created when groundwater dissolves limestone, creating pathways for water to quickly move through the soil surface. Karst systems are marked by the presence of karst elements, such as sinkholes, springs, caves, and disappearing streams. An immature karst system, such as that underlying the UIRW, characteristically has very few, and underdeveloped, examples of karst elements (Brahana 2005). The karst elements present in the UIRW create a scenic landscape that has hidden vulnerabilities to the transport of pollutants (such as nitrates, fertilizers, manures, etc.) through groundwater. There are several caves in the UIRW, including the US Fish and Wildlife Service (USFWS) Logan Cave Natural Wildlife Refuge.

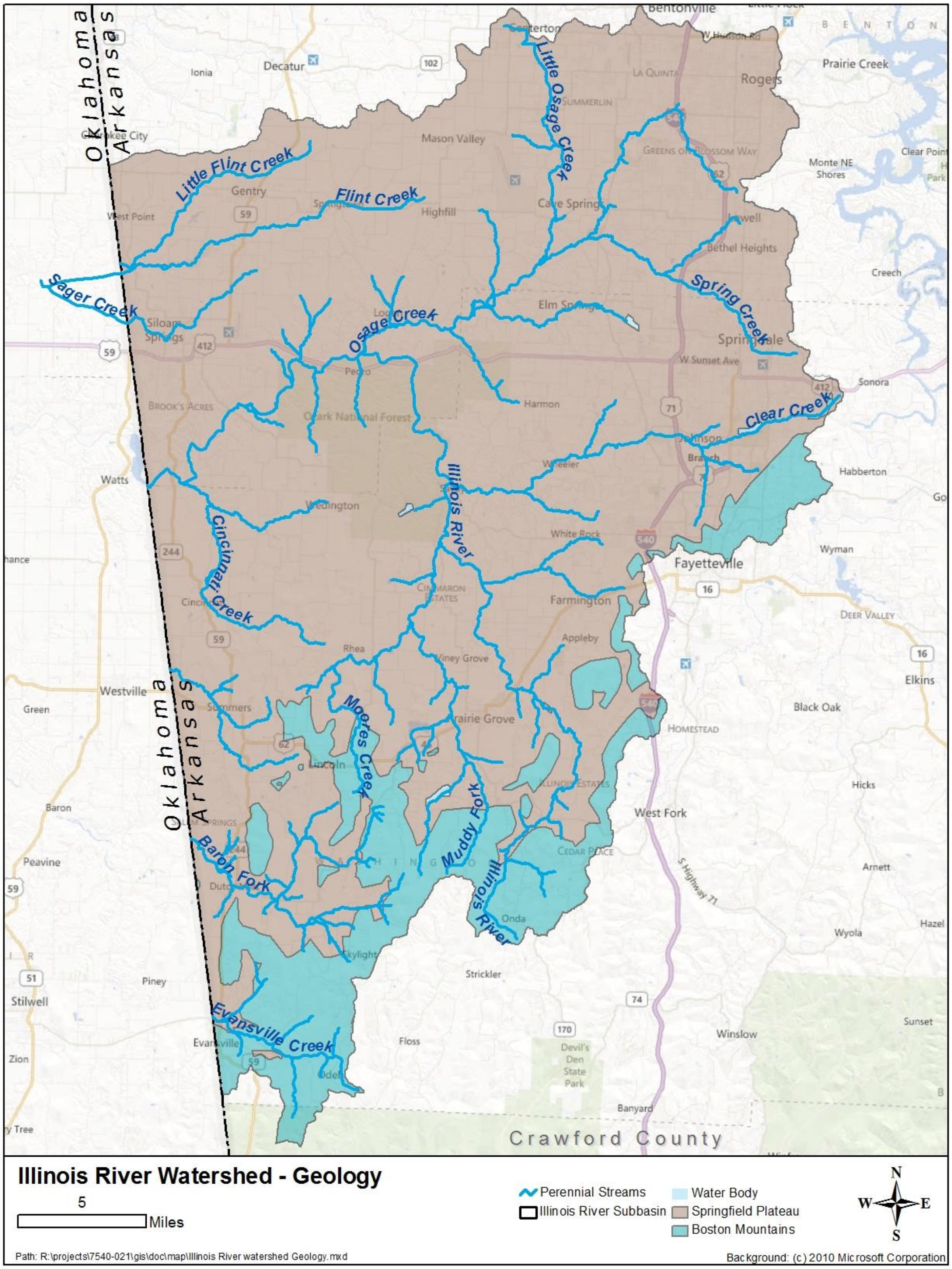


Figure 2.2. Physiographic regions of the UIRW.

2.3 Climate

The regional climate is humid temperate, showing distinct patterns in temperature and precipitation (Figure 2.3). Temperatures range from an average low of 24 °F during January to an average high of 89 °F during July and August. Average annual precipitation in the watershed is about 43 inches per year, while average annual evapotranspiration (loss of water to evaporation and transpiration by plants) is about 25 inches per year. Although the region does receive snowfall, most of the precipitation occurs as rain. May is the wettest month, with an average rainfall of 5.7 inches, while January is the driest month, with an average rainfall of 2.6 inches. In early spring, the watershed receives moisture-laden air from the Gulf of Mexico, which often results in severe weather, including intense thunderstorms that produce surface runoff and potential flooding. The amount of precipitation is typically less during July and August, although occasional intense storm events during summer may produce large amounts of precipitation during a short period of time.

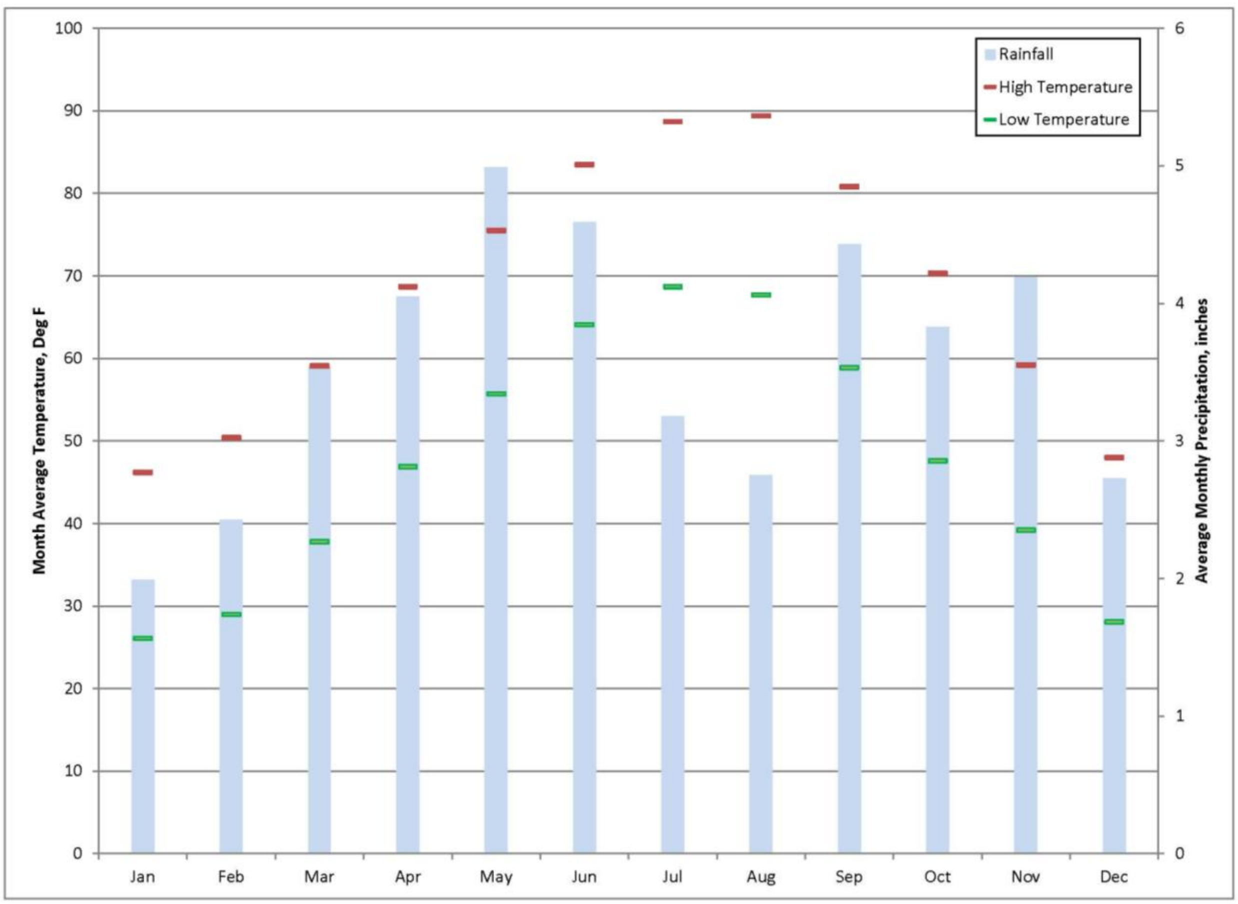


Figure 2.3. Monthly average daily temperature and total precipitation for the UIRW.

2.4 Soils

The common soil types within the UIRW (i.e., the Clarksville, Enders, and Linker series) are Ultisols, which are found primarily in humid, temperate areas across the southeastern United States. The Clarksville series covers the majority (~74%) of the watershed, with Enders (~19%) and Linker (~7%) covering the rest, based on the State Soil Geographic Database (STATSGO).

The word "Ultisol" is derived from "*ultimate*," because Ultisols are seen as the ultimate product of continuous weathering of minerals in a humid temperate climate. Because of this weathering, Ultisols are naturally acidic, generally with low concentrations of nitrogen, phosphorus, potassium, and calcium, and have inherently poor fertility, requiring the application of lime and fertilizer to be agriculturally productive. Application of poultry litter and byproducts to these infertile soils has greatly increased agricultural productivity in the region over the past several decades. In addition, these soils can store nutrients (e.g., phosphorus) when nutrients are applied in excess of forage and crop needs. These nutrients have the potential to leach from the soils during runoff events and enter receiving streams or infiltrate into groundwater.

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) detailed soil series reports indicate the following:

- Clarksville soils are gravelly silt loams; these soils are generally considered very deep (greater than 80 inches to bedrock), and somewhat excessively drained soils that are moderately permeable with medium to high runoff; slopes range from 1% to 65%.
- Enders soils are typically gravelly fine sandy loams; these soils are generally deep (40 to 60 inches to bedrock), well-drained, and slowly permeable with medium to very rapid runoff. Ender soils are typically found on level to moderately steep upland mountain tops and ridges to very steep mountain sides and bases with a slope that can range from 1% to 65%.
- Linker soils are generally fine sandy loams; these soils are moderately deep (20 to 40 inches to bedrock), well-drained, and moderately permeable with slow to rapid runoff, dependent upon slope. Linker soils are generally found on broad plateaus, benches, and mountain and hilltops, with much of the slope ranging from 2 to 8%. The full range of the slope is from 1% to 15%, with a few isolated locations up to 30%.

These descriptions represent the general characteristics of these soils as observed across their larger geographic area, but these soils may have some characteristics specific to the UIRW and northwest Arkansas. As water moves through soil, impurities are filtered out when the molecules bind to soil components such as clays and iron or aluminum minerals. Many of the soils within the watershed have a shallow depth to bedrock, where the local geology may have karst features. As a result, water moves from the soil surface to the groundwater without much natural filtering of the water, making groundwater more vulnerable to pollution.

A soil erosion hazard index can be extracted from the Soil Survey Geographic database (SSURGO) for the UIRW and divided into five categories: Not Rated, Slight, Moderate, Severe, and Very Severe (Figure 2.4). The Baron Fork Creek and Headwaters-Upper Illinois River sub-watersheds have the highest percentages in the "moderate" and "severe" erosion hazard index classes. Also, Clear Creek watershed, portions of the Muddy Fork and Cincinnati Creek watersheds, and the Illinois River watershed between Clear Creek and Osage Creek, are identified as areas that may be subject to higher rates of soil loss if the soils are exposed to wind and water erosion (Figure 2.4). Caution will be needed in conducting land-disturbing activities, such as residential or commercial development, particularly in areas with soils falling in the "moderate" to "very severe" erosion hazard classifications. Most of the agricultural and pasture area (90%) is in areas classified as "slight" erosion hazard. Agricultural land is often located on the lower-sloped areas of a watershed (Figure 2.4). However, there are over 21,485 acres of established cool-season and warm-season grasses (i.e., pasture) in areas classified as "moderate" to "severe" erosion hazard.

Soils in which drain-fields for onsite wastewater treatment discharge (e.g., conventional septic tanks) are buried must have (1) percolation rates (i.e., water infiltration) within an acceptable range; (2) sufficient depth to the water table (i.e., groundwater) or an impermeable layer (e.g., clay layer) between the water table and drain field; and (3) slopes that are amenable to effluent dispersal within the soil. The presence of thin soil and underlying karst features in the UIRW can be problematic for siting these systems.

2.5 Hydrology

2.5.1 SURFACE WATER

The UIRW is identified as HUC 11110103. HUC is an acronym for "hydrologic unit code," which is simply a way of identifying drainage basins in the United States based the basin's geographic area and size. The more digits in the HUC, the smaller the drainage area. The Illinois River watershed is an 8-digit HUC. The subwatersheds in the UIRW in which management practices will be targeted are 12-digit HUCs.

There are twenty-eight 12-digit HUCs (or HUC12s) in the UIRW (Figure 2.5). Three of these HUC12s (listed below) are only partially represented in the UIRW, with the majority of these three HUC12s located in Oklahoma. Because they represent a small portion of the UIRW, the following HUC12s were combined with their adjacent HUC12 subwatersheds to form the 25 HUC12 subwatersheds that will be considered in this watershed-based management plan (Figure 2.6):

- Dripping Springs Branch-Illinois River was combined with Lake Francis-Illinois River,
- Lower Fly Creek was combined with Headwaters Baron Fork, and
- Lower Evansville Creek was combined with Upper Evansville Creek.

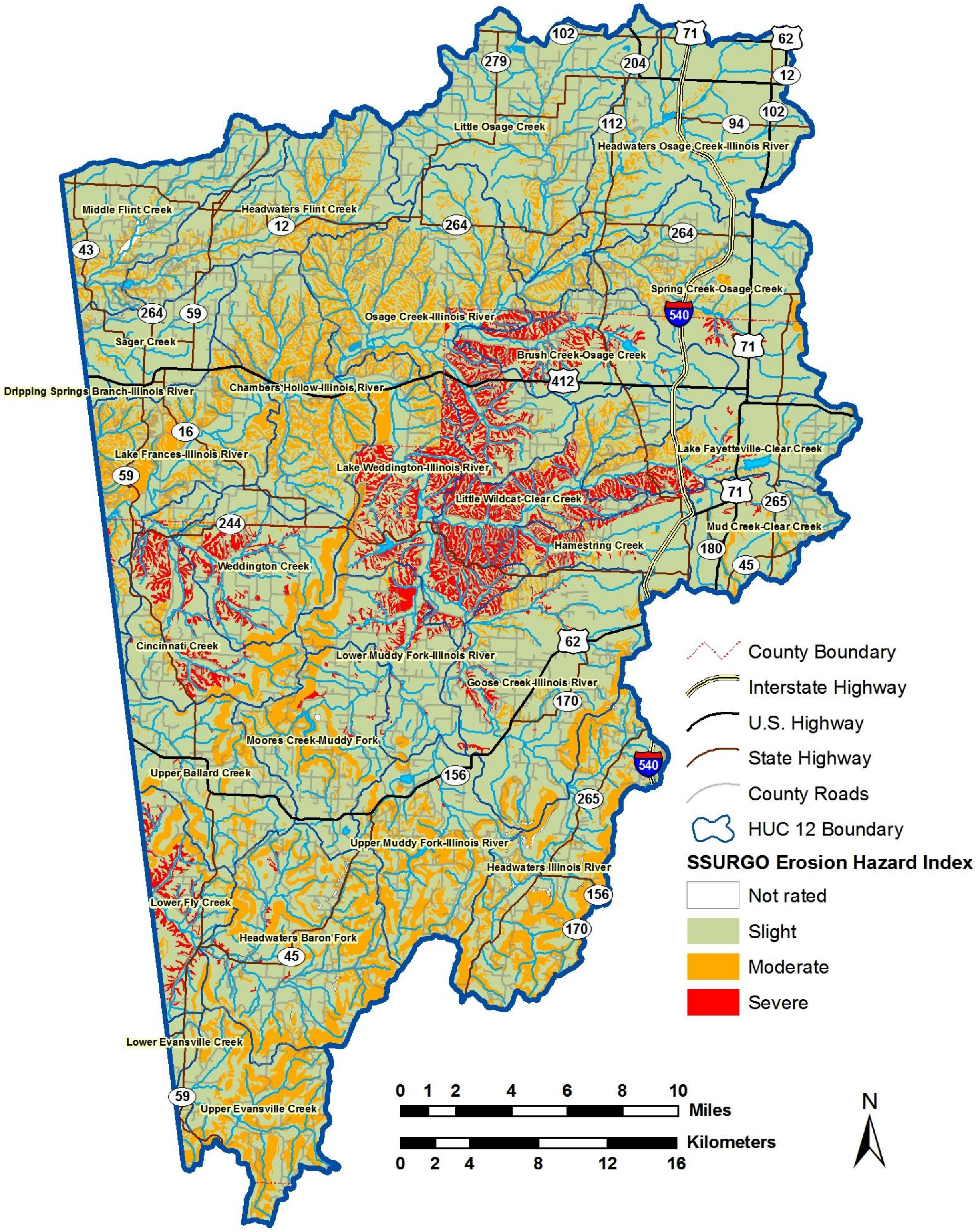


Figure 2.4. Soil erosion hazard index classes for the UIRW.

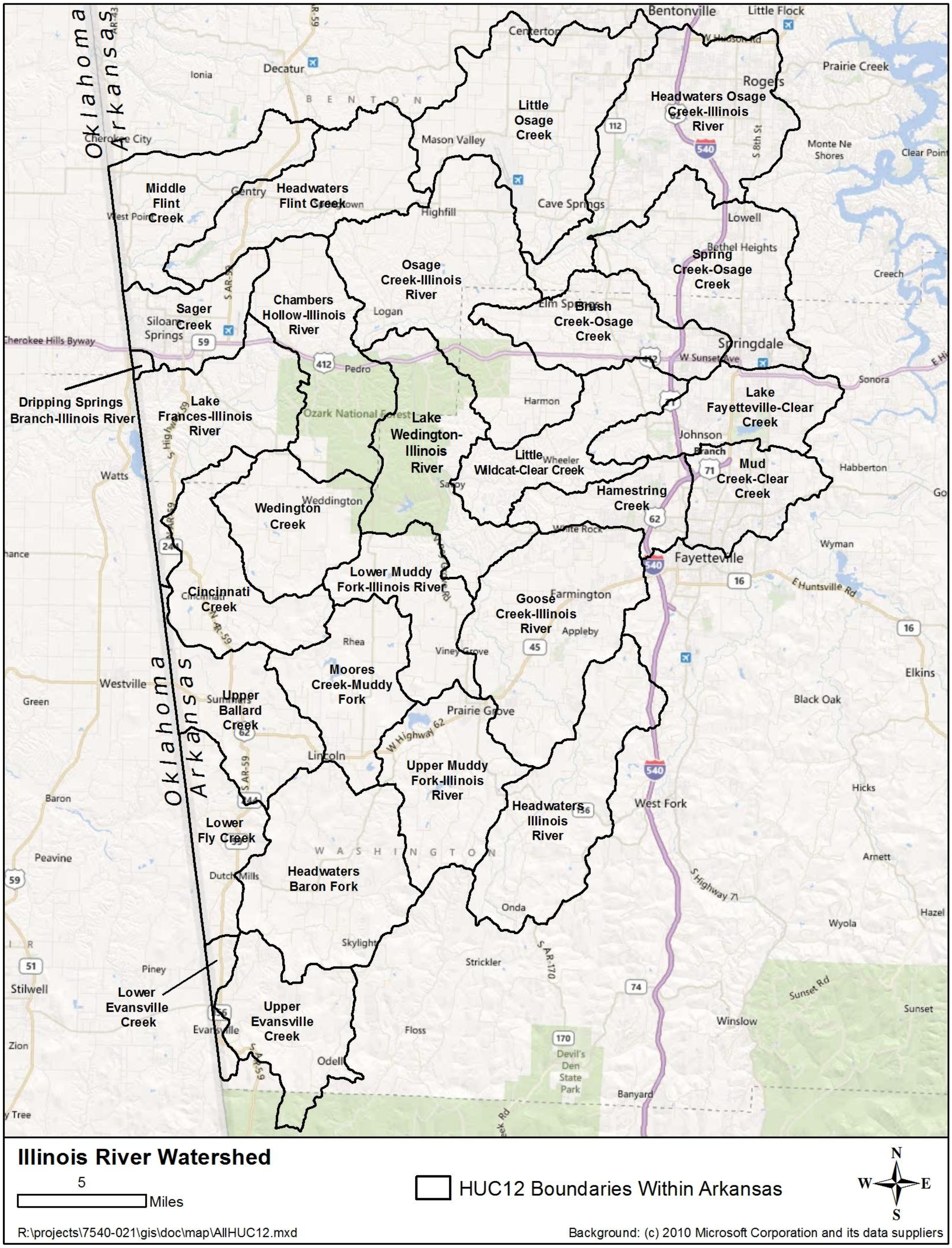


Figure 2.5. The UIRW is part of a HUC8-level watershed. The UIRW is made up of 28 HUC12-level watersheds.

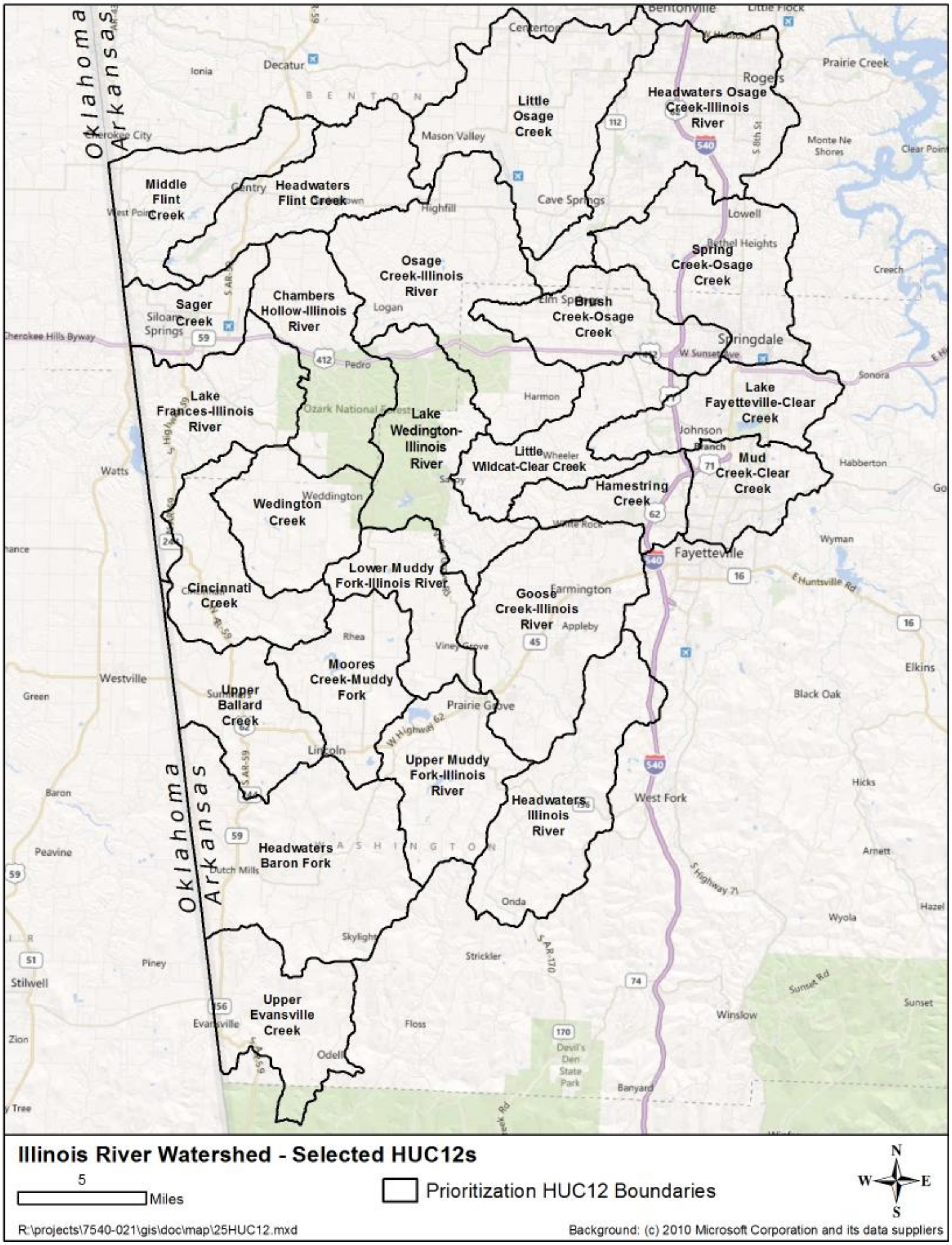


Figure 2.6. Twenty-five HUC12-based subwatersheds used as management units in this plan.

There are over 1,000 miles of streams in the UIRW (Figure 2.7). The main tributary streams to the Illinois River include Osage Creek, Flint Creek, Clear Creek, and Baron Fork Creek. Mean daily discharges from US Geological Survey (USGS) flow gages on the Illinois River and its tributaries, collected over the gage period of record, were averaged by month. The resulting averages of daily flows for each month are shown in Table 2.1. April is typically the month with the greatest average daily discharge in the UIRW, with the lowest average daily flows occurring during August (Table 2.1). Although the greatest precipitation occurs during May (see Figure 2.3), spring growth of forest and grassland vegetation takes up much of this precipitation so that the average daily discharge is less than in April, even though precipitation is greater.

Table 2.1. Average daily flows (cfs) for each month over the entire period of record of USGS flow gages on streams in the UIRW.

Month	Baron Fork @ Dutch Mills, USGS 07196900	Flint Creek @ Springtown, USGS 07195800	Osage Creek near Elm Springs, USGS 07195000	Illinois River @ Hwy 16, USGS 07195400
January	48.8	15.0	115.3	468.1
February	56.5	15.6	143.7	500.4
March	75.9	21.0	172.8	663.1
April	85.3	22.6	206.8	1237.4
May	69.3	19.9	217.9	890.0
June	37.6	18.6	163.9	385.7
July	18.0	9.9	121.7	408.3
August	8.1	7.5	78.2	237.2
September	22.1	8.7	84.9	415.9
October	29.0	11.2	88.0	326.0
November	54.5	17.1	119.1	393.7
December	50.1	16.6	105.5	394.6

Natural stream channels in the watershed generally consist of a series of well-defined riffles and pools along channel beds predominantly consisting of coarse gravels, rubble, boulders, and bedrock. Stream gradients are relatively high, generally exceeding 3 feet per mile, even in larger streams. Several small impoundments (e.g., Lake Frances) are present in the UIRW.

Land clearing and leveling has altered the hydrology in the UIRW. In addition, hydrologic alteration of some channels has occurred through the installation of ditches, other drainage structures, and urban/exurban development. Therefore, some streams have moved, or are moving, toward a different channel configuration. Changes in the flow regime in the watershed can be noted in the long-term flow record for Osage Creek and the Illinois River near Savoy, Arkansas (Figure 2.8). Minimum stream flows during the 1960s through early 1980s were much lower than the minimum flows that have occurred over the past two decades. The reason(s) for the increased minimum flow has not been determined.

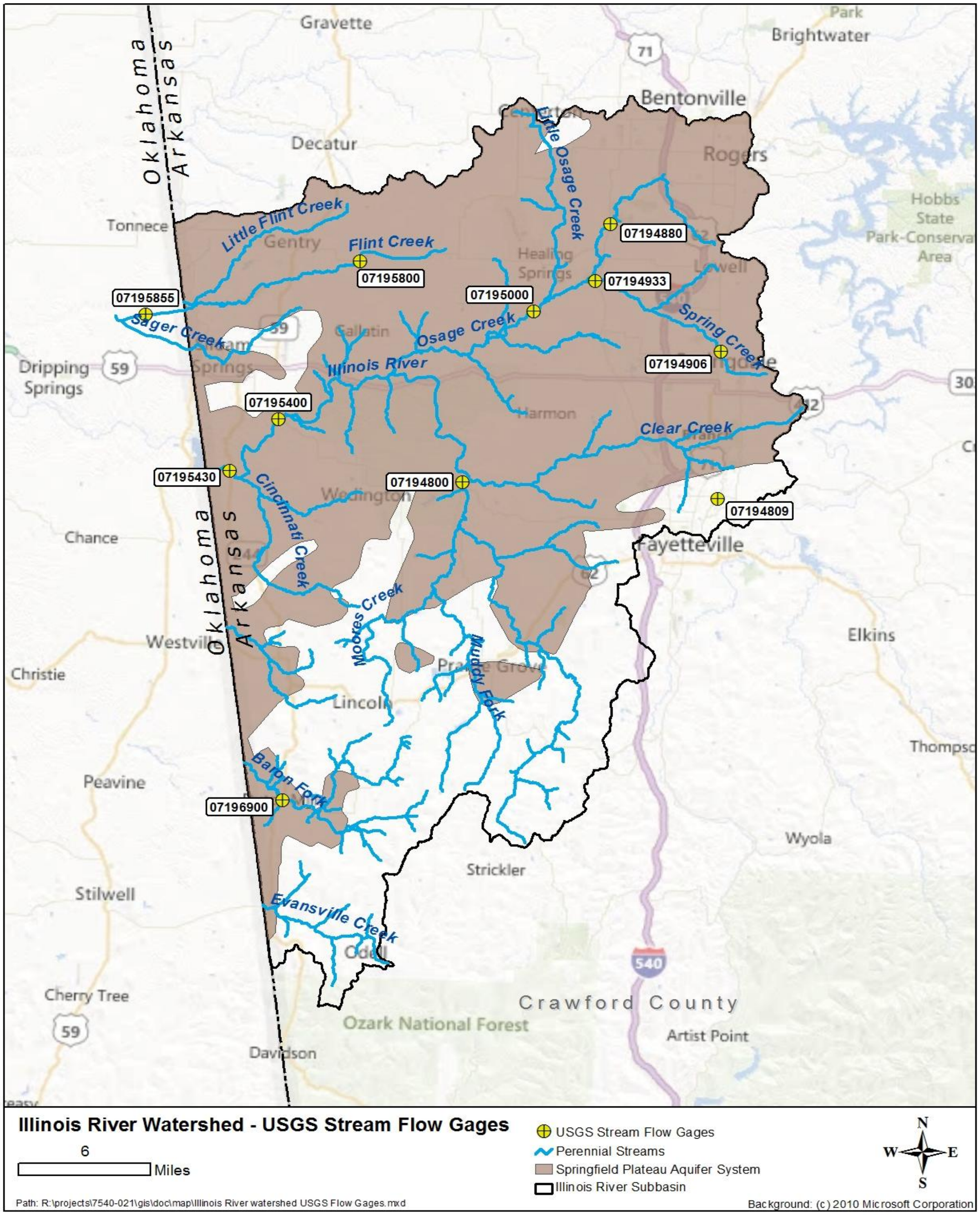
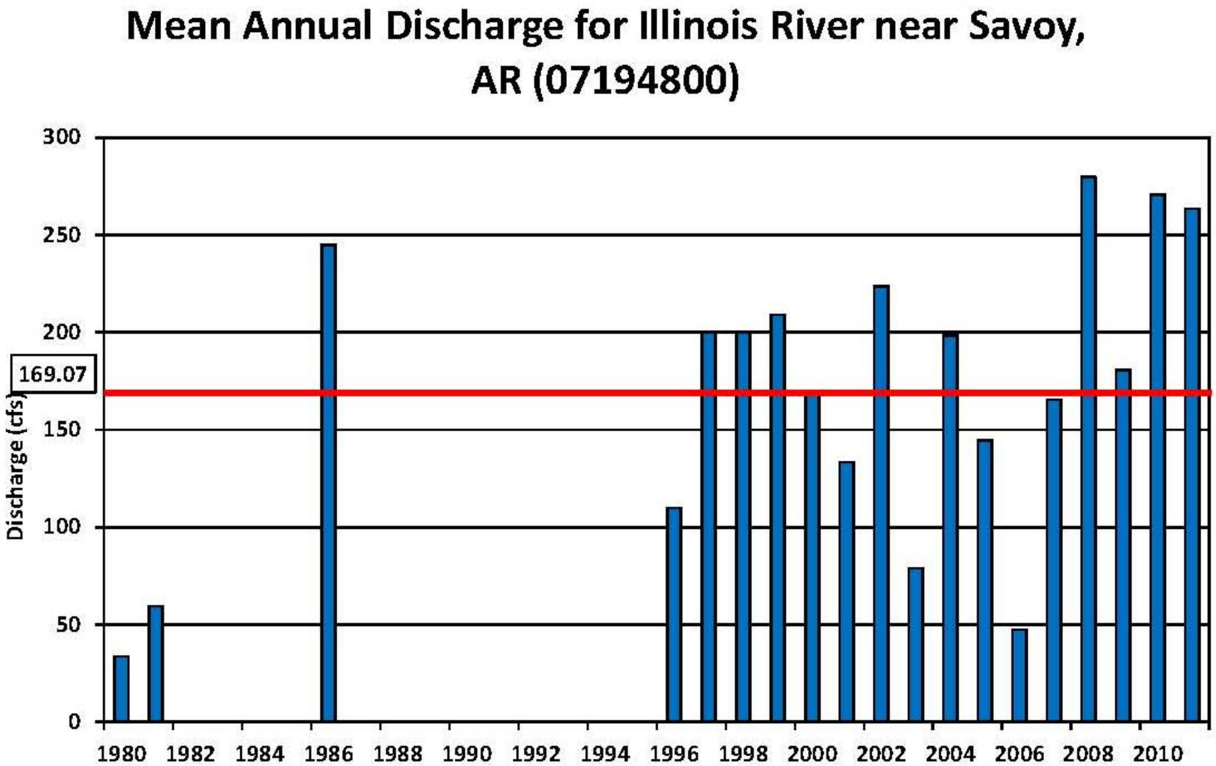


Figure 2.7. Surface water and groundwater features of the UIRW.



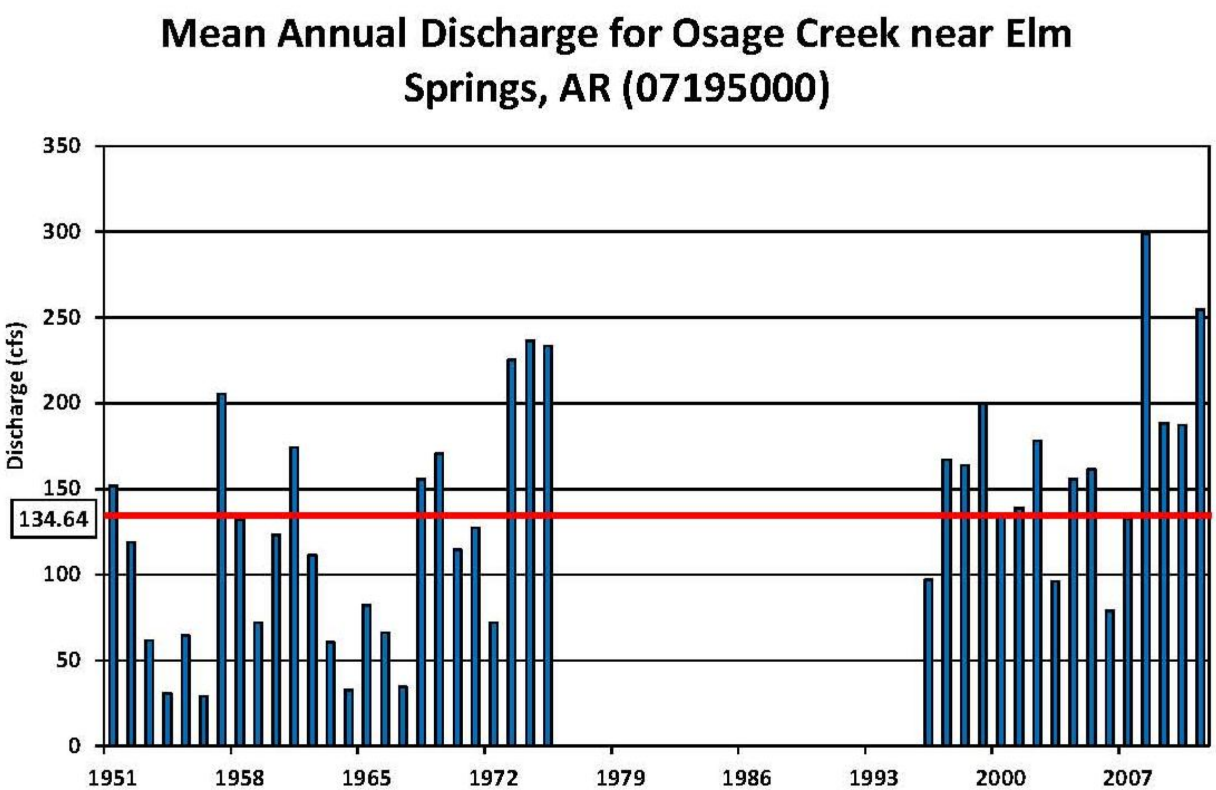


Figure 2.8. Mean annual discharges for the Illinois River and Osage Creek (red lines show average of mean annual discharges over gage period of record).

The volume of water flowing through the Illinois River in Arkansas each year varies depending on the annual precipitation. Over the past decade, annual flow volume at the USGS gage at the Oklahoma border has ranged from 257,000,000 cubic meters during a dry year (2006) to 1,010,000,000 cubic meters during a wet year (2008). The percentage of discharge attributed to base flow and storm flow conditions also varies with annual precipitation; during a wet year as much as 63% of the total flow is attributable to storm events while during dry years storm flow can be as little as 42% of the total flow. The three major WWTPs in Fayetteville, Springdale, Rogers, and the NACA regional WWTP contribute, on average, 10% to 20% of the annual base flow volume of the Illinois River.

2.5.2 GROUNDWATER

The UIRW is underlain by the Ozark Plateaus aquifer system. The Springfield Plateau Aquifer is located nearest the surface in the UIRW, and the majority of wells in the watershed tap this aquifer (Figure 2.7). Well yields in this aquifer are generally less than 20 gallons per minute (Adamski et al. 1995). This aquifer is associated with Boone limestone formation (Gillip, Czarnecki and Mugel 2008). The Boone Formation underneath the UIRW is characterized as an immature karst system (Brahana 2005). This karst geology has resulted in a number of springs and wet caves in the UIRW. This karst system exhibits systems of localized karst flow that behave independently of the overall Ozark Plateaus aquifer system (Brahana 2011).

In the UIRW, the Ozark Aquifer occurs below the Springfield Plateau Aquifer, and is separated from it by a confining layer (Gillip, Czarnecki and Mugel 2008). This aquifer is also used as a water supply in the UIRW. Well yields in this aquifer are commonly around 75 gallons per minute (Adamski et al. 1995). Because of the confining layer, the Ozark Aquifer is less susceptible to contamination from surface activities in the UIRW (Petersen et al. 1998).

2.5.3 INTERACTIONS BETWEEN SURFACE WATER AND GROUNDWATER

Surface water and groundwater interaction is primarily a function of climate, soil type, geology, and topography (Adamski et al. 1995; Winter et al. 1998). In the UIRW, differences in the amount of interaction between surface water and groundwater are primarily the result of differences in the geology and topography of the two physiographic provinces present in the watershed.

In general, there is less surface water-groundwater interaction in the Boston Mountains than in the Springfield Plateau. In the Boston Mountains, streamflow is primarily derived from surface runoff, and none of the streams are considered perennial. Groundwater occurrence is limited to permeable sandstone and limestone beds separated by thick layers of impermeable shale referred to as the Western Interior Plains confining system (Adamski et al. 1995).

In the Springfield Plateau, a high degree of surface water-groundwater interaction exists because of the abundant karst features associated with the shallow groundwater aquifer. In this setting, concentrated flow occurs in dissolutioned fractures and bedding planes that terminate as springs and seeps, which serve as tributaries to primary streams (ADEQ 2008). Along the north and central portions of the Illinois

River, Freiwald (1987) identified several small tributaries where flow is sustained by numerous springs. These springs are well-distributed and many are associated with faults.

Movement of contaminants through karst systems in northwest Arkansas can have a significant impact on surface water and groundwater quality (ADEQ 2008). Green and Haggard (2001) estimated annual phosphorus and nitrogen (n = 35) loads to the Illinois River south of Siloam Springs, Arkansas (gaging station 07195430) from 1997 to 1999. They found that on average, groundwater contributed 15% of the annual total phosphorus load and 46% of the annual total nitrogen load.

In 1983, a losing and gaining stream survey was performed on the Illinois River by Freiwald (1987). Results of the survey indicate that the Illinois River has gaining and losing reaches. In the Boston Mountains (south of Prairie Grove, Arkansas), pools of non-flowing water primarily occur in the channel as depression storage from surface runoff. Flow in the channel was observed north of Viney Grove, Arkansas, where the stream transitions into the Springfield Plateau. Between Viney Grove, Arkansas, and County Road 66 (approximately 4 miles), the Illinois River is gaining. North of County Road 66 to the Arkansas-Oklahoma border (28 miles), the Illinois River is generally a losing stream, with small reaches that are gaining but are insignificant to total flow. A similar survey of Osage Creek in 2001 identified one losing and two gaining reaches on the main stem (Moix et al. 2003).

2.6 Land Use/Land Cover

Historically, the UIRW was primarily covered with hardwood forest and mounded upland prairies. However, much of this forest was cleared and prairies leveled around the start of the 20th century for use as pasture. As the population of northwest Arkansas has increased, especially over the past decade, land use and land cover in the UIRW has shifted away from pasture and towards urban development and forested areas (see Figure 2.9). UIRW land use/land cover information from 2006 is summarized in Table 2.2.

Table 2.2. Summary of 2006 land use/land cover for the UIRW (from the Center for Advanced Spatial Technology).

Land Use	Percentage of UIRW
Forest	41%
Pasture	46%
Urban	13%
Row Crops	< 0.1%
Water	< 1%

The Illinois River and its major tributaries in Arkansas (Osage Creek, Clear Creek, Baron Fork, and the Muddy Fork) exhibit a range of conditions, from areas with dense riparian forest buffers illustrating exceptional beauty and ecological value, to areas of exposed and eroding stream banks with no vegetated buffers.

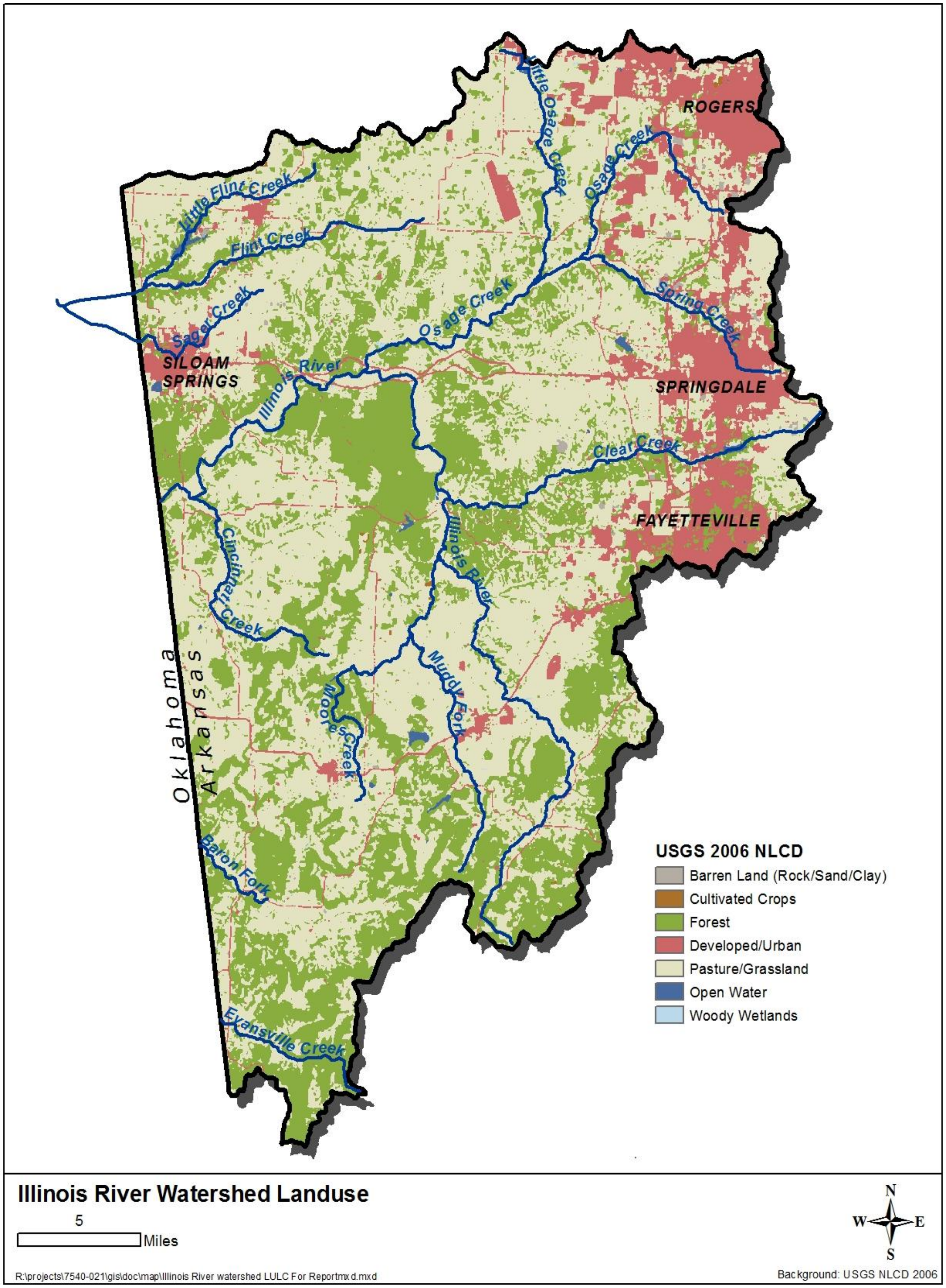


Figure 2.9. Land use distribution across the UIRW in northwest Arkansas (based on 2006 land use/land cover data).

2.6.1 FORESTED AREAS

Forested areas compose about 41% of the watershed area within the UIRW, and these areas can be generally described as mixed upland hardwoods, or oak-hickory forests. Most local forested areas are deciduous hardwoods, but a few smaller areas of coniferous, or evergreen, trees are dispersed throughout the watershed. The large majority of the forested areas are owned by private landowners, although the US Forest Service (USFS) owns and manages a few tracts of land within the UIRW. The Lake Wedington portion of the Ozark National Forest is entirely within the watershed area of the Illinois River, and this area is about 24 square miles. The Ozark National Forest also exists along the southern watershed boundary, but this portion of federally managed forest is less than 2 square miles.

2.6.2 PASTURE LANDS AND FORAGE PRODUCTION

The majority of the land use and land cover within the UIRW is pasture and grasslands. These areas represent the dominant form of agriculture within the region, which is integrated poultry production, and cattle management. Approximately 46% of the watershed area within the UIRW is in pasture and forage production.

2.6.3 URBAN DEVELOPMENT AND IMPERVIOUS SURFACES

The percent of urban land use in the UIRW has more than doubled over the last two decades, where 13% of the watershed area is now classified as either low- or high-density urban development. The main concern with urban development is the increase in impervious areas, which increases the amount of surface runoff following rainfall events and ultimately impacts the tributaries draining urban areas. Urban stream flow increases rapidly following rainfall events, i.e. the streams are “flashy,” which reduces bank and channel stability, aquatic biodiversity, and water quality. The runoff from urban development also carries sediment, nutrients, and other contaminants, representing a nonpoint pollutant source within the UIRW.

There are five major municipal wastewater treatment plants (WWTPs) in the UIRW, these serving the cities of Fayetteville, Springdale, Rogers, Siloam Springs, and the NACA regional WWTP, which discharge effluent into the headwater tributaries of the Illinois River. The NACA regional WWTP discharges into Osage Creek. The influent into these facilities comes from residential, medical, industrial, and food processing centers. The main agricultural or food processing facilities in the region are poultry processing and feed production plants. The majority of the residential properties within the UIRW are served by these municipal facilities. Most of the development within non-municipal areas, and a few areas within those boundaries, are served by individual onsite and community wastewater treatment systems that discharge to soil. Clustered soil discharging systems are also becoming more popular, such as the septic tank effluent pump (STEP) systems that collect wastewater from multiple septic tanks and route it to a centralized treatment facility prior to drip irrigation soil dispersal. All of these wastewater treatment systems represent potential sources of nutrients, pathogens, and contaminants of emerging concern to streams within the UIRW.

2.6.4 LAND USE CHANGES OVER THE LAST DECADE

In the land use categories represented in the watershed map (Figure 2.9), pasture includes areas with bare soil as seedbeds and row crops, forest includes herbaceous vegetation, and urban includes low and high density development as well as barren land (e.g., construction sites and rock quarries). Figure 2.10 and Table 2.3 summarize land use changes in the UIRW between 1992 and 2006. Over the last decade, pasture lands have reduced in area from 64% to 46% as a result of pastures being converted into urban development or restored to forested lands (Figure 2.10). The amount of urbanized areas within the IRWP has more than doubled, with the majority of the growth in the last seven years. The forested areas have increased from 29% to 41% over the past decade because of an increase in both designated forests and herbaceous vegetation (e.g., shrubs and other woody plants) in the watershed. These changes over time (e.g., from 1992 to 2006) show the dynamic nature of watershed land use. Watershed management strategies must be adaptive to landscape dynamics, because changes in land use and land cover may alter the selection of appropriate management strategies to address water quality concerns within the UIRW.

Table 2.3. Change in land use in the UIRW, 1992 to 2006.

Land Use	Change 1992-1999	Change 1999-2006	Change 1992-2006
Forest	+8%	0%	+8%
Pasture	-8%	-10%	-18%
Urban	+1%	+6%	+7%
Herbaceous	0%	+3%	+3%

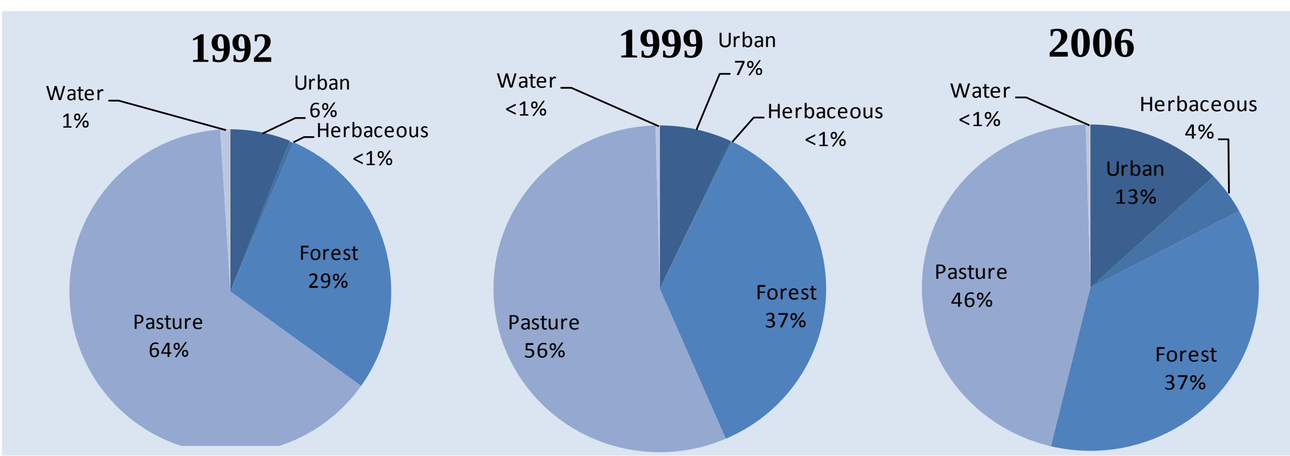


Figure 2.10. Land use in the UIRW during 1992, 1999, and 2006.

2.7 Socioeconomics

The UIRW is characterized by rapidly growing urban centers from south Fayetteville north to Rogers and Bentonville in the headwaters, to more rural areas along the Oklahoma border. The watershed is also home to commercial poultry and non-commercial beef grazing production systems, which are essential to the economic well-being of the region. Arkansas is the second largest producer of broilers in the United States, with Benton and Washington counties the largest contributors of poultry and beef in the state. In addition, northwest Arkansas is home to Walmart headquarters, the world's second largest public corporation, and Tyson Foods, the largest meat producer in the world, as well as hundreds of small businesses supporting these industries.

In 2010, there were approximately 210,700 residents living in the UIRW, representing a 34% increase in population over the last decade (from 2000 to 2010). Population growth has been forecasted in selected watersheds in northwest Arkansas, particularly to understand the future demands or needs from a drinking water perspective. For instance, Carollo Engineers (2005) predicted the number of people living in the UIRW to almost double in the coming decades, from approximately 250,000 in 2010 to almost 500,000 in 2055. (Note: Actual 2010 population was just over 210,000.) The majority of this population growth will occur in the major cities along the eastern watershed boundary (e.g., Fayetteville, Springdale, Rogers, and Bentonville), as well as Siloam Springs near the Arkansas–Oklahoma border. Future increases in population will prompt changes in land use and land cover, which, without proper watershed management, will likely impact water quantity and quality in the UIRW.

2.7.1 POLITICAL BOUNDARIES AND JURISDICTIONS

The UIRW includes parts of Benton, Washington, and Crawford counties within the state of Arkansas. Approximately 40% of the watershed lies in Benton County, while approximately 60% is in Washington County and less than 1% is within Crawford County. There are 21 incorporated municipalities within this watershed, with the largest municipalities defined as the Fayetteville-Springdale-Rogers metropolitan area. This area grew over 13 times faster than the rest of the state from 1990 to 2000. In fact, northwest Arkansas is currently one of the fastest growing metropolitan areas in the state and in the United States. The incorporated municipalities combined cover approximately 22% of the watershed area, while urban land use accounts for only 13%. The towns and cities in the watershed have designated planning areas, defining the potential extent of future annexation and municipal service extensions in the coming decades. The full extent of the municipal planning areas would constitute almost 58% of the total watershed area, approximately tripling the current incorporated area within the UIRW.

Municipalities and counties represent local jurisdictions and political boundaries, which can be used to influence local policies or regulations that might influence water quality conditions within the UIRW. Specific regulations at the municipal, state and federal levels are further described in Chapter 3.

2.8 Water Quality and Monitoring

2.8.1 MONITORING

Waterbodies in the UIRW are monitored by a variety of entities including the Arkansas Department of Environmental Quality (ADEQ), USGS, AWRC, permitted dischargers, and volunteers. Collected data is used to characterize waters, identify trends in water quality over time, identify emerging problems, predict future problems, and determine if pollution control programs are working.

2.8.1.1 *Surface Water*

Figure 2.11 shows locations of historical and active surface water quality monitoring sites in the UIRW. Table 2.4 lists active surface water quality monitoring sites in the UIRW with their location and the year when data collection started at each site. Table 2.5 summarizes the water quality parameters currently monitored at these sites.

ADEQ has been monitoring selected reaches of the Illinois River and its tributaries since the early 1990s. ADEQ's surface water quality monitoring stations data files are available on the web at http://www.adeq.state.ar.us/techsvs/water_quality/water_quality_stations.asp. USGS has been monitoring several of the same sites that ADEQ monitors, as well as additional sites in the watershed. Data are available online at the USGS National Water Information System Web Interface (http://waterdata.usgs.gov/ar/nwis/qw/). AWRC has been monitoring water quality at the Illinois River since 1995 and at Ballard Creek, a tributary to the Illinois River, since 2002. The available data are viewable online at http://www.uark.edu/depts/awrc/pubs-MSC.htm.

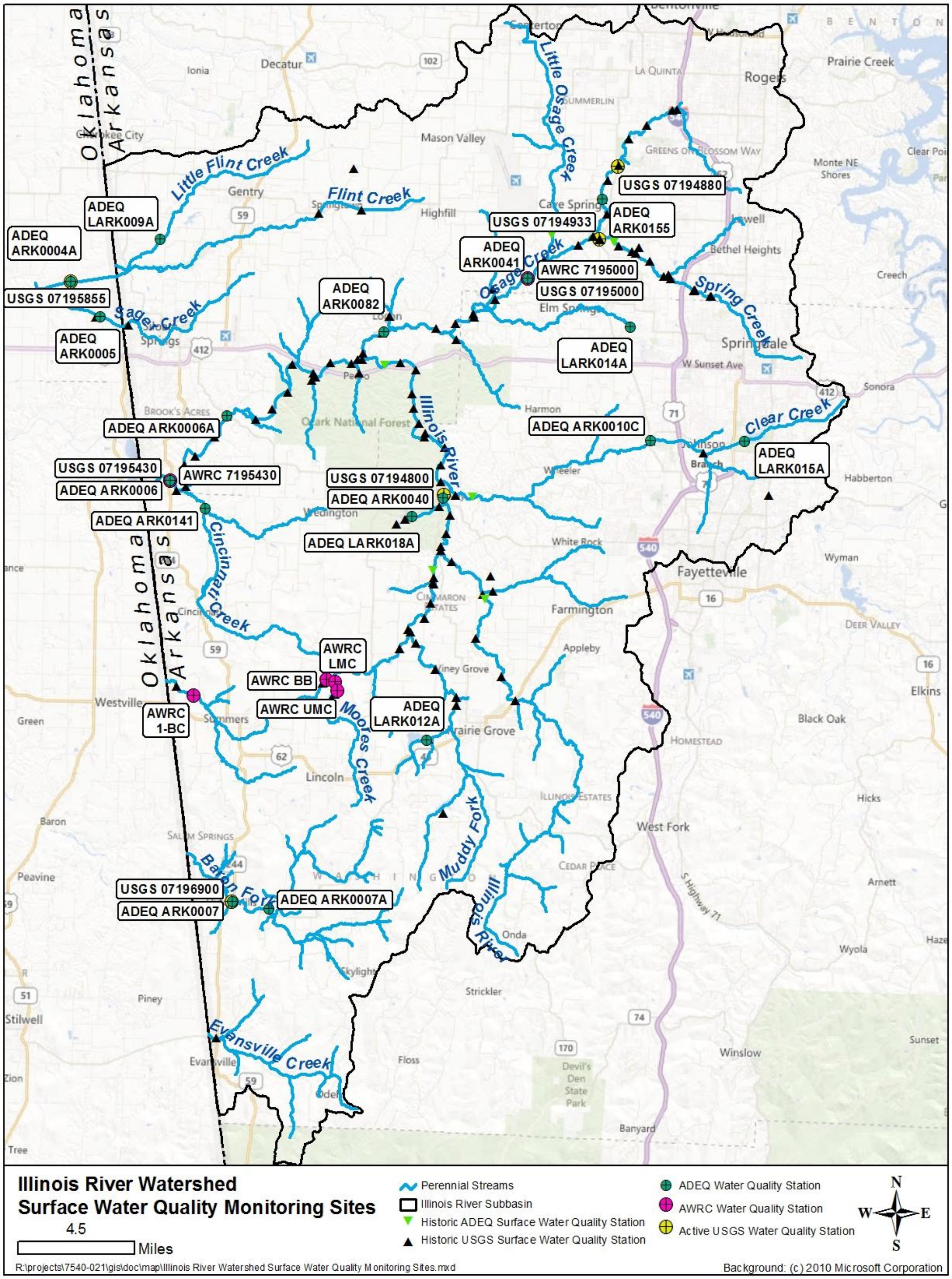


Figure 2.11. Historical and active surface water quality monitoring stations in the UIRW.

Table 2.4. Active routine water quality monitoring sites in the UIRW.

Monitoring Site Location	ADEQ		USGS		AWRC	
	Station ID	Start	Station ID	Start	Station ID	Start
Ballard Creek at County Road 76					Ballard Creek	2000
Baron Fork on County Road 21 near Dutch Mills	ARK0007A	1998	07196900	1973	Baron Fork	2009
Cincinnati Creek at Highway 244	ARK0141	1998				
Clear Creek below Fayetteville	ARK0010C	1994				
Flint Creek at Springtown			07195800	1961	Flint Creek–Springtown	2009
Flint Creek near West Siloam Springs	ARK0004A	1990	07195855	1991	Flint Creek–West Siloam Springs	2009
Illinois River at AR Highway 59, south of Siloam Springs	ARK0006	1997	07195430	1997	Illinois River at AR Hwy 59	2000
Illinois River at Highway 16 near Siloam Springs			07195400	1979		
Illinois River near Savoy	ARK0040	1990	07194800	1974	Illinois River-Savoy	2009
Niokaska Creek at Township at Fayetteville			07194809	1996	Mud Creek Tributary	2009
Osage Creek at Highway 264 Bridge	ARK0155					
Osage Creek at Logan, Arkansas	ARK0082	2008				
Osage Creek near Elm Springs	ARK0041	1990	07195000	1975	Osage Creek	2009

Table 2.5. Parameters monitored in the UIRW.

Parameter	ADEQ Sites	USGS Sites	AWRC Sites
Temperature	X	X	
Dissolved oxygen	X	X	
Turbidity	X		X
Conductivity		X	
pH	X	X	
Total dissolved solids (TDS)	X	X	
Total suspended solids (TSS)	X		X
Total nitrogen		X	X
Organic nitrogen		X	
Ammonia	X	X	X
Nitrate		X	X
Nitrite		X	
Inorganic nitrogen	X	X	
Total Kjeldahl nitrogen (TKN)	X	X	
Dissolved orthophosphate		X	
Soluble reactive phosphorus			X
Total orthophosphate	X		
Dissolved phosphorus		X	
Total phosphorus	X	X	X
Total organic carbon	X		
Hardness	X	X	
Silica	X		
Calcium	X	X	
Magnesium	X	X	
Sodium	X	X	
Potassium	X	X	
Other metals	X		
Chloride	X	X	X
Sulfate	X	X	X
Fluoride	X	X	
Escherichia coli (*E. coli*)		X	
Fecal coliforms		X	
Suspended sediment		X	

2.8.1.2 *Groundwater*

Groundwater quality in the UIRW is primarily monitored by USGS. Figure 2.12 shows locations of historical and active USGS groundwater quality monitoring sites in the UIRW. Water quality of the Ozark Aquifer in this area was evaluated in 2006 and 2007 (Pope, Mehl, and Coiner 2009). Water quality in the Springfield Plateau Aquifer in this area was evaluated from 1992 through 1995 (Adamski 1997, Petersen et al. 1998).

2.8.2 WATER QUALITY

Water quality studies in the UIRW primarily began in the early 1980s and have become more frequent and in-depth as the watershed has changed from its natural characteristics to an urban and agricultural dominated watershed. A list of publications from water quality studies that have been completed in the UIRW is available in Appendix A. Results from some of these studies are discussed below.

2.8.2.1 *Surface Water*

The UIRW occurs primarily in the Ozark Highlands ecoregion (Omernik Ecoregion 39, 1998). Caves, sinkholes, and springs occur, heavily influencing surface water temperature. Clear, cold, perennial, spring-fed streams are common and typically have gravelly substrates; in addition, many small dry valleys occur. ADEQ established reference streams in the mid-1980s in each Arkansas ecoregion and promulgated water quality standards on an ecoregional basis (ADEQ 1987). Water quality characteristics associated with Ozark Highlands streams are different from the other ecoregions in Arkansas and are strongly influenced by the karst geology. Alkalinity (70 to 130 mg/L), total dissolved solids (TDS; 100 to 200 mg/L), and total hardness (70 to 180 mg/L) values are relatively high, with circumneutral pH values, reflecting the influence of the ecoregion's distinctive limestone formations (ADEQ 1987). Fish communities characteristically have a preponderance of sensitive species and are usually dominated by a diverse minnow community along with sunfishes and darters (Keith 1987). Statistics for selected water quality constituents at selected water quality stations over the period of 1997 through 2011 are shown in Table 2.5.

Bailey et al. (2012) evaluated water quality trends at monitoring sites on three streams in the UIRW: Ballard Creek, Osage Creek, and the Illinois River. The water quality parameters evaluated for trends were sulfate, chloride, nutrients, and total suspended solids (TSS). Decreasing trends were identified for a number of water quality constituents at each of the sites. TSS, in particular, exhibited statistically significant decreases in all three streams. The monitoring site on the Illinois River (near Savoy, just upstream of the confluence with Clear Creek) exhibited statistically significant decreasing trends for the majority of the constituents evaluated.

In 2004, USGS, in cooperation with ADEQ, surveyed streams in northwest Arkansas receiving discharge from municipal WWTPs for the presence of 108 contaminants of emerging concern – pharmaceuticals and other organic compounds. The streams sampled in the UIRW were Mud Creek (Fayetteville WWTP), Spring Creek (Springdale WWTP), Osage Creek (Rogers WWTP), and the Illinois River at the state line. Forty-two of the targeted contaminants were detected in northwest Arkansas streams at levels above the minimum that can be detected, with at least one contaminant occurring at each of the sampling sites (Galloway et al. 2005). For the most part, health and environmental effects associated with the presence of these contaminants are unknown, and there are no recommended levels for protection of human health or wildlife.

2.8.2.2 *Groundwater*

Groundwater in both the Springfield Plateau Aquifer and the Ozark Aquifer in the UIRW are generally suitable for use as a drinking water supply. Concentrations of dissolved minerals tend to be higher in the Ozark Aquifer than in the Springfield Plateau Aquifer (Petersen et al. 1998).

Nitrate is the nutrient most commonly found in groundwater in the UIRW, and it generally occurs at higher concentrations than other nutrients. Nitrate concentrations greater than the drinking water standard (10 mg/L) have been found in wells in the UIRW, but not frequently (Adamski 1997). Evaluation of historical groundwater data has shown that nitrate concentrations in shallow or unconfined aquifers (Springfield Plateau Aquifer in the UIRW) increases as the amount of agricultural land in the area around a well or spring increases (Adamski 1997, Davis et al. 1995). Nutrient concentrations are generally higher in springs than in wells, and higher in unconfined aquifers (e.g., Springfield Plateau Aquifer in the UIRW) than in confined aquifers (e.g., Ozark Aquifer in the UIRW) (Petersen et al. 1998). Overall, nitrate levels in the Springfield Plateau Aquifer were higher than in most other water supply aquifers evaluated in the NAWQA program (Petersen et al. 1998).

Sampling for pesticides in the Ozark Plateau Aquifer system did reveal the presence of pesticides in the aquifers at levels above the level where they can be detected, but below levels that are expected to affect human or animal health. Pesticides were detected in both the Springfield Plateau Aquifer and the Ozark Aquifer in the UIRW (Adamski 1997). Overall, pesticides were detected less frequently in these aquifers than in other water supply aquifers evaluated in the NAWQA program (Petersen et al. 1998).

Fecal coliform bacteria have been found in springs in the UIRW (Davis et al. 1995, Graening and Brown 1999). However, fecal coliform bacteria have not been found in the aquifers (i.e., wells) (Davis et al. 1995). Radon levels in these aquifers are lower than in the other water supply aquifers evaluated in the NAWQA program (Petersen et al. 1998).

Volatile organic compounds have been detected in the Springfield Plateau Aquifer, however, concentrations are low. Overall, volatile organic compounds were detected more frequently in this aquifer than in the other water supply aquifers evaluated in the NAWQA program (Petersen et al. 1998).

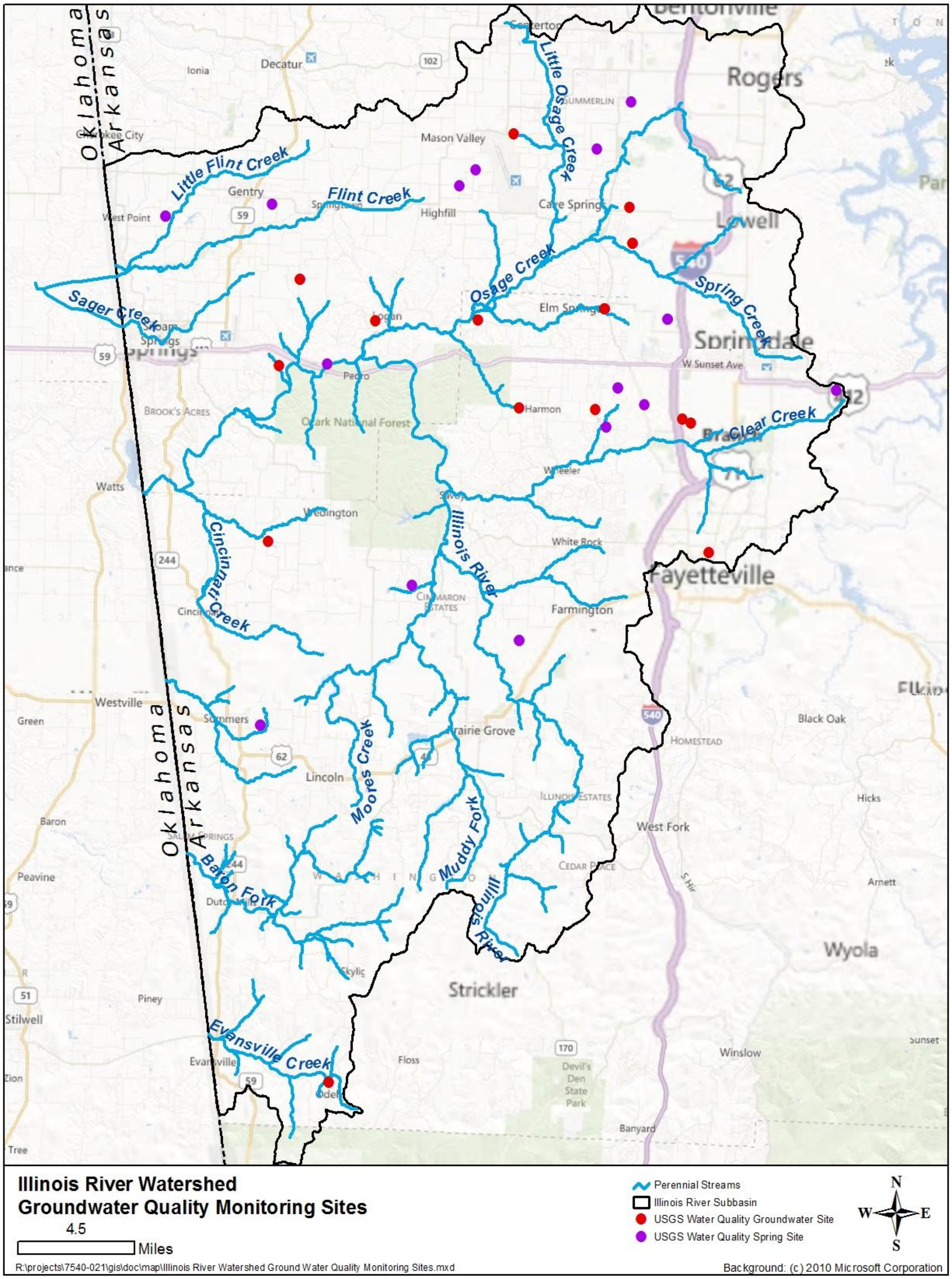


Figure 2.12. USGS groundwater monitoring sites in the UIRW.

Table 2.6. Minimum, maximum, and average values for selected water quality constituents for the period of 1997 to 2011 for selected monitoring stations in the UIRW. Data were collected by ADEQ unless indicated otherwise.

Parameter	Statistic	Illinois River at Savoy	Clear Creek	Osage Creek at Elm Springs	Illinois River near Siloam Springs	Flint Creek	Sager Creek	Baron Fork
Dissolved Oxygen (mg/L)	Min	5.21	6.7	5.18	5.71	5.42	4.67	3.2
	25th	7.95	8.47	8.40	8.06	7.88	8.33	8.10
	Median	9.11	9.66	9.34	9.27	9.12	9.48	10.25
	Mean	9.43	9.98	9.96	9.56	9.75	9.61	10.42
	75th	11.22	11.2	11.1	11.02	11	10.52	12.6
	Max	16.3	16.67	18.1	16.6	88.82	16.43	18.17
Turbidity (NTU)	Min	1.5	0.79	0.86	0.81	0.4	0.57	0.6
	25th	4.23	0.79	2.57	4.39	1.77	1.5	2.27
	Median	6.93	3.9	4.1	6.5	2.6	2.39	3.31
	Mean	16.06	12.99	11.46	7.48	4.24	7.63	8.78
	75th	12.77	7.90	6.44	10.35	3.83	4.5	6.04
	Max	458	488	501	25	118	211	394
TSS (mg/L)	Min	1	1	1	1	1	1	1
	25th	3	2.15	2.5	2.5	2	1.5	1.5
	Median	5.2	3.5	4	5	3	2.5	2.7
	Mean	13.5	16.5	10.5	31.3	4.6	8.5	8.1
	75th	9.8	5.5	6.5	9.5	4.5	4	4.2
	Max	576	700	572	1130	94	6.8	456
TDS (mg/L)	Min	62	112	35	65	117	124	108
	25th	151	189	211	169	156	220	173
	Median	174.5	275	244	190	168	261	192.5
	Mean	169.9	229.6	239.4	188.1	166.5	263.1	190.7
	75th	189	275	271.2	207.6	177	299.5	207
	Max	236	376	327	264	249	416	271
Nitrate + Nitrite (mg/L)	Min	0.132	0.47	0.02	0.948	0.249	0.023	0.012
	25th	1.27	1.72	3.15	1.947	0.987	4.33	1.13
	Median	1.936	2.235	3.64	2.397	1.81	6.76	2.11
	Mean	1.982	2.439	3.598	2.397	1.962	6.963	2.060
	75th	2.44	3.03	4.174	2.835	2.681	8.8	2.67
	Max	5	5.88	34.6	4.64	8.05	19.3	5.982
Ammonia (mg/L)	Min	0.005	0.007	0.005	0.001	0.005	0.005	0
	25th	0.02	0.013	0.01	0.01	0.012	0.017	0.019
	Median	0.04	0.031	0.021	0.02	0.026	0.046	0.031
	Mean	0.048	0.064	0.032	0.034	0.042	0.573	0.032
	75th	0.058	0.059	0.038	0.043	0.06	0.278	0.04
	Max	0.236	1.24	0.154	0.192	0.148	9.1	0.169
Total Phosphorus (mg/L)	Min	0.025	0.013	0.032	0.014	0.01	0.088	0.017
	25th	0.057	0.043	0.12	0.014	0.038	0.672	0.054
	Median	0.076	0.060	0.246	0.141	0.05	0.968	0.074
	Mean	0.105	0.086	0.453	0.184	0.059	1.114	0.090
	75th	0.111	0.109	0.634	0.237	0.064	1.452	0.095

Table 2.6. Minimum, maximum, and average values for selected water quality constituents for the period 1997 through 2011 for selected monitoring stations in the UIRW (continued).

	Max	1.15	0.87	2.49	0.98	0.712	3.89	0.828
Total Nitrogen (mg/L)[2]	Min	0.64	NA	0.32	1.10	0.44	1.90	0.19
	25th	1.90		3.60	2.40	1.30	5.53	1.10
	Median	2.40		4.00	2.80	1.90	7.40	2.10
	Mean	2.46		4.06	2.85	2.12	7.75	2.26
	75th	3.00		4.60	3.20	2.90	9.33	2.90
	Max	5.80		6.50	4.90	5.60	18.00	9.80
Chloride (mg/L)	Min	1.15	3.72	3.07	2.24	4.11	4.93	3.08
	25th	7.24	9.23	17.8	11.12	8.11	25.59	7.19
	Median	9.05	14.8	25.7	14.97	10.15	35.2	9.03
	Mean	9.73	18.69	25.85	15.78	10.06	37.74	10.27
	75th	10.82	24.7	33.29	19.95	11.9	46.5	11
	Max	24.8	57.1	52.4	36	18.1	129.64	36.9
Sulfate (mg/L)	Min	1.12	8.01	2.18	7.41	4.77	6.96	8.9
	25th	9.46	17.3	16.65	11.89	15.17	16.87	15.3
	Median	12.5	27.1	23.06	14.7	20.39	23.29	18.75
	Mean	13.01	31.58	24.89	15.76	20.80	26.77	19.20
	75th	16.1	43.42	32.27	18.75	24.9	34.10	22.6
	Max	27.6	92.5	52.4	32.5	50	77.7	36.3
Calcium (mg/L)	Min	17.7	5.3	1.86	20.9	19.4	14	16.2
	25th	38.575	48.7	47.5	43.7	38.7	46.4	48.1
	Median	45.8	53.35	50.8	46.6	41.65	50.4	52.55
	Mean	44.64	51.15	49.61	45.91	41.06	48.93	51.66
	75th	51	56.9	53.5	49.7	44.15	52.9	56.35
	Max	81.7	92.8	77.2	64.6	53.6	83.9	92
Magnesium (mg/L)	Min	1.69	1.27	0.06	0.08	1.29	1.26	1.91
	25th	2.5	2.78	1.9	2.08	2.09	2.43	3.22
	Median	2.8	3.20	2.01	2.2	2.2	2.7	3.58
	Mean	2.76	3.17	2.01	2.17	2.23	2.79	3.54
	75th	3.02	3.58	2.19	2.31	2.39	2.95	3.8
	Max	3.94	4.57	3.45	3.1	3.54	8.7	5.95
Alkalinity (mg/L)	Min	39.3	47.8	13.4	16	48.9	36	48.6
	25th	95.4	124.2	123	109.3	97.4	95.72	114
	Median	118.4	133	132	119	105	108	129
	Mean	111.9	130.7	127.2	115.2	102.8	106.3	123.8
	75th	132.4	145	138	130.5	110	114.3	139
	Max	166	167	152	144	127	176	172.1

[2] USGS data

2.9 Wildlife Resources—Endangered and Threatened Species and Fisheries

The karst terrain of northwest Arkansas supports numerous springs and spring-fed tributaries which harbor threatened, endangered or endemic species including the Ozark cavefish (*Amblyopsis rosae*), least darter (*Etheostoma microperca*), Oklahoma salamander (*Eurycea tynerensis*), and Neosho mucket (*Lampsilis rafinesqueana*). The presence of endangered species, and other aquatic species of concern, has resulted in several streams within the UIRW being classified as extraordinary resource waters (ERWs) or ecologically sensitive waters (ESWs) as defined by the Arkansas Pollution Control and Ecology Commission (APCEC). In addition, all lakes and reservoirs and most streams in the UIRW are designated as fisheries.

Regulations of the UIRW 3

Designated waterbody uses, water quality criteria, and other regulations that apply in the UIRW both drive the need for restoration and protection in the watershed, and constrain the restoration and protection activities that can be implemented. Waters in the UIRW are under the jurisdiction of federal and state regulations. Lands in the watershed are under the jurisdiction of state, county, and municipal regulations.

3.1 Federal Regulatory Drivers

3.1.1 US ENVIRONMENTAL PROTECTION AGENCY

EPA has primary responsibility for implementation of the Clean Water Act and the Safe Drinking Water Act.

The **Clean Water Act** pertains to protection of surface and groundwater of the United States. The specific objective of the act is to protect the physical, chemical and biological integrity of the nation's waters. Pertinent sections are:

- Section 301, establishing effluent limitations,
- Section 302, establishing water quality-related effluent limitations,
- Section 303, requiring states to develop ambient water quality standards,
- Section 305, requiring states to conduct biennial water quality inventories,
- Section 307, requiring toxic and pretreatment effluent standards,
- Section 314, the clean lakes program,
- Section 319, nonpoint source pollution management,
- Section 402, the National Pollution Discharge Elimination System Program, and
- Section 404, permits for dredged or fill material (enforced by the US Army Corps of Engineers).

The **Safe Drinking Water Act** is the primary federal law pertaining to provision of potable water for the public. Regulations promulgated by EPA under the Safe Drinking Water Act that are pertinent to the source water protection program are:

- National Primary and Secondary Drinking Water Regulations (Title 40 Code of Federal Regulations [CFR] Parts 141, 142, and 143);
- National Primary Drinking Water Regulations; Long Term 2 Enhanced Surface Water Treatment Rule;

- Stage 2 Disinfectants and Disinfection Byproducts Rule; and
- Underground Injection Control Program (40 CFR Parts 144, 145, 146, and 147).

3.1.2 US DEPARTMENT OF AGRICULTURE (USDA)

Beginning in 1985 with the passage of the Food Security Act, or Farm Bill, all farm operators in the United States. were required to meet specific soil erosion control standards. Compliance with these standards (including the sodbuster and swampbuster provisions) is now prerequisite for participation in most federal farm programs.

Subsequent Farm Bills in 1990 and 1996 enhanced the water quality benefits of the program by retiring highly erodible lands from production and adding incentive programs, such as the Wetlands Reserve Program (WRP), encouraging farmers to restore farmed wetlands to their natural condition.

3.1.3 FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

The National Flood Insurance Program (NFIP) is a federal non-regulatory program that can provide some water quality protection by restricting development in the floodplain. The NFIP, which is administered by FEMA, makes federally backed flood insurance available in communities that agree to adopt and enforce floodplain management ordinances to reduce flood damage. The program generally includes identifying flood prone areas, elevating buildings above the base flood, and relocating structures out of the floodplain. Local governments may go beyond the minimum FEMA requirements to provide added protection.

3.2 State Regulatory Drivers

3.2.1 ARKANSAS DEPARTMENT OF ENVIRONMENTAL QUALITY (ADEQ)

ADEQ’s mission is to protect Arkansas' natural resources — its air, water, and land — from the threat of pollution. They do this through a combination of regulatory programs, proactive programs and educational activities. ADEQ is the designated agency in the state for implementation of the state’s water quality management plan and the National Pollution Discharge Elimination System (NPDES) program. ADEQ enforces regulations established by the Arkansas Pollution Control and Ecology Commission. Regulations of the Commission relevant to management of the UIRW are:

- Regulation No. 2, Regulation Establishing Water Quality Standards for Surface Waters of the State of Arkansas, as revised, effective August 26, 2011;
- Regulation No. 4, Regulation to Require a Disposal Permit for Real Estate Subdivisions in Proximity to Lakes and Streams, effective July 7, 1973;
- Regulation No. 5, Liquid Animal Waste Management Systems, as revised, effective April 26, 2008;

- Regulation No. 6, Regulations for State Administration of the National Pollutant Discharge Elimination System (NPDES), effective June 18, 2010;
- Regulation No. 8, Administrative Procedures, as revised, effective February 28, 2009;
- Regulation No. 9, Permit Fee Regulations, as revised, effective March 15, 2008;
- Regulation No. 12, Storage Tank Regulations, as revised, effective December 28, 2009;
- Regulation No. 17 – Arkansas Underground Injection Control Code, effective February 14, 2005;
- Regulation No. 22 – Solid Waste Management Rules, effective April 26, 2008;
- Regulation No. 23 – Hazardous Waste Management, as revised, effective September 26, 2011;
- Regulation No. 29 – Brownfields Redevelopment, as revised, effective March 3, 2006; and
- Regulation No. 30 – Arkansas Remedial Action Trust Fund, Hazardous Substances Site Priority List, effective June 13, 2010.

State water quality standards (Regulation No. 2) are an important driver of activities in the UIRW and are discussed in greater detail in Section 3.4.

3.2.2 ARKANSAS DEPARTMENT OF HEALTH (ADH)

- Rules and Regulations Pertaining to Public Water Systems, effective January 11, 2007 (http://www.healthyarkansas.com/eng/pdf/pwsregsfinal.pdf).
- Rules and Regulations Pertaining to Onsite Wastewater Systems, Designated Representatives and Installers, effective December 16, 2006 (http://www.sosweb.state.ar.us/elections/elections_pdfs/register/novdec_06/016.24.06-009.pdf).
- Rules and Regulations Pertaining to Mobile Home and Recreational Vehicle Parks, effective April 1, 2008 (http://www.healthyarkansas.com/rules_regs/mobile_home_parks.pdf).
- Rules and Regulations Pertaining to General Sanitation, Effective November 1, 2000 (http://www.healthyarkansas.com/rules_regs/general_sanitation.pdf).

3.2.3 ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT (AHTD)

AHTD maintains standards for state highway construction including erosion and sediment control, spill prevention, and site stabilization practices.

3.2.4 ARKANSAS LIVESTOCK AND POULTRY COMMISSION (ALPC)

The mission of ALPC is "to safeguard human and animal health, assure food safety and quality, and promote Arkansas livestock and poultry industries for the benefit of our citizens." ALPC is not a primary environmental agency. However, it regulates disposal of on-farm dead livestock or poultry, which may become a water-quality issue if not properly managed.

3.2.5 ARKANSAS NATURAL RESOURCES COMMISSION (ANRC)

The mission of ANRC is "to manage and protect our water and land resources for the health, safety and economic benefit of the State of Arkansas." In fulfillment of this mission, ANRC has a number of regulations relevant to the source water protection program, including the following:

- Title III, Rules for utilization of surface water;
- Title V, Administrative rules and regulations for financial assistance;
- Title VI, Rules for water development project compliance with the Arkansas Water Plan;
- Title VIII, Rules governing water rights investigations;
- Title IX, Rules and procedures for claiming tax credit;
- Title X, Rules governing the Arkansas water resource cost-share program;
- Title XI, Rules governing the surplus poultry litter removal incentives cost share program;
- Title XII, Rules governing the Arkansas wetlands mitigation bank program;
- Title XIII, Rules governing the tax credit program for the creation and restoration of private wetland and riparian zones;
- Title XIV, Rules implementing the water resource conservation and development incentives act;
- Title XV, Rules governing loans from the safe drinking water fund;
- Title XVI, Rules governing the Arkansas clean water revolving loan fund program;
- Title XVII, Rules governing water authorities;
- Title XXII, Nutrient and poultry litter application and management program; and
- Title XXIII, Rules governing water and wastewater project funding through the Arkansas community and economic development program.

The UIRW has been designated as a **Nutrient Surplus Area** by Arkansas Acts 1059 and 1061, as implemented by Title XXII of ANRC's *Rules Governing the Arkansas Soil Nutrient and Poultry Litter Application and Management Program*, effective January 2006. The purpose of these rules is to maintain the benefits derived from the wise use of poultry litter and other soil nutrients while avoiding undesirable effects on the waters of the State from excess nutrient applications. Among other provisions, these rules state that persons applying nutrients from poultry litter to soils or associated crops on land areas greater than 2.5 acres within a Nutrient Surplus Area must apply it in compliance with a nutrient management plan (NMP) or poultry litter management plan. Requirements for soil testing, record keeping, placement and timing of litter application and other elements of NMPs are specified in the rules. Act 1060 establishes annual registration with ANRC of poultry feeding operations where more than 2,500 poultry are housed or maintained.

3.3 Local Regulatory Drivers

Counties and cities promulgate and enforce their own regulations that impact water quality. Primary among these are zoning and stormwater ordinances.

3.3.1 ZONING

Zoning ordinances guide land use within city limits, and in the counties. Zoning ordinances may contribute to water quality issues by allowing or promoting land uses that can have negative impacts on water quality. Zoning ordinances may also contribute to water quality issues by preventing land uses that can have beneficial effects on water quality. However, zoning ordinances can also be used by municipalities and counties to prevent land uses that harm water quality and promote land uses that benefit water quality.

As an example, Low-Impact Development (LID) is classified in most municipal codes as a non-conforming stormwater system. An LID project in Rogers required 30 zoning variances.[3] Fayetteville has incorporated LID into its Unified Development Code to make it easier to utilize LID practices within the city limits.[4]

3.3.2 STORMWATER ORDINANCES

Through the Clean Water Act, a number of cities in the UIRW, and both Benton and Washington counties, have been required to promulgate ordinances that require practices to prevent pollution of stormwater during and after construction activities. Table 3.1 summarizes stormwater ordinances in the UIRW.

Stormwater ordinances in the UIRW vary significantly with the size of the community. Smaller communities rely largely on ADEQ oversight while larger communities impose stricter requirements by incorporating their own stormwater design manuals and grading standards.

Fayetteville's LID Ordinance establishes design standards that must be met in order for a project to earn "LID Credits." The LID credits include the use of LID systems in lieu of conventional stormwater systems (i.e. curb and gutter, storm drain inlets, etc,), reductions in required volume for retention/detention facilities, and possible fee reductions at such time that a stormwater utility is formed. The site design elements include guidelines for filtration/infiltration, capture and re-use, and impervious surface reductions.

[3] http://places.designobserver.com/feature/venture-design/25918/

[4] http://www.accessfayetteville.org/government/city_clerk/city_code/index.cfm

Table 3.1. Municipal and county stormwater ordinances that apply in the UIRW.

Community	Ordinance	Coverage
Bentonville	Ordinance No. 2006-167	Stormwater discharges from construction activities; post-construction controls
Farmington	Ordinance 2006-6	Stormwater discharges from construction activities; post-construction controls
	Ordinance 2008-19	
Fayetteville	Title XV, Chapter 170	Stormwater discharges from construction activities; post-construction controls
	Title XV, Chapter 179	Low-impact development
Johnson	Ordinance No. 2007-06	Stormwater discharges from construction activities
	Ordinance No. 2007-07	Post-construction controls
Little Flock	Ordinance No. 304-07	Stormwater discharges from construction activities; post-construction controls
	Ordinance No. 338-2010	
Greenland	Stormwater Pollution Prevention, Grading and Erosion Control Ordinance	Stormwater discharges from construction activities
	Private Detention Pond Ordinance	Post-construction controls
Lowell	Ordinance No. 890	Stormwater discharges from construction activities
	Article XI. Land Alteration	
	Ordinance No. 96-14	Post-construction controls
	Ordinance No. 2007-13	
Rogers	Ordinance No. 08-33	Stormwater discharges from construction activities; post-construction controls
Springdale	Chapter 107 – Stormwater Ordinance	Stormwater discharges from construction activities; post-construction controls
	Chapter 56 – Landscaping Ordinance	
	Chapter 106 – Drainage Criteria Manual	
	Chapter 112 – Subdivisions	
Bethel Heights	Ordinance #200	Stormwater discharges from construction activities
	Ordinance #169	Post-construction controls
Benton County	Stormwater Pollution Prevention, Grading, and Erosion Control Court Order 2009-80	Stormwater discharges from construction activities; post-construction controls
Washington County	Stormwater Pollution Prevention, Grading, and Erosion Control Court Order	Stormwater discharges from construction activities; post-construction controls
	Private Detention Pond Ordinance	Post-construction controls

Fayetteville has also promulgated a Streamside Protection Ordinance. This ordinance applies to streams with watersheds of 100 acres or more. Under this ordinance, selected activities are not allowed within 50 feet of these streams, similar to city setback restrictions.

3.4 Water Quality Standards

Regulation No. 2 establishes general and specific water quality standards for surface waters of the state of Arkansas. These standards consist of numeric and/or narrative criteria for selected water quality parameters, and identification of desired (designated) uses for waterbodies. The standards were established based upon present, future and potential water uses.

3.4.1 WATER QUALITY CRITERIA

Numeric water quality criteria applicable to the UIRW are shown in Table 3.2:

Table 3.2. Established water quality standards for waters of the UIRW.

Parameter		Criteria	
Temperature		29 °C, should not exceed due to man-made influences	
Turbidity		10 NTU during base flow; 17 NTU during all flow	
pH		Between 6.0 and 9.0	
Dissolved Oxygen		< 10 mi^2 watershed: 6 mg/L (primary*); 2 mg/L (critical*) 10 to 100 mi^2 watershed: 6 mg/L (primary*); 5 mg/L (critical*) > 100 mi^2 watershed: 6 mg/L (primary*); 6 mg/L (critical*)	
Bacteria	Primary Contact Waters (1 May – 30 September)	*E. coli*	Geometric mean of 126 colonies per 100 mL. Single sample maximum of 298 colonies per 100 mL.
		Fecal Coliform	Geometric mean of 200 colonies per 100 mL. Single sample maximum of 400 colonies per 100 mL.
	Secondary Contact Waters	*E. coli*	Geometric mean of 630 colonies per 100 mL. Single sample maximum of 1,490 colonies per 100 mL.
		Fecal Coliform	Geometric mean of 1,000 colonies per 100 mL. Single sample maximum of 2,000 colonies per 100 mL.
	Note:	Criteria shall not be exceeded in more than 25% of the samples, in no fewer than 8 samples taken during the primary or secondary contact season.	
Chloride		20 mg/L monthly average concentration	
Sulfate		20 mg/L monthly average concentration	
TDS		300 mg/L monthly average concentration	

* The primary season is the period of the year when water temperatures are 22 °C or below. This includes the major part of the year from fall through spring, including the spawning season of most fishes. It normally occurs from about mid-September to mid-May. The critical season is the period of the year when water temperatures exceed 22 °C. This is normally the hot, dry season, and after the majority of the fish spawning activities have ceased. This season normally occurs from about mid-May to mid-September.

3.4.2 STREAM CLASSIFICATIONS AND USE SUPPORT

ADEQ has established designated uses for all waters of the state of Arkansas including streams and publicly-owned lakes in the UIRW. The definitions of these designated uses are based on Regulation No. 2.

- **Extraordinary Resource Waters (ERWs):** These waters are designated for their scenic beauty, aesthetics, scientific values, broad recreation potential and intangible social values based on a combination of chemical, physical, and biological characteristics. **No streams in the UIRW are designated with this use by the state of Arkansas.**
- **Natural and Scenic Waterways (NSWs):** These waters have been legislatively adopted into a state or federal system of natural and scenic waterways. **No streams in the UIRW are designated with this use by the State of Arkansas.**
- **Ecologically Sensitive Waterbodies (ESWs):** These waters are known to provide habitat within the existing range of threatened, endangered or endemic species of aquatic or semi-aquatic organisms, including the Arkansas darter, least darter, Oklahoma salamander, Ozark cavefish, and cave snails and crayfish would be considered ERWs. **In the UIRW, the following stream reaches are considered ESWs (Figure 3.1):**
  1. **Illinois River (from the Arkansas - Oklahoma state line upstream to its confluence with Muddy Fork), and any other portion where the Neosho mucket is known to inhabit;**
  2. **Little Osage (from its confluence with Osage Creek ~2.5 miles upstream); and**
  3. **Numerous springs and spring-fed tributaries, which support threatened, endangered or endemic species (11 locations within the UIRW).**
- **Primary Contact Recreation:** These waters are designated for primary contact recreation, or full body contact, use. **All streams with drainage areas greater than 10 square miles and all lakes and reservoirs are designated with this use within the UIRW; this designated use typically applies from May 1 through September 30.**
- **Secondary Contact Recreation:** These waters are designated for secondary recreational activities including boating, fishing, or wading. **All waters in the UIRW are assigned this designated use.**
- **Domestic, Industrial Agricultural Water Supply:** These waters are designated for use as domestic, industrial or agricultural water supply. **All waters in the UIRW are assigned this designated use.**

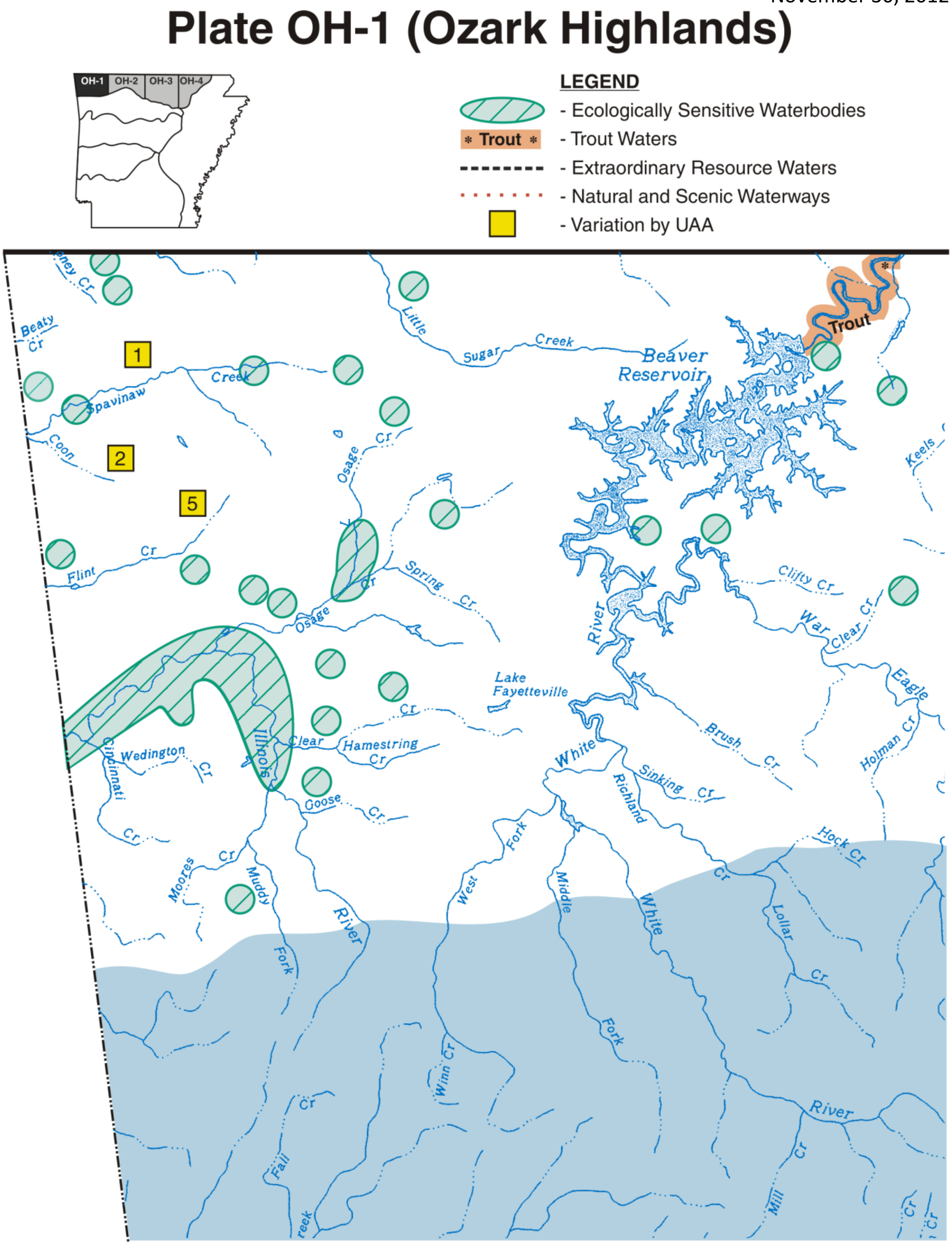


Figure 3.1. Ecologically sensitive waterbodies in the UIRW (from APCEC Regulation No. 2).

3.5 Regulated Activities

3.5.1 WASTEWATER EFFLUENT DISCHARGES

Activities that discharge treated wastewater to waters of the state must be permitted through the NPDES program managed by ADEQ. The NPDES permits set numeric limits for selected chemicals or other constituents that occur in the discharged wastewater to protect the water quality of the receiving waterbody. In May 2012 there were over 45 wastewater discharges with active NPDES permits in the UIRW, including industries, municipalities, and businesses.

The effluent limitations guidelines (40 CFR 400 through 699) specify discharge limitations for industries discharging to collection systems for municipal wastewater treatment facilities. In addition, local pre-treatment ordinances may impose additional and or more stringent limitations. The following cities within the Illinois River Watershed have established pre-treatment programs.

- Fayetteville (Title V, Chapter 51, Article III);
- Siloam Springs (Municipal Code, Chapter 98, Articles IV and V);
- Springdale (Code of Ordinances, Chapter 118); and
- Rogers (Code of Ordinances, Article V).

These cities require industries to pre-treat their wastewater before releasing it to the municipal wastewater treatment system. These cities issue permits to regulate discharges into their collection system.

3.5.2 MULTIPLE SEPARATE STORM SEWER SYSTEMS (MS4S)

Stormwater discharges for large- and medium-sized communities are controlled by the federal NPDES regulations, but are administered and enforced by ADEQ. The NPDES program regulates all major discharges of stormwater to surface waters. The purpose of the NPDES permits is to reduce pollutants in stormwater runoff from certain MS4s and industrial activities by requiring the development and implementation of stormwater management measures.

ADEQ has designated certain communities as MS4 communities and issued a general permit (No. ARR040000) with stormwater management conditions that all MS4 communities had to meet by 2008, which included the following:

- Public education,
- Public involvement/participation,
- Illicit discharge detection and elimination,
- Construction site runoff control plan,

- Post-construction stormwater management program, and
- Pollution prevention/good housekeeping.

Stormwater management plans document the practices and programs that each community will use to achieve the required management conditions. In the UIRW, MS4 communities include Bentonville, Fayetteville, Farmington, Johnson, Little Flock, Greenland, Lowell, Elm Springs, Rogers, Springdale, Bethel Heights, Benton County, Washington County, and the University of Arkansas. These MS4 communities have contracted with UAEX to develop and administer a Northwest Arkansas Regional Stormwater Education Program covering Benton and Washington counties, or the "Fayetteville – Springdale" urbanized area. This program is designed to address the public education and involvement requirements of the MS4 general permit through development of educational materials for the general public and schools (fact sheets, brochures, and posters), conducting public outreach and youth education, and hosting workshops and training events. Table 3.3 summarizes the status of the MS4 requirements for the different jurisdictions.

Table 3.3. Regulated MS4 communities and status of permit requirements.

Area	Public Education	Public Involvement	Illicit Discharge Plan	Construction Site Control	Post-Construction Control	Pollution Prevention Plan
Bentonville	●	●	◗	Ordinance ●	Ordinance ●	●
Fayetteville	●	●	●	Ordinance ●	Ordinance ●	●
Farmington	●	●	◗	Ordinance ●	Ordinance ◗	◗
Johnson	●	●	◗	Ordinance ●	Ordinance ●	●
Little Flock	●	●	●	Ordinance ●	●	◗
Greenland	●	●	◗	Plan ●	●	●
Lowell	●	●	◗	Ordinance ●	●	◗
Elm Springs	●	●	●	◗	●	◗
Rogers	●	●	◗	Ordinance ●	Ordinance ●	●
Springdale	●	●	●	Ordinance ●	Ordinance ●	●
Bethel Heights	●	●	●	Ordinance ●	Ordinance ●	●
U of A	●	●	●	●	◗	●
Benton Co.	●	●	●	Order ●	Order ●	●
Washington Co.	●	●	◗	Order ●	Order ●	●

Note: ○ 0 to 20% complete
◗ 40% to 60% complete
● 100% complete or fully meeting requirements

3.5.3 STORMWATER RUNOFF

Local storm runoff ordinances are discussed in Section 3.3.2. ADEQ issues NPDES permits for stormwater discharges for construction and industrial sites. Agricultural activities are exempt from the requirement to obtain an NPDES stormwater discharge permit. In May 2012, there were approximately 190 active stormwater discharge permits for sites in the UIRW.

3.5.3.1 *Construction*

ADEQ utilizes a statewide general NPDES permit (ARR150000) to authorize stormwater discharges from construction projects that will result in greater than 1 acre of land disturbance. Projects that disturb between 1 acre and 5 acres are deemed “small” construction projects and are automatically covered by the general permit. A Stormwater Pollution Prevention Plan (SWPPP) is required for small construction projects but ADEQ review of the SWPPP is not required. For projects that exceed 5 acres (i.e., “large” projects), application must be made to ADEQ for coverage under the general permit, and the SWPPP must be reviewed and approved by ADEQ prior to construction.

Under the general permit, operators are required to implement best management practices (BMPs) to minimize sediment transport from the construction site. The BMPs must be routinely inspected and maintained, and additional BMPs must be utilized if those in place prove inadequate. Inspections, maintenance activities, and revisions must be documented in the SWPPP. Temporary BMPs must remain in place until the site has been revegetated to at least 80% of pre-construction conditions or otherwise stabilized. For large projects, the operator must document stabilization of the construction site to ADEQ prior to termination of permit coverage.

3.5.3.2 *Industrial*

ADEQ also utilizes a statewide general NPDES permit (ARR000000) to authorize stormwater discharges from certain industrial activities. Eligibility for coverage under the general permit is dependent upon a facility’s Standard Industrial Classification (SIC) code.

Under the general permit, facilities are required develop a SWPPP documenting the BMPs implemented to minimize the transport of contaminants from the areas of industrial activity. Stormwater outfalls from these areas must be sampled twice per year and analyzed for TSS, chemical oxygen demand, oil and grease, and pH. Additional parameters may be required based on the facility’s SIC code. The permit does not establish discharge limitations; however, concentrations are expected to be less than parameter benchmark values specified in the permit. If a benchmark value is exceeded, the facility is required to identify and implement corrective actions to improve stormwater quality. The facility is also required to perform quarterly visual inspections of the stormwater drainage system as well as an annual comprehensive review of the site and any required updates to the SWPPP. The facility must submit an annual report to ADEQ documenting the sampling results, inspections, and any corrective actions taken.

3.5.4 AGRICULTURE

State regulations of agriculture in the UIRW are described in Section 3.2. In the UIRW, poultry feeding operations where more than 2,500 poultry are housed or maintained must be registered with ANRC and prepare a Nutrient Management Plan. These plans must be prepared by persons certified to do so. In addition, agricultural applications of nutrients in any form, whether commercial fertilizer, poultry litter, or other manure, are required to be conducted by persons trained and certified by ANRC.

Element 1: Identification of Causes and Sources of Impairment

4

The objective of this plan is to help UIRW waterbodies to attain designated uses and remove these waterbodies from the 303(d) list. Therefore, this chapter addresses the causes and sources associated with waterbodies in the UIRW that have been identified as not attaining their designated uses by ADEQ or EPA Region 6. EPA Region 6 is currently preparing a TMDL for phosphorus for the Illinois River watershed, which will identify phosphorus sources and load reduction estimates in the watershed. Therefore, phosphorus sources will not be discussed here, and waterbodies listed only for phosphorus will not be addressed. This plan may be modified to address phosphorus once the TMDL is completed.

4.1 Impaired Stream Reaches in the Illinois River

ADEQ submits a list of waterbodies to EPA that do not meet current water quality standards, or assessment criteria, and/or do not support designated beneficial uses, called the 303(d) list. This watershed-based plan addresses the impaired stream reaches identified on the 2008, and 2010 and 2012 Arkansas 303(d) lists, which were based on evaluation of data collected between July 1, 2002, and March 31, 2011. ADEQ listed six stream segments in the UIRW as impaired in 2008 and five stream segments as impaired in the 2010 and 2012 within the UIRW. In 2008, EPA added nine stream segments and one reservoir to this list for a total of 14 listed waterbodies in the UIRW. The locations of the waterbodies included on the three Arkansas 303(d) lists are shown on Figure 4.1. Locations of ADEQ monitoring sites and stream segments are also shown on Figure 4.1. Note that there are HUC12 watersheds where water quality is not routinely assessed. The impairments are listed in Table 4.1. (Note: Segment 29 is listed twice because this segment occurs in two different HUC12 subwatersheds.) The 2010 and 2012 ADEQ 303(d) lists are still s and have not yet been approved by EPA. The majority of the 2008 listed segments were categorized as high-priority for restoration. In 2010 and 2012, only the Sager Creek segment is listed as high-priority for restoration with the remaining sites listed as low-priority.

4.2 Causes of Water Quality Impairment

The pollutants identified as the causes of impairment (Table 4.1), excluding total phosphorus, include:

- Pathogens,
- Sediment, and
- Nitrates.

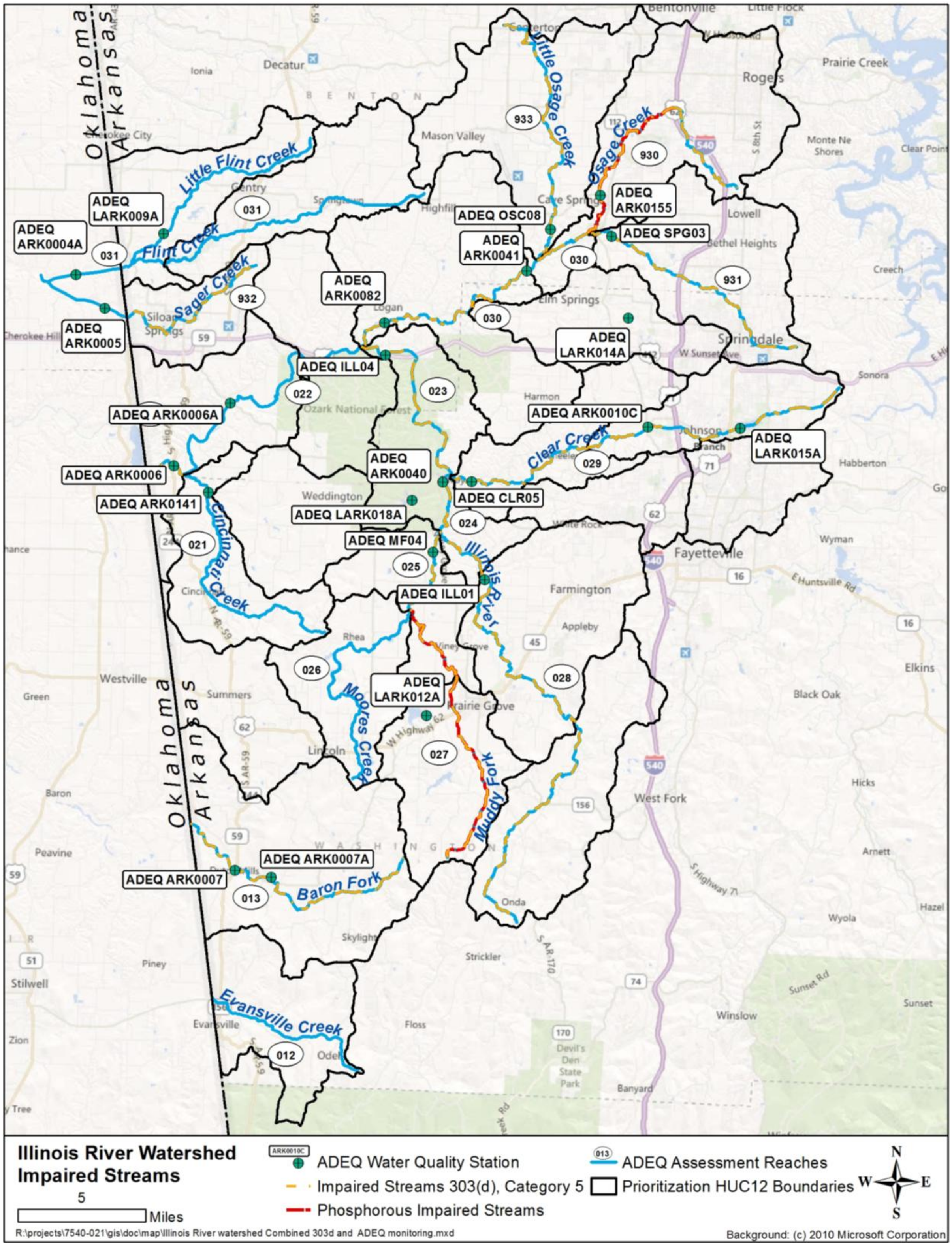


Figure 4.1. 303(d)-listed impaired stream segments within the UIRW. The orange segments represent all 303(d)-impaired streams while the red segments are those impaired due to total phosphorus only (excluded from this watershed-based management plan). Blue line streams were assessed and are not impaired.

Table 4.1. UIRW HUC12 priority watersheds based on approved and Arkansas 303(d) lists.

Impaired Reach	Designated Use Impaired	2008 Pollutant of Concern	2010 Pollutant of Concern	2012 Pollutant of Concern	HUC12 Name	Predominant Pollutant Source
Reaches Listed by ADEQ						
11110103-020	Aquatic Life Fisheries	Sediment	Not listed	Not listed	Lake Frances – Illinois River	Surface Erosion
11110103-023	Primary Contact	Pathogens	Pathogens	Pathogens	Illinois River – Lake Wedington	Agriculture
11110103-024	Primary Contact	Sediment, pathogens	Sediment, pathogens	Sediment, pathogens	Illinois River – Lake Wedington	Sediment: Surface Erosion Pathogens: Agriculture
11110103-025	Primary Contact	Pathogens, total phosphorus	Pathogens	Pathogens	Lower Muddy Fork – Illinois River	Agriculture
11110103-029	Primary Contact	Pathogens	Pathogens	Pathogens	Lake Fayetteville – Clear Creek	Urban
11110103-029	Primary Contact	Pathogens	Pathogens	Pathogens	Little Wildcat – Clear Creek	Urban
11110103-932	__	Nitrate	Nitrate	Nitrate	Sager Creek	Municipal Point Source
Additional 2008 Segments Listed by EPA Region 6						
11110103-013	Primary Contact	Pathogens	Not listed	Not listed	Upper Baron Fork	Unknown
11110103-027		Total phosphorus	Not listed	Not listed	Upper Muddy Fork – Illinois River; Lower Muddy Fork – Illinois River	Unknown
11110103-028	Primary Contact	Pathogens	Not listed	Not listed	Headwaters Illinois River, Goose Creek – Illinois River	Unknown
11110103-030	Primary Contact	Pathogens, total phosphorus	Not listed	Not listed	Osage Creek – Illinois River	Unknown
11110103-930		Total phosphorus	Not listed	Not listed	Headwaters Osage Creek – Illinois River	Unknown
11110103-933	Primary Contact	Pathogens	Not listed	Not listed	Little Osage Creek	Unknown
11110103-931	Primary Contact	Pathogens, total phosphorus	Not listed	Not listed	Spring Creek – Osage Creek	Unknown
Swepco Lake	Aquatic Life	Unknown	Unknown	Unknown	Middle Flint Creek	Unknown

There are about 1,100 miles of streams in the UIRW, and about 103 miles of impaired streams are caused by these pollutants, or about 10% of the total number of stream miles. About 91 stream miles are impaired by pathogens, 4 stream miles impaired by sediment, and 8 stream miles impaired by nitrate.

Turbidity, TSS, *E. coli*, and nitrate data for selected monitoring sites on impaired streams were reviewed for the period from 1997 to the present (Figures 4.2 through 4.4). The relevant water quality standard (WQS) is shown on the respective figures. From 2000 to 2010, the population in the UIRW grew by 30%, yet there were statistically significant decreases in flow-adjusted TSS concentrations at monitoring sites on Ballard Creek, Osage Creek near Elm Springs, and the Illinois River south of Siloam Springs (Bailey et al. 2012). These sites were associated with Section 319 priority watersheds. In addition, there was a significant decrease in nitrate concentrations in Sager Creek over this same period, with concentrations consistently less than the drinking water standard of 10 mg/L beginning in 2007 (Figure 4.4). Possible sources of these pollutants are discussed in the following sections.

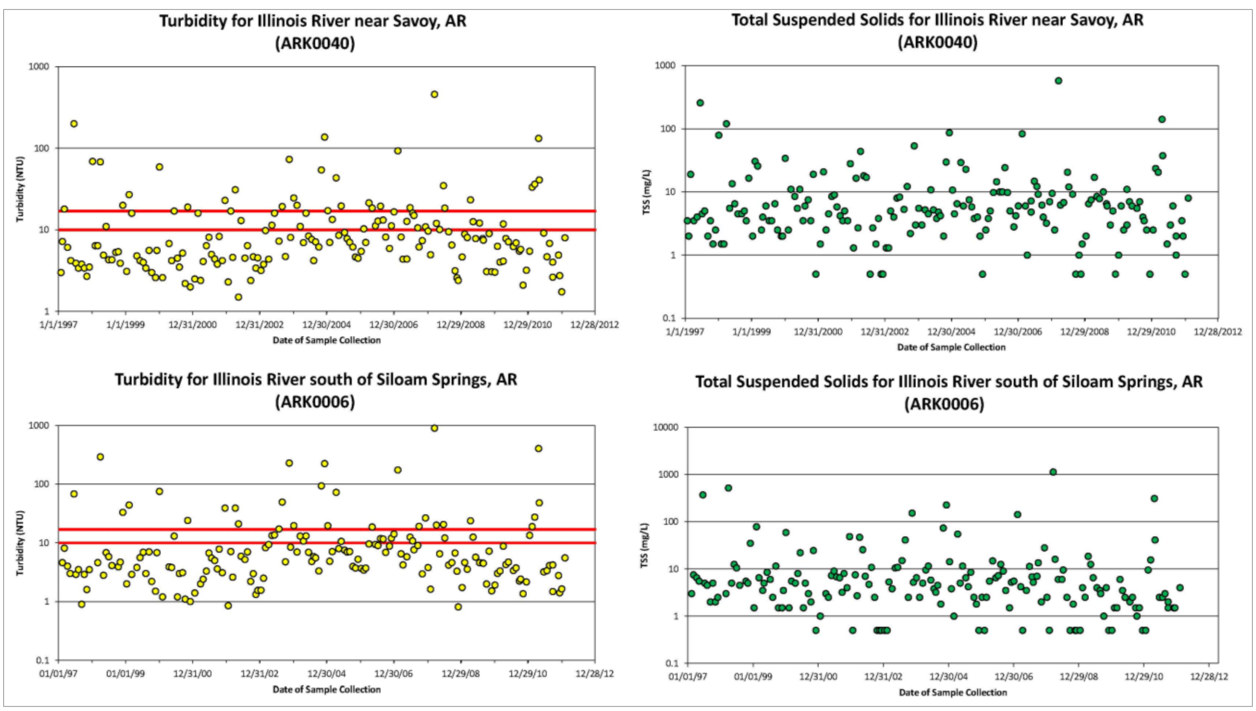
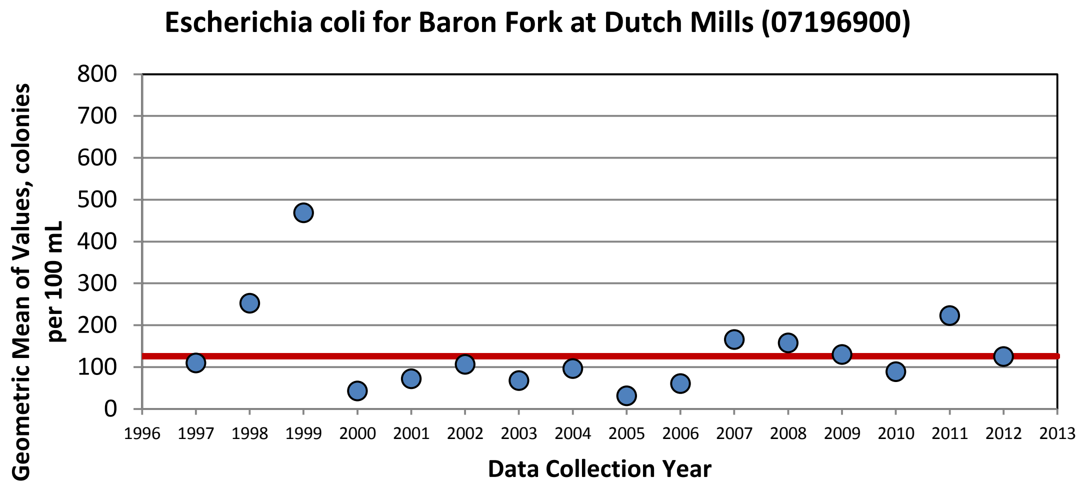


Figure 4.2. Plots of turbidity and TSS data from monitoring stations of impaired streams. The upper red line on the turbidity graphs represents the storm flow turbidity criterion of 17 NTUs while the lower red line represents the base flow turbidity criterion of 10 NTUs. There is no numeric WQS for TSS.



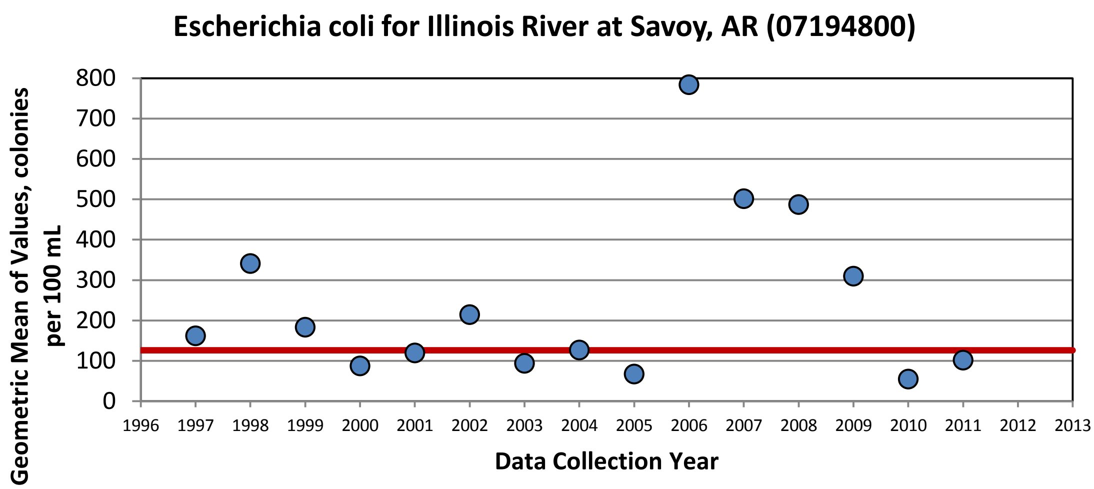


Figure 4.3. Plots of *E. coli* annual geometric means from monitoring stations on impaired streams. The primary contact recreation criterion for *E. coli* is a geometric mean of 126 colonies per 100 mL (red line).

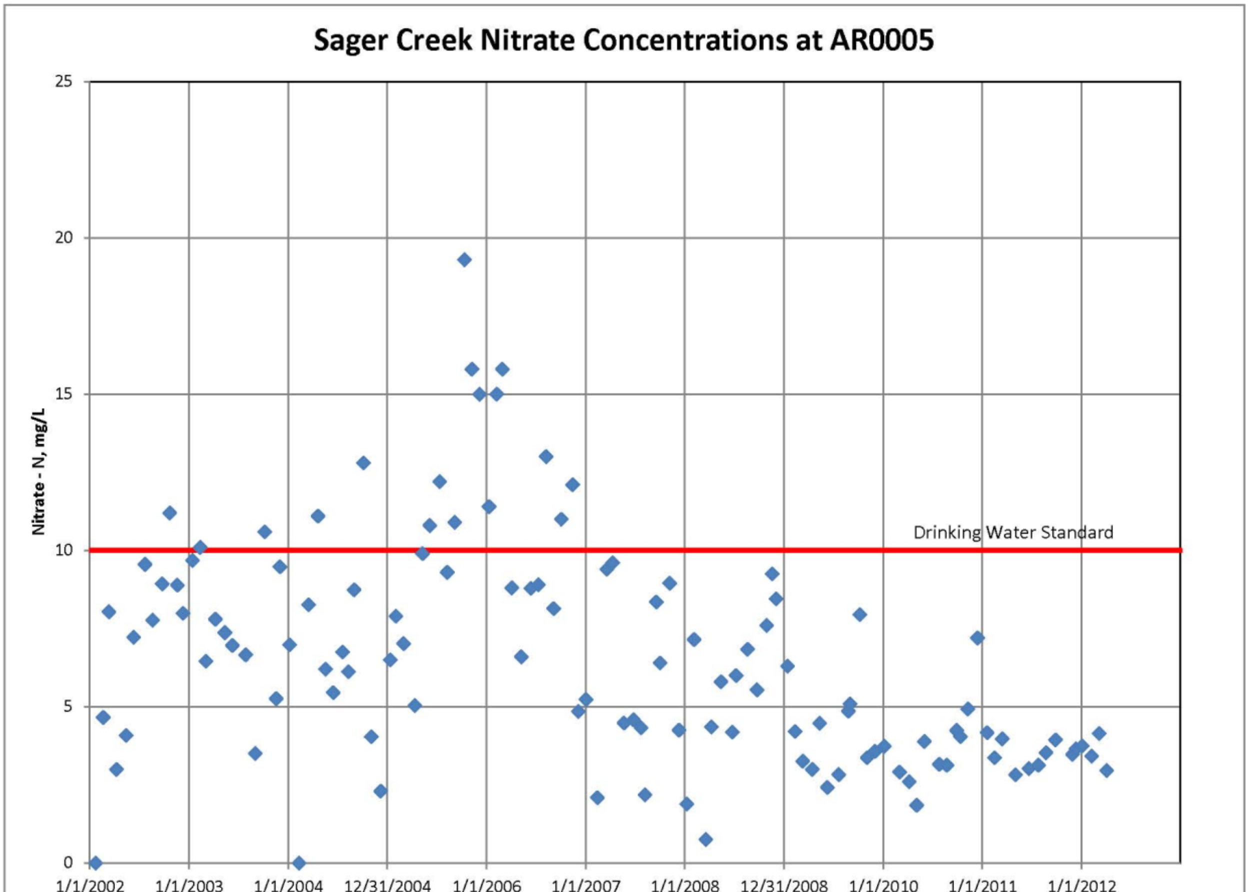


Figure 4.4. Sager Creek nitrate concentrations, January 2002 to January 2012.

4.3 Sources of Pollutants Causing Water Quality Impairment

Possible sources in the UIRW of the pollutants identified in Section 4.2 include municipal wastewater treatment plant effluent; leaking sewers; illicit discharges; combined sewer overflow; failing septic systems; agriculture; fertilizer use in developed areas and golf courses; wildlife, domestic pets, or other warm-blooded animals; and erosion from pasture, roads, road crossings, and stream banks. In addition, because of the karst geology, groundwater contaminated through infiltration might serve as a source of some pollutants when it discharges into the stream (Davis et al. 2000, 2006; Marshall et al. 1995). Greater specificity in possible pollutant sources can be obtained by considering the land use/land cover in the HUC12 subwatershed, wastewater treatment plant outfall locations, karst sensitive areas, and the location of the monitoring station in the watershed. Possible sources of impairment are listed in Table 4.2 for each HUC12 subwatershed that contains stream segments that are impaired. These sources are discussed for rural and urban watersheds.

Table 4.2. Land use within each UIRW HUC12 with impaired stream reaches. The pollutant impairing the reach, and possible source, if any, of the pollutant identified in the ADEQ 303(d) list are shown in bold. Other possible sources are also listed below the bold-faced source. Land use legend—green: forest; yellow: grassland/pasture; red: urban; blue: water.

ILLINOIS RIVER -LAKE WEDINGTON | HUC NO. 3 (111101030103)

Lake Wedington-Illinois River HUC lies downstream of and is influenced by 10 other HUCs in the UIRW.

Land Use	% Area	Pollutant	Possible Sources
Developed	4.4	Pathogens	**URBAN:** Failing septic systems, illicit discharge, wildlife, waterfowl and domestic pets, urban runoff
		Sediment	**URBAN:** Impervious roads, parking lots, stream bank erosion, construction
Forested	58.7	Pathogens	Wildlife, waterfowl
		Sediment	Unpaved roads, stream bank erosion, harvesting disturbances
Grassland/Pasture	34.2	Pathogens	**AGRICULTURE:** Manure/litter application runoff, cattle in stream, poultry litter storage, failing septic systems, illicit discharge, wildlife, waterfowl, animal feeding operations (AFOs)
		Sediment	**SURFACE EROSION:** Unpaved roads, stream bank erosion, cattle in stream, overgrazed pasture

LOWER MUDDY FORK-ILLINOIS RIVER | HUC NO. 15 (111101030403)

Lower Muddy Fork-Illinois River HUC lies downstream of and is influenced by Upper Muddy Fork and Moores Creek HUCs.

Land Use	% Area	Pollutant	Possible Source
Developed	4.5	Pathogens	**URBAN:** Failing septic systems, illicit discharge, wildlife, waterfowl and domestic pets, urban runoff
Forested	20.6	Pathogens	Wildlife, waterfowl
Grassland/Pasture	74.1	Pathogens	**AGRICULTURE:** Manure/litter application runoff, cattle in stream, poultry litter storage, failing septic systems, illicit discharge, wildlife, waterfowl, AFOs

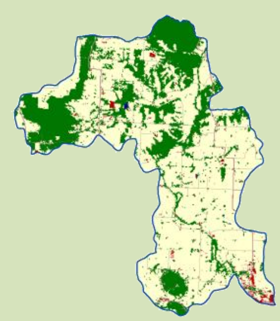
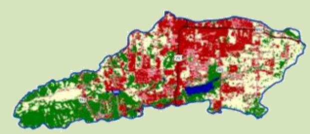


Table 4.2. Land use within each HUC12 with impaired stream reaches in the UIRW (continued).

LAKE FAYETTEVILLE-CLEAR CREEK | HUC NO. 4 (111101030201)

Lake Fayetteville-Clear Creek HUC lies downstream of and is influenced by Mud Creek-Clear Creek HUC.

Land Use	% Area	Pollutant	Possible Source	
Developed	33.2	Pathogens	**URBAN:** Failing septic systems, illicit discharge, urban runoff, domestic pets, wildlife, waterfowl, sewer overflow or leaks, urban runoff	
Forested	20.8	Pathogens	Wildlife, waterfowl	
Grassland/Pasture	43.0	Pathogens	Manure/litter application runoff, cattle in stream, poultry litter storage, failing septic systems, illicit discharge, wildlife, waterfowl, AFOs	

LITTLE WILDCAT-CLEAR CREEK | HUC NO. 7 (111101030204)

Little Wild Cat-Clear Creek lies down stream of and is influenced by three other HUCs in the UIRW.

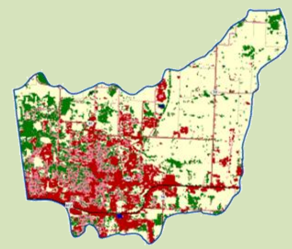
Land Use	% Area	Pollutant	Possible Source	
Developed	7.3	Pathogens	**URBAN:** Failing septic systems, illicit discharge, urban runoff, domestic pets, wildlife, waterfowl, sewer overflow or leaks, urban runoff	
Forested	35.1	Pathogens	Wildlife, waterfowl	
Grassland/Pasture	56.6	Pathogens	Manure/litter application runoff, cattle in stream, poultry litter storage, failing septic systems, illicit discharge, wildlife, waterfowl, AFOs	

Table 4.2. Land use within each HUC12 with impaired stream reaches in the UIRW (continued).

SAGER CREEK | HUC NO. 17 (111101030502)

Sager Creek HUC is a headwaters HUC and is not influenced by other HUCs in the UIRW.

Land Use	% Area	Pollutant	Possible Source
Developed	34.6	Nitrates	**MUNICIPAL POINT SOURCE (WWTP):** Home fertilizers, failing septic systems, illicit discharges, leaking sewers, wildlife, waterfowl, domestic pets, urban runoff
Forested	6.3	Nitrates	Fertilizer applications, wildlife, waterfowl
Grassland/Pasture	58.3	Nitrates	Manure/litter application, wildlife, waterfowl, AFOs, septic systems, cattle in stream



HEADWATERS BARON FORK | HUC NO. 24 (111101030701)

Headwaters Baron Fork HUC is not influenced by other HUCs in the UIRW.

Land Use	% Area	Pollutant	Possible Source
Developed	3.7	Pathogens	**UNKNOWN:** Failing septic systems, illicit discharge, wildlife, waterfowl and domestic pets, urban runoff
Forested	46.0	Pathogens	**UNKNOWN:** Wildlife, waterfowl
Grassland/Pasture	49.9	Pathogens	**UNKNOWN:** Manure/litter applications, failing septic systems, illicit discharge, wildlife, waterfowl, domestic pets, AFOs, cattle in stream

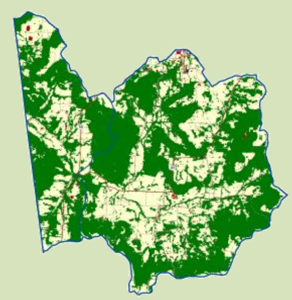
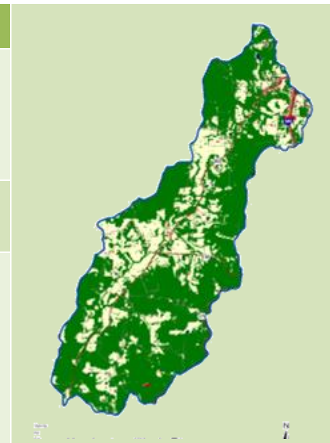


Table 4.2. Land use within each HUC12 with impaired stream reaches in the UIRW (continued).

HEADWATERS ILLINOIS RIVER | HUC NO. 1 (111101030101)

Headwater Illinois River HUC is not influenced by any other HUC in the UIRW.

Land Use	% Area	Pollutant	Possible Source
Developed	4.4	Pathogens	**UNKNOWN:** Failing septic systems, illicit discharge, wildlife, waterfowl, domestic pets
Forested	55.7	Pathogens	**UNKNOWN:** Wildlife, waterfowl
Grassland/Pasture	39.4	Pathogens	**UNKNOWN:** Manure/litter applications, failing septic systems, illicit discharge, wildlife, waterfowl, domestic pets, AFOs, cattle in stream



GOOSE CREEK-ILLINOIS RIVER |HUC NO. 2 (111101030102)

Goose Creek HUC lies downstream of the headwaters of the Illinois River HUC.

Land Use	% Area	Pollutant	Possible Source
Developed	11.1	Pathogens	**UNKNOWN:** WWTP, failing septic systems, illicit discharge, wildlife, waterfowl, domestic pets, urban runoff, sewer overflow or leaks
Forested	23.1	Pathogens	**UNKNOWN:** Wildlife, waterfowl
Grassland/Pasture	64.9	Pathogens	**UNKNOWN:** Manure/litter applications, failing septic systems, illicit discharge, wildlife, waterfowl, domestic pets, AFOs, cattle in stream

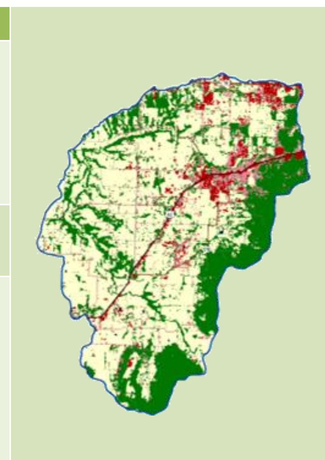


Table 4.2. Land use within each HUC12 with impaired stream reaches in the UIRW (continued).

OSAGE CREEK-ILLINOIS RIVER | HUC NO. 12 (111101030305)

Osage Creek-Illinois River HUC lies downstream of and is influenced by five other HUCs in the UIRW.

Land Use	% Area	Pollutant	Possible Source
Developed	5.8	Pathogens	**UNKNOWN:** WWTP, failing septic systems, illicit discharge, wildlife, waterfowl, domestic pets, urban runoff, sewer overflow or leaks
Forested	29.5	Pathogens	**UNKNOWN:** Wildlife, waterfowl
Grassland/Pasture	63.9	Pathogens	**UNKNOWN:** Manure/litter applications, failing septic systems, illicit discharge, wildlife, waterfowl, domestic pets, AFOs, cattle in stream

LITTLE OSAGE CREEK-ILLINOIS RIVER | HUC NO. 10 (111101030303)

Little Osage Creek is a headwaters HUC and is not influenced by other HUCs in the UIRW.

Land Use	% Area	Pollutant	Possible Source
Developed	18.2	Pathogens	**UNKNOWN:** failing septic systems, illicit discharge, wildlife, waterfowl, domestic pets, urban runoff, sewer overflow or leaks
Forested	10.9	Pathogens	**UNKNOWN:** Wildlife, waterfowl
Grassland/Pasture	70.1	Pathogens	**UNKNOWN:** Manure/litter applications, failing septic systems, illicit discharge, wildlife, waterfowl, domestic pets, AFOs, cattle in stream

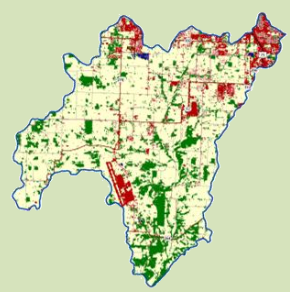
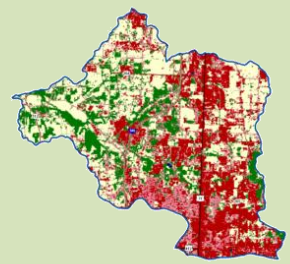


Table 4.2. Land use within each HUC12 with impaired stream reaches in the UIRW (continued).

SPRING CREEK-OSAGE CREEK | HUC NO. 9 (111101030302)

Spring Creek is a headwaters HUC and is not influenced by other HUCs in the UIRW.

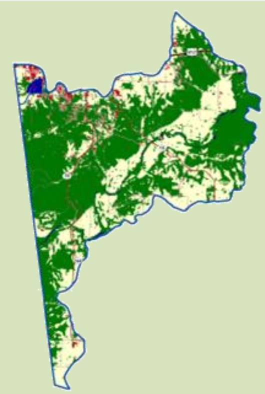
Land Use	% Area	Pollutant	Possible Source
Developed	38.3	Pathogens	**UNKNOWN:** WWTP; failing septic systems; illicit discharge, wildlife, waterfowl, domestic pets, urban runoff, sewer overflow or leaks
Forested	12.2	Pathogens	**UNKNOWN:** Wildlife, waterfowl
Grassland/Pasture	47.6	Pathogens	**UNKNOWN:** Manure/litter applications, failing septic systems, illicit discharge, wildlife, waterfowl, domestic pets, AFOs, cattle in stream



LAKE FRANCES-ILLINOIS RIVER | HUC NO. 23 (111101030606)

Lake Frances-Illinois River HUC is the outlet of the UIRW and lies downstream of 19 other HUCS.

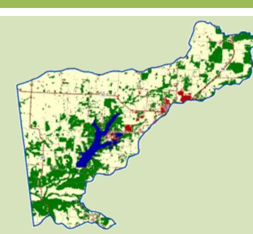
Land Use	% Area	Pollutant	Possible Source
Developed	6.8	Sediment	**SURFACE EROSION:** Impervious roads, parking lots, stream bank erosion, construction
Forested	45.1	Sediment	**SURFACE EROSION:** unpaved roads, stream bank erosion, harvesting disturbances
Grassland/Pasture	46	Sediment	**SURFACE EROSION:** Cattle in stream, overgrazed pasture, unpaved roads, stream bank erosion



MIDDLE FLINT CREEK | HUC NO. 18 (111101030503)

Middle Flint Creek HUC lies downstream of and is influenced by Headwater of Flint Creek HUC.

Land Use	% Area	Pollutant	Possible Source
Developed	7.0	**UNKNOWN**	**UNKNOWN**
Forested	20.9	**UNKNOWN**	**UNKNOWN**
Grassland/Pasture	68.7	**UNKNOWN**	**UNKNOWN**



* Land-use percentages do not sum to 100% because of small areas of open water, barren land, shrub, cultivated land, etc.

4.3.1 PATHOGENS

The pathogenic indicators monitored by ADEQ are fecal coliforms and *E. coli*, both of which are of fecal origin and are found in warm-blooded animals such as cattle, swine, deer, poultry, wild turkey, other birds, ducks, geese, other waterfowl, cats, dogs, other pets, and humans. These pathogenic indicators are not pathogenic themselves, but can co-occur with pathogens and serve as surrogates to indicate fecal contamination.

4.3.1.1 *Rural Areas*

Several of the HUC12 watersheds have agriculture listed as the possible source of pathogens, while others have the source listed as unknown (Table 4.1). The segments with the source listed as unknown were added by EPA Region 6 to the 2008 303(d) list based on an analysis of *E. coli* data collected primarily from a special study conducted in these watersheds during 2006. The EPA Region 6 assessment determined that there were exceedances of the primary contact recreation criterion for *E. coli* of a geometric mean greater than 126 colonies per 100 mL or greater than 25% of the samples exceeding 410 colonies per 100 mL. There were no exceedances of secondary contact recreation criteria for *E. coli* (geometric mean of greater than 630 colonies per 100 mL or single sample greater than 2,050 colonies per 100 mL) in the EPA Region 6 assessment of monitored data in the UIRW.

Annual geometric means for *E. coli* were determined for Baron Fork, Osage Creek, and the Illinois River at Savoy, AR (Figure 4.3). During the period from 2007 through 2009, *E. coli* geometric means were greater than the WQS in all three subwatersheds. Precipitation and runoff were significantly greater in 2008 in all three subwatersheds (Figure 4.5), which may have contributed to the higher geometric means during 2008. While precipitation and flow can contribute to higher stream *E. coli* concentrations, other watershed factors are as important as flow, if not more so, with regard to elevated fecal coliform concentrations. For example, the highest *E. coli* annual geometric mean at the Illinois River at Savoy gage was observed in 2006, which was a drought year in that subwatershed. Changes in watershed land use or management likely contributed to increased fecal coliform concentrations in addition to flow. Some of these possible changes include urbanization, leaking sewer lines or failing septic systems, increased runoff, cattle wading in the streams, or increased waterfowl populations. Nutrient management plans and watershed management activities should be reviewed for these subwatersheds over the past 5 years to determine what changes, if any, might have occurred within these subwatersheds.

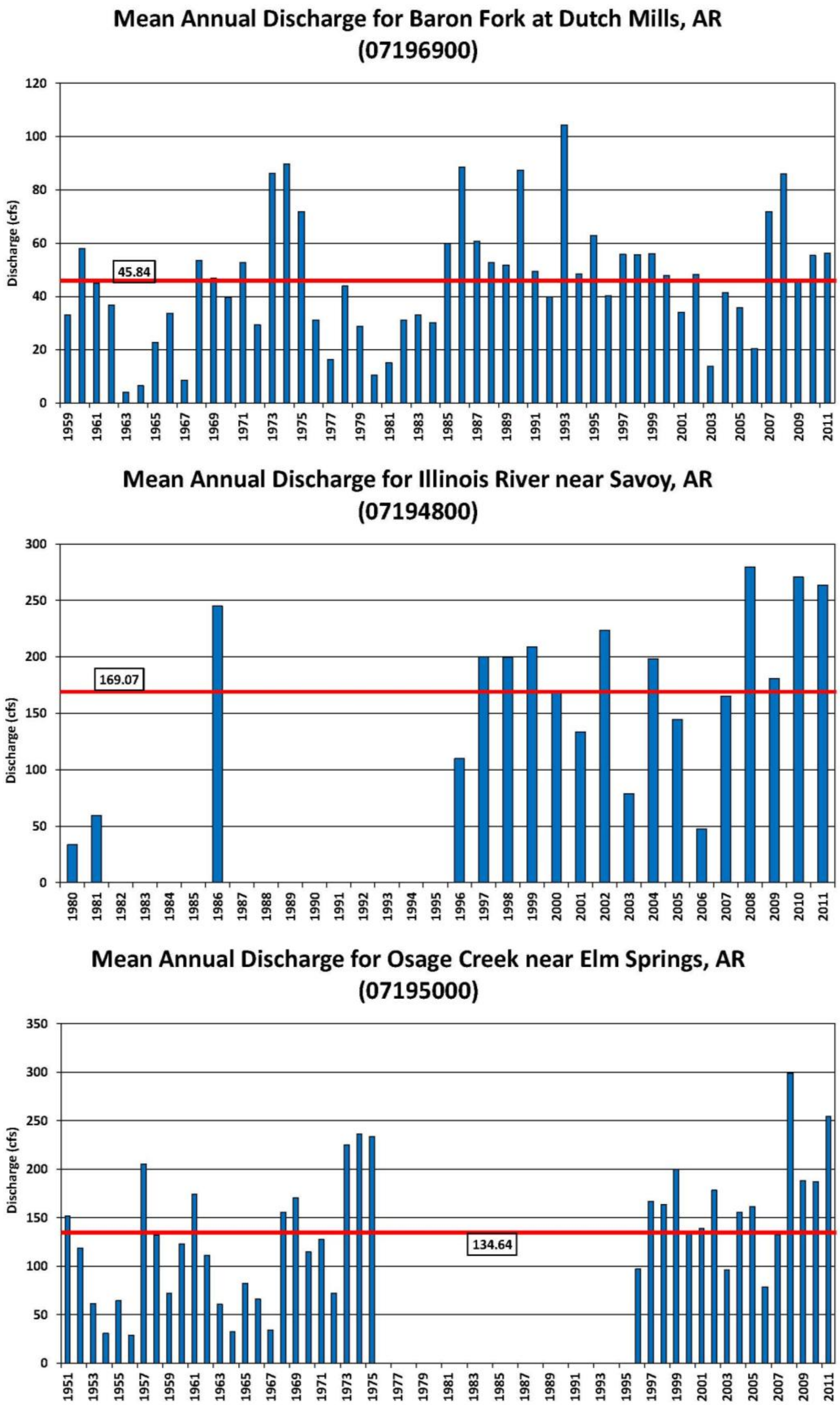


Figure 4.5. Mean annual discharge at selected water quality stations.

Rural land use areas in HUC12 subwatersheds with pathogen-impaired stream reaches ranged from 58% forested with 34% grassland/pasture in the Illinois River-Lake Wedington HUC to 11% forested with 70% grassland/pasture in the Little Osage Creek-Illinois River subwatershed (Table 4.2). Poultry litter applications in these sub watersheds represents one possible source of pathogens. Pathogens present in poultry litter can wash into the streams during storm events (Sistani et al. 2010, Soupir et al. 2006). The 2011 application of poultry litter in each watershed is shown in Table 4.3. In addition to the applications, the amount of poultry litter generated, stored, and transferred out of the watershed, as well as used in-house, is also shown in Table 4.3. Over 80% of the generated poultry litter is being transferred out of the UIRW watershed. As fertilizer prices increase and producers in other watersheds discover the value of poultry litter not only as fertilizer, but also an energy source, this percentage could increase further. Runoff from litter storage and poultry house areas also has the potential to contribute pathogens to surface waters.

Table 4.3. 2011 Application of poultry litter in each HUC12 with pathogen-impaired streams.

HUC12 Name	Poultry Litter Applied (tons)	Poultry Litter Stored (tons)	Poultry Litter Exported (tons)	% of Total Generated Exported	Poultry Litter Used In-House (tons)	Poultry Litter Generated (tons)	No. Houses
Lake Frances – Illinois River	48	0	894	90	55	998	15
Middle Flint Creek	107	196	6,383	87	655	7,342	58
Lower Muddy Fork – Illinois River	684	245	8,477	87	293	9,700	55
Headwaters Illinois River	448	102	1,939	65	460	2,990	24
Goose Creek – Illinois River	527	0	681	48	200	1,408	17
Lake Wedington – Illinois River	20	0	0	0	225	245	6
Lake Fayetteville – Clear Creek	240	0	829	78	0	1,069	12
Little Wildcat Creek – Clear Creek	157	50	2,291	71	714	3,212	29
Sager Creek	392	100	3,146	85	50	3,688	24
Upper Baron Fork	3,084	599	7,005	58	1,418	12,106	86
Osage Creek – Illinois River	1,067	0	5,033	56	250	3,650	60
Little Osage Creek	521	0	4,665	90	0	5,186	46
Spring Creek – Osage Creek	162	50	8,626	84	1,377	10,215	59

Benton and Washington counties are the largest producers of beef in the state. Estimates of commercial animal production in Benton and Washington counties are shown in Table 4.4. Beef production in the UIRW consists of non-commercial grazing systems. Pasture in the UIRW is fertilized. In the past, poultry litter was the fertilizer of choice for pasture in the watershed. Manure from swine operations is also applied to pastures in the UIRW. In addition, manure from swine operations is typically stored in ponds, which have the potential to overflow during rainstorms. It is believed that runoff from pastures fertilized with poultry litter or manure (swine and/or cattle) has resulted in bacterial contamination of streams (Soupir et al. 2006). While bacteria typically disappear from the water column within a few days, bacteria may reside and remain viable in watershed soils or stream sediments for weeks or up to months (Burton et al. 1987, Davies et al. 1995, Edwards 1997, Marshall 1998, Teague et al. 1995).

Table 4.4. Estimated commercial animal production (animal units) in Benton (B) and Washington (W) counties from 1997 to 2007 (USDA NASS 2002, 2007).

Type	1997		2002		2007	
	B	W	B	W	B	W
Broilers	20,360,012	16,291,890	18,987,821	16,067,787	18,950,094	20,487,381
Swine	70,000	84,000	ND*	56,051	ND*	80,817
Cattle	110,000	109,000	112,000	111,000	107,000	106,000

*ND – No data reported in reference.

Cattle on pasture can contribute bacteria to pasture streams by defecating directly into the stream. Cattle manure on pasture may also contribute bacteria to pasture runoff. In addition, many of these rural subwatersheds are forested, so wildlife excrement is another pathogen source.

Rural areas are primarily served by onsite wastewater treatment systems, which could also represent a potential source of pathogens. Failing septic or onsite systems can contribute pathogenic indicators to the stream or leach into groundwater and subsequently be discharged into the stream. Even in HUC12s considered rural, the developed area percentages range from 3.7% to 38%. Some of these HUC12s have small municipal wastewater treatment facilities. A list of the major municipal facilities, cluster facilities, and other permitted sewage treatment discharges in the HUC12s is provided in Table 4.5. While there is no indication that these wastewater treatment systems are pathogen sources, the objective of this element is to identify *possible* sources, and municipal wastewater treatment systems are possible sources.

Karst areas underlying manure/litter applications, leaking sewers, or failing septic systems might be susceptible to groundwater contamination. Groundwater can transport pathogens from the area of contamination to the stream where groundwater discharges to surface flow (Davis et al. 2006). *E. coli* have been found in groundwater and cave streams in the UIRW (Davis et al. 2000, 2006). Brown et al. (1998) and Graening and Brown (1999, 2000) found a correlation between *E. coli* in cave streams and the infiltration of runoff during storm events. The karst geology in the watershed permits rapid infiltration into groundwater. LID and stormwater management practices that promote infiltration may contribute pathogens to groundwater in karst-sensitive areas. This contaminated groundwater may then discharge into streams. Management practices in karst-sensitive areas should receive greater scrutiny to ensure these practices do not inadvertently contribute to surface or groundwater pollution.

Table 4.5. Major municipal facilities, cluster facilities, and other permitted sewage treatment discharges in the UIRW.

HUC12 Name	Percent Urban	Permitted Wastewater Discharges	Receiving Waterbody
Goose Creek- Illinois River	11.1	Fayetteville	Goose Creek
Headwaters Osage Creek	44.0	Rogers NACA Regional Mandalea and Legacy Subdivisions, Cave Springs	Osage Creek
Lake Fayetteville – Clear Creek		Steel Creek Subdivision, Springdale	
Little Osage Creek		Cowager Property, Centerton	
Lower Muddy Fork- Illinois River	4.4	Prairie Grove	Muddy Fork
Middle Flint Creek	7.0	Gentry	SWEPCO Lake
Sager Creek	34.6	Siloam Springs	Sager Creek
Spring Creek – Osage Creek		Chantel and Great Meadows Subdivisions, Logan Heights, Courtyard 3, and Lexington Addition in Bethel Heights, The Meadowlands, Lowell	
Spring Creek- Osage Creek	60.6	Springdale	Spring Creek
Upper Baron Fork	3.7	Lincoln	Bush Creek

The monitoring sites are located in the downstream portion of most of the HUC12 watersheds and represent cumulative contributions from the upstream watershed, so specific locations of potential pathogen sources within the watersheds are unknown. However, watershed reconnaissance studies, including analyses to identify pathogen sources, could be conducted for priority watersheds to confirm impairment and identify probable sources of pathogenic indicators. Site reconnaissance can identify cattle in the stream, straight pipes discharging wastewater directly into the stream, failing onsite systems, and other possible sources. A pathogen monitoring program is being initiated in 2012 through ANRC with monthly sampling at two to three sites in each non-attaining stream reach because of exceedances of pathogenic indicator criteria. This monitoring program will continue through 2014.

4.3.1.2 *Urban Areas*

There are two subwatersheds whose nonattainment of the primary contact recreation designated use because of pathogens is attributed to urban sources: the Lake Fayetteville-Clear Creek subwatershed and the Little Wildcat-Clear Creek subwatershed (ADEQ 2008). In addition, several other HUC12s with stream reaches listed by EPA Region 6 have relatively large percentages of urban area with pathogen sources listed as unknown (e.g., Spring Creek-Osage Creek, with 38% developed area). Sources of pathogens in urban watersheds include wastewater treatment plant discharges that are inadequately disinfected; upsets in treatment operation and release of elevated pathogenic indicators; combined sewer overflow during storm events; domestic animal, wildlife, waterfowl, and bird excrement that washes into streams during storm events; illicit discharges of domestic sewage; failing septic systems; and leaking sewer pipes. There have been reported incidents of sewer overflows from the Springdale and Fayetteville sewer systems, which could contribute pathogens to the impaired stream reaches.[5] Pitt et al. (2004) found that fecal coliform concentrations in urban stormwater were typically well above WQS for primary contact recreation, regardless of the land use (e.g., commercial, residential, open-space, or freeway).

In many cases, source identification for urban systems occurs through a process of elimination of possible sources. None of the municipalities discharging wastewater in these watersheds has combined sewers. The storm sewers and sanitary sewers are separate. For most sewer systems, inflow and infiltration into sewer pipes represent possible additional sources of volume for treatment. If infiltration is occurring, exfiltration of sewage out of these sewer pipes is also possible, representing a possible source of pathogens.

Domestic animal and wildlife populations, including geese populations, can be significant sources of pathogens in urban watersheds (Balkcom 2010, Young and Thackson 1999). Virtually every golf course with water hazards will have duck or geese populations, which in some cases have become resident populations. Domestic animal populations in these watersheds have increased as development has occurred. In addition, the number of domestic animals abandoned has also increased over the past decade, which represents a pathogen source. Even in those HUC12s where the primary focus is on urban pathogen sources, the majority of the watershed land use is forested or grassland/pasture, so there is a significant potential for pathogens to be contributed to pastures by wildlife and waterfowl populations, as well as through manure/litter applications. Cattle grazing in pastures and wading in streams in these watersheds also represent potential pathogen sources.

As with rural sites, the specific location of contributing pathogen sources in the watershed is currently unknown. When the priority watersheds are identified, site-specific reconnaissance can occur, including analyses to identify pathogen sources. As noted above, a pathogen monitoring program will be conducted from 2012 through 2014 in these subwatersheds.

4.3.2 SEDIMENT

Siltation occurs as a result of increased sediment load in streams, from erosion. There are large areas of the UIRW that have been classified as having moderate to severe erosion hazard (Figure 2.3). Changes in land use in a watershed can affect the stability of stream channels, resulting in channel or bank erosion in some stream segments, and siltation in others.

The two Illinois River stream segments listed as impaired due to siltation on the 2008 303(d) list are located in the Lake Wedington-Illinois River HUC12 and the Lake Frances-Illinois River HUC12, respectively. Several Section 319 restoration projects have been conducted in the UIRW to restore streams that have had increased stream sedimentation because of failing stream banks.

[5] ADEQ complaints and inspections database at www.adeq.state.ar.us/home/pdssql/complaints_inspections.asp, accessed April 2012.

4.3.2.1 *Rural*

Pasture

Pastures that are overgrazed or that have been heavily used by cattle can be susceptible to erosion. Every HUC12 in the UIRW has extensive areas in grassland/pasture land use, even those with extensive urban areas, e.g., the Spring Creek-Osage Creek subwatershed, which is 38% urban and 47% grassland/pasture. Riparian areas can be extensively disturbed and erode where cattle have direct access to the stream.

The Illinois River-Lake Wedington and Lake Francis-Illinois River watersheds have 34% and 46% of their areas in grassland/pasture, respectively. The condition of these grassland/pasture areas have not been inspected, but will be if either of these two watersheds are ranked as high-priority. In general, vegetated pasture and grassland represent optimal management practices for reducing erosion, nutrient and pathogen loading to streams.

Forestry

Sources of sediment associated with forestry activities include erosion due to removal of streamside vegetation, road construction and use, timber harvesting, and mechanical preparation for the planting of trees. Road construction and road use are the primary sources of sediment on forested lands, contributing up to 80% of the total sediment from forestry operations (Brinkley and Brown 1993, Hagans et al. 1986, Rice and Lewis 1991). Harvesting trees in the area beside a stream can affect erosion by removing vegetation that stabilizes the stream banks (http://www.epa.gov/nps/forestry.html). High all-terrain vehicle (ATV) traffic from recreational activities can also affect erosion and sediment yield from forested lands.

The Illinois River-Lake Wedington and the Lake Francis-Illinois River subwatersheds have 59% and 45% of their areas in forest, respectively. Neither the condition of these forested areas nor their logging history has been inspected, but will be if either of these two watersheds is ranked as high-priority. In general, forests represent the most desired land use for reducing erosion and nutrient and pathogen loading to streams.

Unpaved Roads

In 2009 there were approximately 1,295 miles of unpaved roads in the UIRW. As discussed above for forestry, construction and use of unpaved roads can contribute sediment to surface waters. Roads with steep gradients, deep cut-and-fill sections, poor drainage, erodible soils, and road-stream crossings contribute to most of this sediment load, with road-stream crossings being the most frequent sources of erosion and sediment (http://www.epa.gov/oecaagct/trur.html). The status of the unpaved roads will be evaluated in priority watersheds.

Mining

Disruption of soils associated with mining can result in increased erosion and sediment loads to surface waters. There are 39 active mining permits in Benton and Washington counties (ADEQ permit database, accessed May 26, 2010). No stream mining permits were active for any of the streams in the UIRW. Permitted mining operations are required to use management practices that prevent pollution of surface waters, including erosion and sediment controls (Arkansas Pollution Control and Ecology Commission Regulation 15, 2006).

Stream Bank Erosion

With much of the watershed in forest, pasture and grassland, stream bank and stream bed erosion have been identified as likely sources of sediment throughout the UIRW (Matlock 2008, Shepherd et al. 2010, Saraswat et al. 2010). Grassland, pasture, or forest typically do not have significant upland erosion. Watershed disturbances — even local disturbances — that affect a stream segment can result in a change in the sediment transport regime of the stream that can propagate both upstream though head cutting, and downstream through bank erosion, bed scour, or sediment aggregation (Ashby et al. 2006). These changes in the stream sediment regime can continue to propagate through the stream network until the stream network reaches a new dynamic equilibrium.

4.3.2.2 *Urban Areas*

Modeled sediment yield from urban areas in the UIRW were similar to yields from pasture (White 2009). Urban land use typically includes significant areas of impervious cover, which increases runoff volume. The increased runoff volume and velocity leads to changes in stream channel shape that can result in erosion or sediment deposition (Shepherd et al. 2010). Keen-Zebert and Shepherd found the unit stream power (potential energy to scour stream banks and beds) of urban streams in the UIRW was almost four times greater than for forested streams (334W/m^2 vs. 85W/m^2) and three times greater than agricultural streams (334W/m^2 vs. 103W/m^2).[6] Urban streams were wider and more deeply incised or scoured than either forested or agricultural streams.[7] In addition, erosion at construction sites can also contribute sediment to surface waters. Management of erosion and runoff at construction sites is a requirement under state stormwater permits (see Chapter 3).

[6] http://serc.carleton.edu/vignettes/collection/58524.html
[7] http://serc.carleton.edu/vignettes/collection/58524.html

Construction

Until 2008, there was significant construction throughout the UIRW. Several studies have identified construction as a major contributor of sediment to streams (Chiang et al. 2010, WCRC 2008). Erosion at the construction sites can contribute sediment to surface waters. However, construction can also result in increased impervious cover in the watershed, which increases runoff volume, and in changes in stream channel shape, which can be exacerbated by increased runoff volume (O'Driscoll et al. 2010). Increased runoff volume and altered stream channels also contribute to increased stream bank and stream bed erosion and greater instream sedimentation. A study of Lincoln Lake determined that construction was the primary source of sediment to the lake (Chiang et al. 2010).

Roads, Parking Lots, and Other Impervious Surfaces

Impervious surfaces such as roads, parking lots, sidewalks, driveways, and other surfaces not only increase runoff volume, but also accumulate dust, dirt, and other particulate matter that washes off these surfaces during storm events and contributes to sedimentation in the receiving waterbody (Heisenring et al. 2011, International BMP Database). Having vegetated strips between the impervious area and the receiving waterbody can reduce these sediment loadings. These practices are discussed in subsequent chapters.

4.3.3 NITRATE

Sager Creek was listed on the 2008 ADEQ 303(d) list as non-attaining because the nitrate concentration exceeded the drinking water criterion of 10 mg/L. A municipal point source (Siloam Springs WWTP) was identified as the source of the nitrate causing the impairment. The Siloam Springs WWTP was upgraded in 2007 with biological treatment. Since 2007, the nitrate concentrations in Sager Creek have decreased significantly, and since 2009, the average nitrate concentrations have averaged less than 5 mg/L (4.78 mg/L) and are no longer exceeding the drinking water criterion (Figure 4.4).

Other nitrate sources in the subwatershed include fertilizer applications to lawns and gardens by homeowners; manure or poultry litter applications to pastures; groundwater contaminanted with nitrate that is discharging into Sager Creek; exfiltration from leaking sewer lines or failing septic systems; cattle grazing the the stream; wildlife, waterfowl, and domestic animal excrement washing into the stream during storm events; and illicit discharges of sewage. These sources of nitrate are also possible sources of pathogens. Sager Creek has not been listed because of pathogens. It is unlikely these alternative sources were the cause of nitrate concentrations previously exceeding 10 mg/L, particularly since the instream nitrate concentrations decreased following the upgrade of the Siloam Springs WWTP.

Element 3: Management Measures 5

5.1 Objective

The overall objective of this watershed-based management plan is to restore and sustain the natural resources of the UIRW so that the vision of its citizens can be achieved. The management objective is to implement management practices so the designated uses of the Upper Illinois River are attained. Recently, several stream reaches in the UIRW have been assessed as not supporting their designated uses. These stream reaches were placed on the 2008 Arkansas 303(d) list. The management practices discussed in this section can reduce the pollutants identified on the 303(d) list as the sources of impairment of the designated uses, so that Arkansas water quality criteria are met and the designated uses of the streams are attained.

The primary focus of this plan is to address surface water quality. However, the intention is to manage the UIRW holistically, so that addressing surface water quality does not adversely affect other management efforts (e.g., endangered species management), or give rise to, or exacerbate, other issues. In particular, given the hydrogeology of the UIRW, the potential for management measures to affect groundwater quality must be considered. Management measures that encourage water infiltration have the potential to transfer pollutants to groundwater (Davis et al. 2000, Gillip et al. 2009, Moore and Brauer 2009). Studies of a cave in the UIRW that harbors endangered species have detected changes in cave water quality that are attributed to land and surface water management activities (Brown et al. 1998; Graening and Brown 1999, 2000, 2001; Graening 2000). Thus, management measures have the potential to impact endangered species in the UIRW through changes in groundwater quality.

This chapter discusses (1) the target pollutants of concern, (2) the prioritization process for selecting the initial watersheds for implementation of management practices, and (3) management practices for reducing the target pollutants and attaining Arkansas water quality standards.

5.2 Target Pollutants

Pollutants that will be targeted for reduction through implementation of management measures are those parameters for which the State of Arkansas has numeric limits as of January 2012, and which have been identified as being a cause of waterbody impairment in the UIRW. ADEQ has identified waterbodies in the UIRW where pathogen, nitrate, and turbidity water quality criteria are not being met. There is one waterbody, SWEPCO Lake, where the aquatic life use has been assessed as non-supporting. The cause and source of non-attainment in SWEPCO Lake is unknown. This waterbody will require additional diagnostic studies. As a result, pathogens, nitrate, and sediment will be targeted by the management measures in this plan.

Nutrients, particularly total phosphorus (TP), have long been considered an issue in the UIRW. Arkansas currently has numeric water quality criteria only for nitrate (NO_3-N). Appropriate numeric criteria for nutrients are the subject of much ongoing research. Therefore, TP and total nitrogen (TN) will not be specifically targeted for management at this time. While management measures will not be targeted specifically at the control of nutrient loads, an ancillary benefit of almost all of the management practices that reduce pathogens and sediment is that nutrient loads (TP and TN) are also reduced. EPA is preparing a TMDL for total phosphorus in the UIRW. Once completed, this TMDL will provide targets for total phosphorus concentrations and loads that can be addressed through targeted management practices.

5.3 Management Units

The HUC12 watersheds in the UIRW have been the basis for several previous prioritization approaches and are used to define management areas for this plan (see Figure 2.6).

5.4 Watershed Prioritization

There have been a number of studies of the UIRW that prioritized streams or sub-basins in the watershed for water quality improvement. These studies each used a different approach for prioritization. The following sub-sections summarize some of the prioritization studies of the UIRW, and compare their results. The approach used to identify the HUC12s to be addressed through this plan is also discussed below. The studies are discussed in chronological order.

Table 5.1 summarizes and compares the results from the prioritization approaches summarized below. A number of HUC12s have been identified as high-priority for water quality improvement by several of the approaches. No HUC12s were consistently ranked as high-priority by all of the prioritization approaches.

5.4.1 SOIL CONSERVATION SERVICE PRIORITIZATION

In the early 1990s, the Arkansas Soil and Water Conservation Commission ranked 37 streams in the UIRW in terms of priority for water quality improvement (USDA FSA et al. 1992). The system used to rank the UIRW streams considered potential agricultural nonpoint source data, land use data, municipal water supply location data, benthic data, and water quality data. The streams with the highest priority in the UIRW were generally low-order streams or headwater streams. The stream ranked as the highest priority in the UIRW was Clear Creek (Table 5.1).

Table 5.1. Comparison of results from six prioritization approaches.

HUC12	SCS Watershed	SCS 1992 Ranks	AWRC 1996 Sediment	AWRC 1996 TN	AWRC 1996 TP	Haggard Overall	Saraswat 2010 Overall	Stream Biology Impact Based on USGS 2012	2008 303(d) List	Draft 2010 & 2012 303(d) List
Brush Creek–Osage Creek	Brush Creek	25	High	High	High	Low	Medium			
Chambers Hollow–Illinois River	Chambers Creek	36	High	Low	High	Low	Low			
	Pedro Creek	37	Low	Medium	Low					
Cincinnati Creek	Cincinnati Creek	20	High	Low	High	Medium	Medium			
Goose Creek-Illinois River	Goose Creek	22	Low	High	Medium	High	High	High	High	
	Ruby Creek	12	Medium	Medium	High					
Hamestring Creek	Hamestring Creek	18	Medium	Medium	Low	Medium	High		High	High
Headwaters Baron Fork	Baron Fork Creek	5	High	High	High	Low	Low	High	High	
	Fly Creek	23	High	Medium	Medium					
Headwaters Flint Creek	Flint Creek	9	High	Medium	Medium	Low	Low			
Headwaters Illinois River	Upper Illinois River	10	Medium	Medium	Medium	Low	Medium		High	
Headwaters Osage Creek-Illinois River	Upper Osage	2	Medium	Medium	Medium	High	High	High	High	
Lake Fayetteville-Clear Creek	Clear Creek	1	High	Low	High	Medium	High		High	High
Lake Frances-Illinois River	Frances Creek	35	High	Medium	Medium	Low	Low			
	Gallatin Creek	30	Low	High	Low					
	Gum Springs	13	Medium	Medium	Medium					
Lake Wedington-Illinois River	Fish Creek	14	High	Medium	Low	Low	Low		High	High
	Lake Wedington	32	Low	Medium	Low					
	Robinson Creek	29	Medium	Medium	High					
Little Osage Creek	Little Osage	3	Medium	High	High	High	High		High	
Little Wildcat-Clear Creek	Wildcat Creek	16	Medium	Medium	Medium	Low	Medium		High	High
Lower Muddy Fork-Illinois River	Kinion Creek	24	Low	Medium	Low	Medium	Medium	High	High	High
	Muddy Fork of Ill. River	26	Medium	Low	Low					
Middle Flint Creek	Flint Creek	9	High	Medium	Medium	Low	Low	High	High	
	Little Flint Creek	15	Low	Medium	Low					
Moore's Creek-Muddy Fork	Blair Creek	4	High	High	High	Medium	Low			
	Lower Moore's Creek	21	Medium	High	High					
	Muddy Fork of Ill. River	26	Medium	High	Medium					

Table 5.1. Comparison of results from six prioritization approaches (continued).

HUC12	SCS Watershed	SCS 1992 Ranks	AWRC 1996			Haggard Overall	Saraswat 2010 Overall	Stream Biology Impact Based on USGS 2012	2008 303(d) List	Draft 2010 & 2012 303(d) List
			Sediment	TN	TP					
	Upper Moore's Creek	7	Medium	Medium	Medium					
Osage Creek-Illinois River	Galey Creek	17	Low	High	Low					
	Lick Branch	28	Low	Medium	Low	Low	Low		High	
	Lower Osage Creek	11	Medium	High	High					
Sager Creek	Sager Creek	27	Medium	Medium	Low	High	High	High	High	High
Spring Creek-Osage Creek	Cross Creek	34	High	Low	Low					
	Puppy Creek	33	Medium	Low	Low	Medium	Medium	High	High	
	Spring Creek	6	Medium	Medium	Low					
Upper Ballard Creek	Upper Ballard Creek	8	Medium	Medium	Low	Low	Low			
Upper Evansville Creek	Evansville Creek	31	High	Medium	Low	Medium	Medium			
Upper Muddy Fork-Illinois River	Upper Illinois River	10	Medium	Medium	Medium	Low	Low			
Wedington Creek	Wedington Creek	19	Medium	Medium	Medium	Medium	Medium			

5.4.2 POLLUTANT LOAD PRIORITIZATION

During 1993 through 1995, the Arkansas Water Resources Center (AWRC) collected water quality data from 37 sub-basins in the UIRW during both low-flow and storm-flow conditions. Using these data, annual unit area nonpoint source loads of TN, TP, and TSS (representing sediment) were calculated for each sub-basin, and used to prioritize the sub-basins, developing a separate prioritization for each parameter (Parker et al. 1996). No prioritization was developed based on consideration of the three parameters together. However, three sub-basins in the Osage Creek watershed were classified as high-priority for all three of the parameters (Table 5.1).

5.4.3 SWAT MODEL PRIORITIZATION

In 2006, ANRC selected ten 8-digit HUCs in Arkansas for prioritization of their HUC12 watersheds. The UIRW was one of the 8-digit HUCs selected. In 2008, ANRC contracted with UAEX to calibrate the Soil & Water Assessment Tool (SWAT) model to these ten 8-digit HUC watersheds and prioritize the HUC12 watersheds within these larger watersheds, based on the proportion of sediment and nutrient loads originating in each HUC12. Saraswat et al. (2010) applied the SWAT model to the UIRW HUC12s. The specific pollutants modeled were sediment, TP, and NO_3-N.

For the UIRW, the SWAT model predicted monthly loadings of sediment, TP, and NO_3-N, which were used to determine flow-weighted pollutant concentrations that were aggregated on an annual basis (Saraswat et al. 2010). The average annual flow-weighted pollutant concentration for the period 2006 to 2008 was used to prioritize UIRW HUC12s based on their relative contributions of sediments and nutrients. The range of flow-weighted concentration data was divided into three categories using the quantile classification method: low (0-33 percentile), medium (34-66 percentile), and high (67-100 percentile). For each pollutant, a score of 1, 2, or 3 was assigned for low-, medium- or high-priority categories, respectively. In determining overall priorities, an overall impact index was developed by adding the individual constituent scores for each of the HUC12s. The overall impact index score ranged from 3 (for the low-low-low combination) to 9 (for the high-high-high combination). This approach classified five of the HUC12s as high-priority overall (Table 5.1).

5.4.4 WATER QUALITY AND LAND USE

During 2010, Haggard et al. (unpublished) prioritized HUC12s in the UIRW based on three parameters – TP, TN, and sediment. These are the parameters that the ANRC Nonpoint Source Management Program uses to set priorities. In this approach, each HUC12 was assigned a separate priority category based on each of the three parameters. The priority categories were 1 for low priority, 2 for medium priority, and 3 for high priority. The three parameter priority ranks were then summed to determine an overall rank for each HUC12: low for a sum of 3 to 5, medium for a sum of 6 to 7, and high for a sum of 8 to 9. This method assigned four of the HUC12s to the high-priority category based on their overall ranks (Table 5.1).

Non-forested riparian area was used as a surrogate indicator for sediment issues. The percentage of the area in a 300-ft buffer along the streams in the HUC12 was calculated using GIS. The HUC12s were sorted based on these percentages and the sorted list divided into three priority categories. The third of the HUC12s with the highest percentages of non-forested riparian area were classified as high-priority, and the third with the lowest percentages of non-forested riparian area were classified as low-priority. The remaining third of the HUC12s was classified as medium-priority.

The approach used to prioritize the HUC12s based on TP and TN utilized regression relationships between measured base flow nutrient concentrations and land use. Several studies conducted in northwest Arkansas (e.g., Giovannetti 2007; Haggard et al. 2003, 2007) have shown that stream nutrient concentrations are positively correlated to the percent of pasture and urban development within its watershed. Water quality data collected by the IRWP Volunteer Monitoring Program during 2009 from 37 sites in the UIRW were used to develop regression relationships between TP and TN and to calculate percentage of the watershed in urban and pasture land uses. HUC12s were assigned to a priority category based on the position of the watershed base flow nutrient concentration relative to the regression line. HUC12s with base flow TN and TP concentrations above the upper 95% confidence interval of the regression line were assigned to the high-priority category. Medium-priority HUC12s were those with nutrient concentrations between the 95% confidence interval and the regression line. Low-priority HUC12s were those with nutrient concentrations below the regression line.

5.4.5 BIOLOGICAL MONITORING

In 2011, USGS surveyed biological communities, water quality, and habitat at 14 sites in the UIRW. USGS has developed metrics describing fish and invertebrate communities from the survey data, and used these metrics and macrophyte coverage to compare biological condition across land-use categories. Each site was assigned to a land use category based on land use percentages and whether a municipal WWTP discharge was present upstream of the site. The land use categories were agricultural, agricultural with wastewater treatment plants, urban, and urban with wastewater treatment plants. The study plan also calls for evaluation of forested sites; however, samples were not able to be collected from the forested sites in 2011. Sampling at forested sites is planned for 2012.

When fish metric averages were compared among land use categories, most metrics indicated that the least-disturbed fish communities occurred at sites in agricultural watersheds. Most metric averages indicated that the most-disturbed communities occurred at two sites downstream of WWTP discharges in urban watersheds. Metric averages also indicated intermediate (compared to the other two categories) levels of disturbance at the other four sites in urban watersheds and at the site downstream of a WWTP in an agricultural watershed [Petersen and Justus, unpublished(a)].

Five invertebrate metrics were averaged and compared among land use categories. Most metric averages indicated that invertebrate communities downstream of WWTP discharges were more disturbed than those that were not downstream of a WWTP, urban or rural. Average values for three of the metrics were similar in both urban and agricultural sites. Average values for the other two metrics indicated less disturbance of invertebrate communities at agricultural sites than at urban sites [Justus and Petersen, unpublished].

When macroalgae cover was compared by land use category, category averages indicated that the least amounts of macroalgae occurred at sites in agricultural and urban watersheds. The average macroalgae cover values for the two WWTP categories were approximately four to six times greater than the averages for the agricultural and urban land use categories. The greatest macroalgae cover occurred at sites with less shading and higher nutrient (dissolved nitrate and total phosphorus) concentrations. Macroalgae cover was negatively related to riparian shading and positively related to base-flow concentrations of total phosphorus [Petersen and Justus, unpublished(b)].

Overall, the initial results from analyses of this most recent biological monitoring seem to indicate that the greatest biological impact occurs in streams that drain urban areas and have a WWTP discharge. This would suggest that HUC12s with significant urban area and a WWTP discharge should be a priority for water quality improvement. The HUC12s with wastewater treatment plant discharges are listed in Table 5.2 along with the percentage of the HUC12 that is urban. The three HUC12s with the greatest urban area and WWTP discharges could be classified as the highest-priority watersheds: Spring Creek–Osage Creek; Headwaters Osage Creek–Illinois River; and Sager Creek (Table 5.2).

Table 5.2. High-priority HUC12s based on potential for biological impacts.

HUC12 Name	Percent Urban	Urban Area Rank (of 25)	WWTP	Receiving Waterbody
Goose Creek- Illinois River	11.1	9	Fayetteville	Goose Creek
Headwaters Osage Creek-Illinois River	44.0	2	Rogers	Osage Creek
			NACA Regional	
Lower Muddy Fork-Illinois River	4.4	21	Prairie Grove	Muddy Fork
Middle Flint Creek	7.0	13	Gentry	SWEPCO Lake
Sager Creek	34.6	4	Siloam Springs	Sager Creek
Spring Creek-Osage Creek	60.6	1	Springdale	Spring Creek
Upper Baron Fork	3.7	25	Lincoln	Bush Creek

5.4.6 IMPAIRED STREAMS

Another prioritization approach considered HUC12s with streams identified as impaired by ADEQ (and/or EPA) as priorities for water quality improvement. The most current approved Arkansas list of impairments is from the 2008 state assessment. lists of impaired waterbodies have also been developed from the 2010 and 2012 state water quality assessments. Table 4.1 summarizes the impairments in the UIRW from the approved 2008, and 2010, and 2012 303(d) lists. There are 15 HUC12 watersheds associated with the 13 impaired stream reaches and one impaired lake listed on the 2008 303(d) list (Figure 4.1). Note that there are several HUC12 watersheds in the UIRW where no stream reaches are assessed; these HUC12s are excluded from this prioritization.

5.4.7 PRIORITY WATERSHEDS FOR THIS PLAN

Because the objective of this plan is to help restore impaired stream reaches and attain Arkansas water quality standards, the priority watersheds were selected based on the Arkansas 303(d) lists of impaired waters. Phosphorus is not a target pollutant for this watershed-based management plan, so the HUC12s with stream reaches listed only for total phosphorus on the 2008 303(d) list will not be a priority for this plan. To keep the number of priority HUC12s at a manageable level, the five HUC12s with stream reaches identified as impaired on the approved 2008 Arkansas 303(d) list and the 2010 and 2012 303(d) lists will be targeted in this watershed-based management plan (Table 4.1). Table 5.3 displays the rankings for the plan priority watersheds from each of the prioritization approaches discussed above. These HUC12 watersheds are identified as high-priority by more than one prioritization approach. No HUC12 watersheds were identified as high-priority by all approaches.

Table 5.3. Rankings from multiple approaches for the five watersheds on the Arkansas 2008, 2010, and 2012 303(d) lists.

HUC12 Name	SCS Rank (out of 37)	SWAT Sediment Priority	SWAT Nitrate Priority	AWRC TSS Priority	Empirical Sediment Priority	Biological Disturbance
Illinois River–Lake Wedington	32	Low	High	High	Low	Not ranked
Lake Fayetteville–Clear Creek	1	High	Low	Medium	High	Not ranked
Little Wildcat–Clear Creek	1	Low	High	Medium	Low	Not ranked
Lower Muddy Fork–Illinois River	26	High	High	Medium	Medium	Not ranked
Sager Creek	27	High	Low	Medium	High	High

5.5 Management Measures for Urban Sources

On the 2008 Arkansas 303(d) list, the source of pathogens impairing the Clear Creek reach in the Lake Fayetteville-Clear Creek and Little Wildcat–Clear Creek watersheds is identified as urban sources. Urban pathogen sources to be addressed by management measures discussed below include WWTPs, treatment upsets, sewer overflows, leaking sewer pipes, septic systems, illicit discharges, and wildlife and pets. Pathogens generally do not survive long in the water column of streams and rivers (Anderson et al. 2005, Burton et al. 1987, and Jamieson et al. 2003). However, sediments can be a repository or reservoir for pathogens, and pathogen sorption onto sediments can result in both resuspension of pathogens into the water column and downstream transport (Howell et al. 1995, Koirala et al. 2007, Smith et al. 2008, and Traister and Anisfield 2006). To reduce pathogens at monitoring station ARK0010C on Clear Creek (see Figure 4.1), management measures for urban sources will initially be targeted along Clear Creek between Highway 112 (location of ARK0010C) and the confluence of Mud Creek.

On the 2008 Arkansas 303(d) list, the source of nitrate impairing Sager Creek at monitoring station ARK0005 is identified as the Siloam Springs WWTP. Therefore, this is the source that is addressed.

Table 5.4 is a summary of projects and programs for implementing management measures that have been implemented or are planned that address urban sources in the UIRW. Ongoing or planned management measures that address these sources include measures for stormwater volume and quality management, riparian and stream restoration, and wastewater management. Each of these categories is discussed in a separate subsection below. Table 5.5 identifies the management measures for each project, which pollutants the management measure addresses, and the pollutant source that is managed. Note that the majority of the management measures associated with the urban areas in the UIRW are focused on reduction of sediment and erosion. Sediment and erosion are considered issues in these urban settings, even though turbidity criteria are being met in Clear Creek.

5.5.1 PAST MEASURES

5.5.1.1 *Wastewater Management*

Several of the municipal WWTPs located in the UIRW have been upgraded to reduce nutrient concentrations in their discharges. These upgrades are described below.

The City of Fayetteville built a new facility, the Westside WWTP, that began discharging into Goose Creek, a tributary to the Illinois River, in June 2008. This facility has a daily average discharge of 10 million gallons per day (MGD) and a maximum permitted discharge of 32 MGD. When the new facility went online, the discharge to Mud Creek from the Noland plant was discontinued. The Westside WWTP treats effluent through screening, biological treatment, clarification, deep-bed sand filtration, UV disinfection, and post-treatment oxygenation.

The Springdale WWTP serves Springdale and the surrounding areas, including parts of Lowell. The Springdale WWTP treats residential and industrial wastewater before discharging an average of 12 MGD, with a maximum permitted discharge of 24 MGD, into Spring Creek, a tributary to the Illinois River. The facility implemented nitrogen management in the 1990s and phosphorus management in 2002. The plant currently treats its wastewater by screening, biological treatment, clarification, filtration and chlorination.

The Rogers WWTP serves Rogers and the surrounding areas including parts of Lowell. The Rogers WWTP discharges an average of 7 MGD and has the capacity to discharge up to 14 MGD into Osage Creek, a tributary to the Illinois River. During the dry season, about 10% (up to 1.0 MGD) of the treated effluent is used as irrigation water by a nearby golf course. Currently, the plant treats its wastewater by screening, biological treatment, clarification, sand filtration, chlorination, and post-treatment oxygenation.

The Siloam Springs WWTP serves the City of Siloam Springs; the plant discharges 3 MGD of treated effluent on average into Sager Creek, a tributary to Flint Creek, which is a tributary to the Illinois River. The WWTP has been recently upgraded and now treats its wastewater by screening, biological treatment, clarification, filtration, and disinfection. Average nitrate concentrations in the effluent are currently less than 10 mg/L.

Table 5.4. Management measures in the UIRW addressing urban sources.

Project/Program	Pollutants (source)	Measures	Amount	Location (HUC12)	Status
MS4 NPDES stormwater management plans	Pathogens, nutrients, and toxics (wastewater)	Illicit discharge detection and elimination	NA	MS4s in UIRW	Programs active
MS4 NPDES stormwater management plans	Sediment and nutrients (construction site and developed area stormwater runoff)	Construction stormwater control: ordinances or procedures for "zero impact" on stormwater runoff from pre- to post-construction	NA	MS4s in UIRW	Programs active
02-900*: Demonstration of Greenway Development to Protect Ecological Services in Urban Streams 05-400: Demonstration of Best Management Practices for Stream Bank Protection	Sediment and nutrients (stream bank erosion)	Greenway development and stream channel restoration	4,900 ft	Blossom Way Creek (Headwaters Osage Creek–Illinois River)	Completed
03-400: Urban Nutrient Management in the Illinois River Landscape	Nutrients (lawns associated with residences and commercial buildings)	Nutrient management, proper lawn watering, improved grass cutting, filter strips	90 plans completed, 28 implemented impacting 429,101 square feet	Clear Creek watershed (Lake Fayetteville–Clear Creek)	Completed
04-700: Developing Resource Management Systems for Golf Courses in Washington County, Arkansas: Phase I	Nutrients (golf courses)	Nutrient management plans, filter strips, proper vegetation planting, improved grass cutting, proper lawn watering, structural practices	Nine plans for BMPs impacting 600 acres in UIRW	Washington County	Plans completed; not implemented.
05-1100: Demonstration of Low Impact Development BMPs	Runoff volume, sediment, toxics (impervious surfaces, stream bank erosion, stormwater runoff)	Bioswale detention pond, LID manual	Not reported	Fayetteville (Lake Fayetteville–Clear Creek, Mud Creek–Clear Creek)	Completed

Table 5.4. Management measures in the UIRW addressing urban sources (continued).

Project/Program	Pollutants (source)	Measures	Amount	Location (HUC12)	Status
Stream Restoration Demonstration at Niokaska Creek in Sweetbriar Park	Sediment and nutrients (stream bank erosion)	Stream channel restoration	1,600 ft	Niokaska Creek in Sweetbriar Park, Fayetteville (Mud Creek–Clear Creek)	Completed
06-600: Demonstration of a Natural Channel Design to Restore a Stream Reach Draining an Urbanized Sub-Watershed	Sediment and nutrients (stream bank erosion)	Stream channel restoration	1,200 ft	Niokaska Creek in Gulley Park, Fayetteville (Mud Creek–Clear Creek)	Completed
07-200: Utilizing Water Treatment Residuals to Reduce Phosphorus Runoff from Biosolids	Phosphorus (land-applied sewage sludge)	Treat sewage sludge with drinking water treatment residuals (alum sludge)	Not reported	Rogers (Spring Creek–Osage Creek)	Completed
07-600: Implementation of Low Impact Development Best Management Practices to Remediate Sediment from Urban Development in Fayetteville, AR	Sediment and nutrients (construction sites)	LID manual, neighborhood LID design including infiltration zone, constructed stream, bioswale, and wet meadow	Not reported	Fayetteville (Lake Fayetteville–Clear Creek, Mud Creek–Clear Creek)	Completed
07-900: Sager Creek Urban Stream Restoration 09-1300: Sager Creek Phase II	Sediment and nutrients (stream bank erosion)	Stream channel restoration	1,900 ft	Sager Creek (Sager Creek)	Ongoing
IRWP Riparian Restoration Program	Sediment and nutrients (stream bank erosion)	Tree planting	19,000 tree seedlings planted	Scull Creek (Mud Creek–Clear Creek), Sager Creek (Sager Creek), Illinois River, Blossom Way Creek (Headwaters Osage Creek–Illinois River), Spring Creek (Spring Creek–Osage Creek), Flint Creek (Headwaters Flint Creek)	Completed 2008 through 2012
IRWP Rain Garden Program	Runoff volume, sediment, toxics (impervious surfaces, stream bank erosion, stormwater runoff)	Public rain gardens	Nine gardens	Springdale (Brush Creek–Osage Creek), Rogers (Headwaters Osage Creek–Illinois River), Fayetteville (Lake Fayetteville–Clear Creek), Siloam Springs (Sager Creek)	Completed through 2010

Table 5.4. Management measures in the UIRW addressing urban sources (continued).

Project/Program	Pollutants (source)	Measures	Amount	Location (HUC12)	Status
Sewering of smaller communities in the MSA	Pathogens and nutrients (malfunctioning septic systems)	Sewage collection & transfer to WWTP		Tontitown (Lake Fayetteville–Clear Creek), Lowell (Spring Creek–Osage Creek)	Completed
Municipal Wastewater Treatment Upgrades	Phosphorus (WWTPs)	WWTP upgrade or replacement	Five facilities	Fayetteville (Goose Creek–Illinois River, Mud Creek–Clear Creek), Rogers, Springdale (Spring Creek–Osage Creek), Siloam Springs (Sager Creek), Prairie Grove (Muddy Fork)	Completed
Spring Creek Streambank Restoration and Stabilization	Sediment (stream bank erosion)	Riparian buffers, stream bank stabilization	1,045 ft	Springdale (Spring Creek–Osage Creek)	Completed
NACA Regional WWTP	Pathogens and nutrients (malfunctioning septic systems, WWTP)	WWTP Construction	Current capacity of 3.6 MGD. Ultimate design capacity of 80 MGD.	Tontitown (Brush Creek–Osage Creek)	Phase I completed, three expansion s planned
11-200: Botanical Gardens	Sediment and nutrients (stream bank erosion, stormwater runoff)	Riparian restoration plan	One plan	Hilton Creek and two unnamed creeks in the Botanical Gardens of the Ozarks (Lake Fayetteville–Clear Creek)	Ongoing
11-400: IRWP Rain Gardens	Runoff volume, sediment, toxins (impervious surfaces, stream bank erosion, stormwater runoff)	LID: public rain gardens	30 gardens (10 per year); total area approximately 7,000 square feet.	Rogers (Headwaters Osage Creek–Illinois River), Fayetteville (Lake Fayetteville–Clear Creek), Siloam Springs (Sager Creek), Farmington (Goose Creek–Illinois River), Prairie Grove (Upper Muddy Fork–Illinois River), Bentonville (Little Osage Creek)	Ongoing
IRWP Rain Garden Academy	Runoff volume, sediment, toxins (impervious surfaces, stream bank erosion, stormwater runoff)	Private rain gardens	10 gardens per year	Fayetteville (Mud Creek–Clear Creek, Lake Fayetteville–Clear Creek), Springdale (Spring Creek–Osage Creek), Rogers (Headwaters Osage Creek–Illinois River)	Ongoing

Table 5.4. Management measures in the UIRW addressing urban sources (continued).

Project/Program	Pollutants (source)	Measures	Amount	Location (HUC12)	Status
Fayetteville 2030 Plan	Runoff volume, sediment, toxics (impervious surfaces, stream bank erosion, stormwater runoff)	Specifications for LID in new and retrofit development, permit LID facilities in public rights of way	NA	Fayetteville (Mud Creek–Clear Creek, Lake Fayetteville–Clear Creek)	Plan completed 2011, implementation ongoing
Fayetteville LID & drainage criteria manual	Runoff volume, sediment (impervious surfaces, stream bank erosion, stormwater runoff)	Manual and stormwater design using LID principles	NA	Fayetteville (Mud Creek–Clear Creek, Lake Fayetteville–Clear Creek)	Ongoing
Fayetteville Streamside Protection Ordinance	Runoff volume, sediment, (stream bank erosion, stormwater runoff)	Riparian buffers for new and re-development	NA	Fayetteville (Mud Creek–Clear Creek, Lake Fayetteville–Clear Creek, Hamestring Creek, Goose Creek–Illinois River)	Adopted 2011, phased implementation through 2013
Sewer system planning, maintenance, rehabilitation & expansion	Pathogens and nutrients (malfunctioning septic systems, sewer overflows, leaking sewer pipes)	Maintenance and rehabilitation of sewer pipes and lift stations, centralized sewer service		Springdale, Fayetteville (Lake Fayetteville–Clear Creek) Siloam Springs (Sager Creek)	Ongoing
IRWP Septic pumping assistance program	Pathogens and nutrients (malfunctioning septic systems)	Septic maintenance training and rebate for septic pumping	30 homes per year	Lowell (Spring Creek–Osage Creek), Siloam Springs (Sager Creek) in 2012	Ongoing
IRWP Riparian Restoration Program	Sediment and nutrients (stream bank erosion)	Tree planting	4,000 tree seedlings planted per year	Along trails and in parks associated with streams	Ongoing
Osage Creek stream restoration project	Sediment and nutrients (stream bank erosion)	Channel restoration	1,000+ ft	Osage Creek (Osage Creek–Illinois River)	Planned
Phosphorus removal from urban runoff	Phosphorus (stormwater runoff)	Passive phosphorus removal structures	To be determined	To be determined	Planned
Septic system identification and evaluation in Clear Creek watershed	Pathogens and nutrients (malfunctioning septic systems)	Identify failing septic systems	To be determined	Clear Creek between Hwy 112 and Mud Creek z(Lake Fayetteville–Clear Creek)	Proposed

*ANRC Section 319 project number. Additional information about these projects is available online at www.arkansaswater.org.

The Prairie Grove WWTP serves the City of Prairie Grove. This WWTP was expanded and upgraded in 2011. The expanded plant has a capacity of 0.9 MGD and discharges to the Muddy Fork of the Illinois River. The upgraded treatment system now includes screening, biological treatment, clarification, UV disinfection, and post-treatment aeration.

There are several smaller cities located within or adjacent to the Fayetteville-Springdale-Rogers MSA in the UIRW that have historically not been sewered, including Tontitown, Elm Springs, Bethel Heights, and Lowell. Before 2006, wastewater treatment in Tontitown was accomplished with individual septic systems. In 2005, Tontitown began construction of a sewage collection system that transferred sewage to the Springdale WWTP. Tontitown now sends its sewage to the Northwest Arkansas Conservation Authority (NACA) regional WWTP. The majority of the areas of Lowell in the UIRW are currently provided sewerage collection and treatment by Springdale. In 2005, Lowell began development of STEP (septic tank effluent pumping) wastewater treatment systems for subdivisions in the Cross Creek watershed (ordinance 786). Elm Springs began development of a STEP wastewater treatment system in 2003.[8] Bethel Heights began development of its STEP wastewater treatment system in 2002 (ordinance 128). STEP wastewater treatment systems are small community wastewater treatment systems that collect wastewater from multiple septic systems and treat the combined effluent in a larger drain field.

In 2010, the NACA regional wastewater treatment facility became operational. This facility was constructed to address wastewater treatment shortfalls resulting from the rapid development in Benton and Washington Counties. Currently, Tontitown is the only UIRW community utilizing the NACA regional wastewater treatment facility. As noted in the previous paragraph, use of the regional facility has replaced some of the septic systems in Tontitown, removing those septic systems as a potential source of nutrients and pathogens in the Brush Creek–Osage Creek HUC12.

5.5.1.2 *Stormwater Management*

Low impact development (LID) can reduce runoff volumes from urban areas. Reduced runoff volume can contribute to improved channel stability, and reduce stream bank and channel erosion. In addition, when LID reduces the volume of runoff, it also reduces pollutant loads, since any pollutants carried by the intercepted runoff do not enter the receiving stream. In the spring of 2010, Fayetteville became one of a few cities in the country to permit LID facilities in public rights of way.[9] An LID project was completed in Rogers in 2008[10].

Rain gardens are an LID measure that can reduce stormwater runoff volumes, and trap pollutants such as pathogens from pet waste and sediment from erosion. The IRWP has participated in design and implementation of nine rain gardens in public areas in Northwest Arkansas. These include the joint cooperative project with Beaver Water District, Arkansas Forestry Commission, City of Fayetteville, and UAEX to design and implement seven rain gardens in 2006-2007. Six of these rain gardens were

[8] http://elmsprings.web.officelive.com/Documents/VIII.%20Health%20and%20Sanitation%20as%20of%203-11.pdf
[9] http://newswire.uark.edu/article.aspx?id=16864
[10] Arkansaswater.org/index.php?option=com_content&viewarticle&id=13&Itemid=5

constructed in the UIRW. During 2010, the IRWP designed and implemented two public area rain gardens in Rogers and one in Springdale. The IRWP, Beaver Water District, and UAEX collaborated in developing a how-to guide for rain gardens in NWA (UAEX 2009).

Many LID practices, such as rain gardens and bioswales, encourage infiltration of stormwater. However, increased infiltration in karst-sensitive areas can result in the contamination of groundwater, which can affect cave ecosystems and surface water quality.

5.5.1.3 *Restoration Projects*

Two stream restoration projects, using natural channel design, have been implemented in Fayetteville city parks on Niokaska Creek, a tributary of Mud Creek. These projects were undertaken to correct actively eroding stream banks, which were contributing sediment and nutrient loads and posed a safety hazard to park users. Together, these projects have addressed erosion-related issues along approximately 2,800 feet of Niokaska Creek.

A stream bank stabilization and restoration project was implemented along Spring Creek in the City of Springdale in 2011. This project addressed stream bank erosion along a 1,045 ft section of the creek.

Stream bank and channel restoration was implemented on Blossom Way Creek in Rogers through Section 319 projects (Arkansas Game and Fish Commission, City of Rogers, and Nelson Engineering 2008; Matlock et al. 2006). This restoration was undertaken to reduce nutrients and sediment in the creek from eroding stream banks, and to demonstrate the benefits of a “greenways approach” for urban stream management. The stream restoration was part of the development of the Blossom Way Creek Greenway (Matlock et al. 2006).

5.5.2 ONGOING AND PLANNED MEASURES IN PRIORITY WATERSHEDS

As can be seen in Table 5.4, management measures are both ongoing and planned for areas outside the priority watersheds to address pollutants other than this plan’s priority pollutants (e.g., nutrients). Past, ongoing, and planned measures outside the priority watersheds contribute to management of the priority watersheds because they contribute to the testing of concepts and development of procedures and processes that can be applied in the priority watersheds. In addition, many measures developed or implemented to control or treat urban nutrient and sediment loads, also control urban pathogen and/or nitrate levels.

The discussion below covers only management measures that can reduce pathogen loads at ARK0010C. The sources of pathogens in Clear Creek are not clear. There are no longer any municipal WWTPs discharging to Clear Creek or its tributaries. Therefore, WWTPs and treatment system upsets are not pathogen sources that will be addressed. Sewer system overflows, leaking sewer pipes, illicit discharges, septic systems, and wildlife and pets are potential pathogen sources that will be addressed to achieve the pathogen criteria at ARK0010C.

In addition, it is uncertain if pathogen water quality criteria are currently being violated in Clear Creek, since 2006 represents the most recent pathogen data collected from the stream. A 3-year pathogen monitoring project beginning in the summer of 2012 will determine whether pathogen criteria are currently being attained in Clear Creek (see Chapter 11 for information about this project). If the pathogen criteria are exceeded, the monitoring project will help in identifying the pathogen source(s), which can then be targeted for management by local government, interest groups, and/or ADEQ.

5.5.2.1 *Wastewater Management*

Portions of the Fayetteville, Johnson, Springdale, and Washington County MS4s discharge to the Lake Fayetteville-Clear Creek priority watershed. The MS4s in the priority watershed are implementing illicit discharge detection and elimination programs as outlined in their stormwater management plans.[11] Illicit discharges are a potential source of pathogens in Clear Creek. The section of Clear Creek between Highway 112 and the confluence of Mud Creek is located in the City of Johnson. The City of Johnson conducts dry weather screening to identify illicit discharges. No illicit discharges were identified in the 2011 screening. Continued implementation of dry weather screening is expected to control illicit discharges that may contribute pathogens to Clear Creek.

The Fayetteville and Springdale wastewater utilities are responsible for maintaining and repairing sewer system elements in the Lake Fayetteville–Clear Creek priority watershed. Their maintenance and planning programs are intended to minimize the potential for leaking sewer pipes and sewer overflows, which could contribute pathogens to Clear Creek.

5.5.2.2 *Stormwater Management*

Stormwater runoff from urban areas generally has poor water quality, potentially contributing pollutant loads to receiving streams. Pollutants in urban stormwater runoff can include toxics (e.g., gasoline, oil, and pesticides), nutrients, sediment, and pathogens (from human, wildlife, and pet waste). Measures to control and treat urban stormwater runoff can reduce these pollutants in stormwater receiving streams. Stormwater management measures that encourage stormwater infiltration (e.g., rain gardens, bioswales) have the potential to contribute to groundwater pollution. These types of stormwater management measures should be avoided or modified so as to prevent groundwater contamination in areas in the Lake Fayetteville–Clear Creek priority watershed that have been identified as sensitive to groundwater pollution (TNC 2007).

In 2011, the IRWP received a grant from ANRC and EPA for a 3-year rain garden project to install 30 public area rain gardens in the cities and towns of the UIRW. The goal of the Rain Garden Project is to reduce nutrient and sediment load into the Illinois River, to improve water quality, and to enhance aquatic and terrestrial habitat. However, rain gardens can also trap pathogens from wildlife and pet waste that are carried in storm runoff. At least 10 rain gardens will be installed per year in public areas over the next 3 years using grant money. Twelve public rain garden sites have been identified for installation in 2012. In addition, the IRWP sponsors a Rain Garden Academy twice a year to train local

[11] http://www.adeq.state.ar.us/home/pdssql/pds.asp, accessed 4/2/12

people to build rain gardens on their private property (see Chapter 7), with the goal of 10 private rain gardens installed per year.

5.5.2.3 *Restoration Projects*

A stream restoration project is ongoing on Sager Creek. The goal of this project is to restore the natural hydrology, stream channel geomorphology, and habitat along a 1,920-foot reach of Sager Creek in downtown Siloam Springs. The purpose of this restoration is to reduce sediment and nutrient transport in the system during storm flows. The stream restoration has the potential to change how nitrogen is processed in Sager Creek, which could affect nitrate concentrations.

5.6 Management Measures for Surface Erosion

Surface erosion is identified on the 2008 Arkansas 303(d) list as the source of sediment impairing the stream reach in the Lake Wedington–Illinois River priority watershed. The sediment may be coming from areas within the priority watershed upstream of the ADEQ monitoring station, or from other HUC12s farther upstream. In this plan, as an initial step in addressing the sediment impairment, management measures will be targeted in the priority watershed, upstream of the ADEQ monitoring site, i.e., upstream of the Clear Creek confluence with the Illinois River.

Development in this subwatershed is scattered, and there are no urban areas in the subwatershed, as classified by the US Census.[12] Therefore, only rural sediment sources will need to be addressed. Rural sediment sources that could occur in the priority watershed, and that are addressed in this plan, are the following: areas heavily used by livestock, livestock in streams, stormwater runoff, forestry, road crossings, unpaved roads, and stream bank erosion. Table 5.5 is a summary of management measures addressing erosion sediment sources that have been implemented or are planned for the UIRW.

5.6.1 PAST MEASURES

There have been two Section 319 projects in the UIRW to reduce erosion and sediment from road banks. Approximately 4 acres of road bank were planted using a hydromulcher as part of a Section 319 project in Washington County UIRW (Dunigan and Franklin 2005). The hydromulcher was used in a second Section 319 project, along with erosion control.[13]

Other management measures installed as part of Section 319 projects in the UIRW that have reduced sediment loads include filter strips, critical area planting, fencing, and alternative water supply. Filter strips trap sediment as runoff flows through them. Critical area planting stabilizes soils in areas where livestock have removed vegetative cover. Fencing installed along streams prevents livestock from damaging stream banks and stream channels, and allows riparian areas to revegetate and stabilize stream banks. When livestock are fenced off from streams, alternate water sources are developed.

[12] http://www.nwarpc.org/pdf/Regional_Development/Census2010/URBANIZED_AREA_2010.pdf
[13] Arkansaswater.org

The Farm Services Agency (FSA) Conservation Reserve Program (CRP) has not been widely utilized in the UIRW. In the September 2011 sign-up, no applications were received from Benton or Washington counties. In Benton County, only 94 acres are currently enrolled in CRP; and in Washington County, only 118 acres are enrolled (USDA FSA 2011a).

5.6.2 ONGOING AND PLANNED MEASURES IN PRIORITY WATERSHED

A study to identify sources of sediment in the sediment-impaired reach of the Illinois River would be useful for selecting and effectively targeting sediment management measures. Management measures that address possible sediment and turbidity sources to the impaired Illinois River stream reach are discussed below.

5.6.2.1 *Unpaved Roads and Roadbank Erosion*

As can be seen in Table 5.5, there are road management measures for sediment and erosion control planned for the UIRW. In the 2011-2016 Nonpoint Source (NPS) Management Plan (ANRC 2011), one of the goals identified by ANRC for the UIRW is to "identify severe erosion sites at rural road crossings and work with county government to develop and implement erosion control plans for high impact sites (e.g., promote use of conservation district hydromulcher for treatment)." This type of activity, if implemented in the Lake Wedington-Illinois River priority subwatershed and upstream HUC12 watersheds could reduce sediment loads to this stream reach.

There are approximately 23 miles of unpaved county roads in the portion of the Lake Wedington-Illinois River priority subwatershed that drains to the sediment-impaired stream reach (AHTD 2006). Improved maintenance of these unpaved roads through road grader operator training in Washington County can reduce sediment loads to this stream reach.

Ozark National Forest lands are located in the priority watershed. Road construction and road use are the primary sources of sediment on forested lands (see Section 4.3.2.1). NRCS management measures for forest trails and landings (NRCS Standard Practice 655) are core practices in the Illinois River Sub-basin and Eucha-Spavinaw Lake Watershed Initiative.

5.6.2.2 *Stream Bank Erosion*

ANRC included a survey of stream bank erosion in the UIRW as a goal in the 2011-2016 NPS Management Plan (ANRC 2011). The Lake Wedington-Illinois River priority watershed could be surveyed as part of this project. A stream bank stabilization project can be implemented to address any bank erosion issues identified by the survey.

Table 5.5. Management measures in the UIRW addressing sediment from erosion sources.

Project/ Program	Pollutants (source)	Measures	Amount	Location (HUC12)	Status
02-500: Ballard Creek Implementation Project	Sediment (road bank erosion)	Road bank stabilization plantings, critical area planting, filter strips, fencing, alternate water sources	4.28 acres road bank planted, 5 acres critical area planted, 1,379 acres filter strips, 50,196 ft fence, 1 well, 1 pond	Ballard Creek (Upper Ballard Creek)	Completed
00-155: Washington County Erosion Control Project	Sediment (road bank erosion)	Road bank stabilization plantings and erosion control blankets	10,000 ft X 50 ft area blanketed, 400,000 sq ft planted	Washington County	Completed
04-300: Benton County Cost Share	Nutrients, sediment and pathogens	Nutrient management plans, fencing, pasture planting, pipeline, ponds, water wells, watering facilities	17,422 ft fence, 390 acres planted, 4,885 ft pipeline, 12 ponds (8,238 cu yd total), 13 watering facilities	Benton County UIRW (Headwaters Flint Creek, Middle Flint Creek, Osage Creek – Illinois River)	Completed
08-600: Demonstrating Runoff Capture from Poultry Houses to Improve Water Quality in 12-Digit HUCs of the Illinois River Watershed	Sediment, pathogens, nutrients (stormwater runoff)	Detention pond	Runoff from 10.9 acres	(Headwaters Baron Fork)	On-going
County Road Department training for road graders	Sediment (road erosion)	Training for road graders		Washington and Benton Counties	Planned
Erosion control for rural road crossings with severe erosion sediment, road bank erosion	Sediment (road bank erosion)	Erosion control plan, stabilization planting	To be determined	UIRW	Planned
NRCS Conservation Programs	Sediment, pathogens, nutrients (stormwater runoff)	Fencing, pasture planting, cover crop, pipeline, prescribed grazing, ponds, water wells, watering facilities, wind break, filter strip, forage harvest mgt, access control, conserve or restore riparian buffers	In 2008, 94 EQIP contracts for 9,868 acres in Benton and Washington Counties	Benton and Washington Counties	On-going

Table 5.5 Management measures in the UIRW addressing sediment from erosion sources. (continued)

Project/ Program	Pollutants (source)	Measures	Amount	Location (HUC12)	Status
Arkansas Illinois River Watershed Conservation Reserve Enhancement Program	Sediment (streambank erosion)	Conserve or restore riparian buffers	15,000 acres	Adjacent to impaired streams (priority HUC12s)	On-going
Illinois River Sub-basin and Eucha-Spavinaw Lake Watershed Initiative	Sediment (streambank erosion, forestry roads)	Streambank and Shoreline Protection, riparian buffers, forest trails and landings	In 2011, 131 contracts for 13,964.72 acres in UIRW	UIRW	On-going
USDA Farm Services Agency Conservation Reserve Program	Sediment (streambank erosion)	Conserve or restore riparian buffers	214 acres	Illinois watershed	Enrolled through 2011
Conduct targeted geomorphological and bio-assessment to identify and target implementation of streambank stabilization projects for high-impact sites	Sediment (streambank erosion)	Identify sites for stream bank stabilization projects		UIRW	Planned
Improving water quality in high-priority karst and aquatic habitats in the Illinois River Watershed, Arkansas	Sediment (road and road bank erosion)	Improved road design, road maintenance training	3 designs; 1 implemented	UIRW	Planned
Identification of sources of sediment impairing Illinois River reach 11110103-024	Sediment	Identify sediment sources	2.5 stream miles	Illinois River Reach 11110103-024 (Lake Wedington – Illinois River)	Proposed

Protection and restoration of riparian buffers are the management measures that have been utilized in the UIRW that can stabilize eroding stream banks. These are also the management measures being used in Oklahoma to address eroding stream banks in the Illinois River Watershed (Oklahoma Conservation Commission 2011). Stream bank and shoreline protection is one of the NRCS practices eligible for funding assistance through the Illinois River Sub-Basin and Eucha-Spavinaw Lake Watershed Initiative, as is riparian buffer planting (NRCS Conservation Practice Standard Nos. 390, *Riparian Herbaceous Cover*; 391, *Riparian Forest Buffer*; and 655, *Forest Trails & Landings*). In 2012, the USDA Farm Services Agency began implementing the Arkansas Illinois River Watershed Conservation Reserve Enhancement Program. The IRWP is using GIS analysis to identify landowners along impaired stream reaches (2008 303(d) list) in the UIRW. The IRWP, and Washington and Benton County Conservation Districts will conduct targeted outreach to these landowners about the Arkansas Illinois River Watershed Conservation Reserve Enhancement Program, to encourage their use of the program.

5.6.2.3 *Heavy Use Areas*

Through the Illinois River Sub-Basin and Eucha-Spavinaw Lake Watershed Initiative, NRCS is targeting a number of vegetative cover management practices for the UIRW that can be used to stabilize soils in areas heavily used by livestock, if this source is contributing to the impairment of the listed stream reach. Targeted practices for the initiative that address erosion from heavy use areas include NRCS Conservation Practice Standards for planting (NRCS Conservation Practice Standard Nos. 512, *Forage and Biomass Planting*; 381, *Silvopasture Establishment*; 612, *Tree & Shrub Planting*; 342, *Critical Area Planting*; 393, *Filter Strip*; 601, *Vegetative Barriers*; and 412, *Grassed Waterway*), and prescribed grazing. Given the high soil erosion hazard indices in the priority watershed (see Figure 2.3), these management measures are important.

5.6.2.4 *Livestock in Streams*

Through the Illinois River Sub-Basin and Eucha-Spavinaw Lake Watershed Initiative, NRCS is targeting stream fencing and alternate water supply management measures (e.g., NRCS Conservation Practice Standard No. 614, *Watering Facility*) in the UIRW for control of livestock access to streams.

5.6.2.5 *Stormwater Runoff*

Runoff control measures targeted in the UIRW through the Illinois River Sub-Basin and Eucha-Spavinaw Lake Watershed Initiative include land-forming (NRCS Conservation Practice Standard Nos. 330, *Contouring*; and 600, *Terrace*), vegetation (NRCS Conservation Practice Standard Nos. 412, *Grassed Waterway*; 393, *Filter Strip*; and 601, *Vegetative Barriers*), and structures (NRCS Conservation Practice Standard Nos. 587, *Structure for Water Control*; 410, *Grade Stabilization Structure*; 350, *Sediment Basin*; 356, *Dike*; and 638, *Water & Sediment Control Basin*). An ongoing Section 319 project in the UIRW is studying the effects of storing runoff from areas around poultry houses in a farm pond. Sediment is one of the parameters being tracked in this project.

5.7 Management Measures for Rural Sources

Significant areas of rural pasture and forest are present in all of the priority subwatersheds (see Table 4.2). Pathogen sources that will be addressed in the rural areas of the priority watersheds are confined animal feeding operations, pastures, pastured livestock, and onsite wastewater treatment systems. In the Illinois River–Lake Wedington and Lower Muddy Fork–Illinois River priority watersheds, ADEQ has identified agricultural activities as the primary sources of pathogens affecting the impaired stream reaches in the subwatersheds (Table 4.1) (ADEQ 2009). There are also poultry houses and large areas of pasture in the Little Wildcat–Clear Creek and Lake Fayetteville–Clear Creek priority watersheds (downstream of the ADEQ monitoring site on Clear Creek) and the Sager Creek priority watershed (Tables 4.2 and 4.3). Onsite wastewater treatment systems are also expected to be present in rural areas of the priority watersheds.

Manure produced by AFOs is a source of pathogens in the priority watersheds. Proper manure storage, treatment, and disposal removes or reduces this source of pathogens. Maintaining good vegetative cover traps bacteria before they reach streams. Reducing access of pastured livestock to streams, while providing alternate water sources, reduces pathogen inputs from livestock standing in the streams. Identification and repair of malfunctioning onsite wastewater treatment systems removes or reduces this source of pathogens.

Management measures for agriculture nonpoint sources that are appropriate for the karst hydrogeology in the UIRW were identified in the 1990s (Davis, Brahana and Johnston, Ground Water in Northwest Arkansas: Minimizing Nutrient Contamination from Non-Poin Sources in Karst Terrane, Publication No. MSC-288 2000). The management measures targeted in the Illinois River Sub-basin and Eucha-Spavinaw Lake Watershed Initiative are appropriate for karst systems.

Table 5.6 is a summary of management measures addressing rural sources that have been implemented or are planned in the UIRW.

5.7.1 PAST MEASURES

Management measures to control and reduce agriculture nonpoint source pollution have been implemented in the UIRW for decades. Some of the more recent projects and programs are described here.

5.7.1.1 *Manure Management*

Past measures that addressed manure management in the UIRW have included legislation, demonstration projects, and manure brokering. The Arkansas agricultural nutrient management legislation is discussed in detail in Chapter 3. Manure management measures are part of the nutrient management plans required by this legislation. Initial nutrient management plans were required by 2007. Several projects in the UIRW have included development of nutrient management plans.

Table 5.6. Management measures in the UIRW addressing pathogens from rural sources.

Project/Program	Pollutants (source)	Measures	Amount	Location (HUC12)	Status
04-300: Benton County Cost Share	Nutrients, sediment and pathogens (poultry litter)	Nutrient management plans, alum treatment of litter, fencing, pasture planting, pipeline, ponds, waste storage structures, water wells, watering facilities	188 plans, 59.4 tons alum, 17,422 ft fence, 390 ac planted, 4,885 ft pipeline, 12 ponds (8,238 cu yd total), 8 facilities 12,000 sq ft storage, 13 watering facilities	Benton County UIRW (Headwaters Flint Creek, Middle Flint Creek, Osage Creek – Illinois River)	Completed
05-1600: ANRC Litter Transport from designated Nutrient Surplus Area (NSA) in Arkansas	Nutrients and pathogens (poultry litter)	Subsidy payments for transfer of poultry litter to nutrient poor area	17,018 tons litter	UIRW	Completed
08-600: Demonstrating Runoff Capture from Poultry Houses to Improve Water Quality in 12-Digit HUCs of the Illinois River Watershed	Sediment, pathogens, nutrients (stormwater runoff)	Detention pond	Runoff from 10.9 ac	(Headwaters Baron Fork)	On-going
NRCS Environmental Quality Incentive Program (EQIP)	Sediment, pathogens, nutrients (stormwater runoff)	fencing, pasture planting, cover crop, conservation crop rotation, pipeline, prescribed grazing, ponds, waste storage structures, water wells, watering facilities, wind break, filter strip, animal mortality facility, forage harvest mgt, waste treatment, composting facility, access control	In 2008, 94 contracts for 9,868 ac in Benton and Washington Counties	Benton and Washington Counties	On-going

Table 5.6. Management measures in the UIRW addressing pathogens from rural sources (continued).

Project/Program	Pollutants (source)	Measures	Amount	Location (HUC12)	Status
Illinois River Sub-Basin and Eucha-Spavinaw Lake Watershed Initiative	Sediment, pathogens, nutrients (stormwater runoff)	fencing, pasture planting, pipeline, ponds, waste storage structures, water wells, watering facilities, wind break, filter strip, animal mortality facility, forage harvest mgt, waste treatment, composting facility, access control	In 2011, 131 contracts for 13,964.72 ac in UIRW	UIRW	On-going
Arkansas Illinois River Watershed Conservation Reserve Enhancement Program	Sediment, pathogens, nutrients (stormwater runoff)	Conserve or restore riparian buffers	15,000 acres	Adjacent to impaired streams (priority HUC12s)	On-going
NRCS Conservation Reserve Program	Sediment, pathogens, nutrients (stormwater runoff)	Conserve or restore riparian buffers	214 acres	UIRW	Enrolled through 2011
Nutrient management legislation	Nutrients and pathogens (stormwater runoff)	Nutrient management plans	Estimate approximately 650 plans	UIRW	Initial plans completed, updates on-going
Nutrient management training	Nutrients (manure, fertilizer)	Timing and application rates	All certified nutrient appliers	UIRW	On-going
Development and implementation of nutrient runoff reduction measures for poultry houses	Nutrients (stormwater runoff)	Conservation practices		U of A poultry farm (headwaters baron fork)	On-going
IRWP septic pumping assistance program	Pathogens and nutrients (septic systems)	Septic maintenance training and rebate for septic pumping	30 homes per year	Lowell (Spring Creek – Osage Creek), Siloam Springs (Sager Creek) in 2012	On-going

During the period 2004 through 2006, a 319 project was implemented to demonstrate the feasibility of combustion as an alternate use of poultry litter. The demonstration furnace was installed and tested at the University of Arkansas poultry farm in the Upper Baron Fork HUC12. This study found combustion of poultry litter to be technically feasible as a method for the disposal of the majority of the manure produced on a farm and for providing heat for poultry houses. The state of the technology during the project was such that combustion of the litter did not appear to be economically beneficial to producers (Costello 2007). However, poultry litter digesters are being used successfully in other states.[14]

A BMP demonstration project conducted in the UIRW in Washington County between 2002 and 2005 included installation of 16 waste storage facilities (Dunigan and Franklin 2005).

During the period 2004 through 2007, a Section 319 project was conducted to demonstrate and evaluate the use of proprietary technology to convert poultry litter to biogas, fertilizer, and other products with potential commercial value.

During the period 2003 through 2005, several Section 319 research projects assessed the feasibility of establishing a poultry litter bank in the Ozarks region. The proposed bank would be a non-profit entity for coordinating, and tracking poultry litter removal from nutrient sensitive watersheds. Technical, financial, market and administrative feasibility were evaluated.[15] Several scenarios were developed to determine conditions that would be necessary for profit generation (Carreira and Goodwin 2005). In 2004, five poultry companies operating in northwest Arkansas formed the nonprofit BMPs Inc. to operate an online poultry litter bank serving Arkansas, Oklahoma, Missouri, and Kansas.[16] Data from the NRCS show that in 2011, over 80% of the poultry litter produced in the priority watersheds was exported out of the UIRW (see Table 4.3).

5.7.1.2 *Vegetative Cover Management*

Vegetative cover filters pathogens from runoff. Vegetative cover management includes planting, protection, conservation, grazing management, and harvest. The Oklahoma Illinois River watershed based plan identifies riparian protection as essential for reducing nonpoint source pollution in the Illinois River Watershed (Oklahoma Conservation Commission 2011).

A BMP demonstration project conducted between 2002 and 2005 in the UIRW in Washington County included 5 acres of critical area planting; 2 acres of planting in heavy use areas; 4,884 acres of forage harvest management; 1,379 acres of filter strips; 250 acres of pasture planting; and 5,189 acres of prescribed grazing (Dunigan and Franklin 2005).

[14] www.npr.org/templates/story/story.php?storyId=125640525
[15] http://www.arkansaswater.org/319/Document%20Database/images/Poultry_Litter_Bank_Summary.pdf
[16] http://www.litterlink.com

5.7.1.3 *Livestock Exclusion from Streams*

The condition of stream banks in the UIRW is important for maintaining or improving water quality. The trampling of riparian vegetation by livestock reduces the filtering capacity. In addition, pathogens can enter streams through the deposition of manure directly in streams instead of on pastures.

To eliminate these deleterious effects, streams associated with pastures can be fenced off to prevent access by livestock, and improve the filtering capacity of riparian areas. Excluding livestock from pasture streams can reduce pathogen loads to streams. When producers have relied on cattle access to streams or ponds to provide water to livestock, alternate water sources for the cattle will need to be provided. Establishment of alternative water sources requires some financial investments, but improved cattle health, farm sustainability, farm profits, and reduced environmental impacts can often justify those costs.

A BMP demonstration project conducted between 2002 and 2005 in the UIRW in Washington County, included 50,196 feet of fencing; nine watering tanks; 7,800 feet of pipeline; one well, and one pond (Dunigan and Franklin 2005).

5.7.2 ONGOING AND PLANNED MEASURES IN PRIORITY WATERSHEDS

5.7.2.1 *Manure Management*

All AFOs in the UIRW that are required to by state law, including those in the priority watersheds, have Nutrient Management Plans (NMPs) in place (see Chapter 3). NMPs must be updated every 5 years and are designed to manage the amount, source, placement, form, timing, and record-keeping requirements associated with the application of nutrients to the landscape, whether from manure or commercial fertilizers. NMPs provide a field-by-field inventory of soils, soil fertility, nutrient applications, and nutrient transport in nutrient-sensitive areas, which can aid in improved nutrient-use efficiency. While NMPs are by definition focused on control of nutrients, particularly phosphorus in the UIRW, manure management practices specified in these plans can also reduce pathogens in runoff. UAEX offers nutrient management training for producers in the UIRW. It is not expected that continued implementation of nutrient management plans in the UIRW will further reduce poultry litter application to any great degree. However, continued implementation of the nutrient management plans is expected to result in maintenance of the lower poultry litter application rates occurring in the watershed.

In 2010 the Arkansas NRCS initiated the Illinois River Sub-Basin and Eucha-Spavinaw Lake Watershed Initiative to improve water quality while maintaining agricultural production. NRCS has identified a suite of practices to be targeted as part of the initiative, several of which address manure management. The NRCS practices prescribed for manure management in the UIRW include waste storage facilities (NRCS Conservation Practice Standard No. 313), composting facilities (NRCS Conservation Practice Standard No. 317), land application (NRCS Conservation Practice Standard Nos. 590, *Nutrient Management*, and 633, *Waste Utilization*), transport (NRCS Conservation Practice Standard No. 634), and treatment (NRCS Conservation Practice Standard No. 591). There have been two sign-up periods, one in 2011 and one in 2012. This program is expected to continue at least through 2013.

BMPs Inc. continues to assist with litter export in the Illinois River Watershed. BMPs Inc. coordinates broiler house clean-out, litter hauling, and spreading of litter for poultry producers and litter buyers.[17] It is expected that the percentage of poultry litter exported from the priority watersheds (at least 80%) will remain similar to 2011 levels.

In addition to the measures discussed above, several management measures are being researched in the UIRW and have the potential to be used in the priority HUC12s in the future, including litter combustion, and subsurface manure application.

5.7.2.2 *Vegetative Cover Management*

Through the Illinois River Sub-Basin and Eucha-Spavinaw Lake Watershed Initiative, NRCS is targeting a number of vegetative cover management practices for the UIRW. Targeted practices include planting (NRCS Conservation Practice Standard Nos. 512, *Forage and Biomass Planting*; 381, *Silvopasture Establishment*; 612, *Tree & Shrub Planting*; 342, *Critical Area Planting*; 393, *Filter Strip*; 601, *Vegetative Barriers*; and 412, *Grassed Waterway*), protection and conservation (NRCS Conservation Practice Standard Nos. 390, *Riparian Herbaceous Cover*; 391, *Riparian Forest Buffer*; and 655, *Forest Trails and Landings*), prescribed grazing (NCRS Conservation Practice Standard No. 528), and harvest (NRCS Conservation Practice Standard No. 511, *Forage Harvest Management*).

The Farm Services Agency Conservation Reserve Program (CRP) has not been widely utilized in the UIRW. In the September 2011 sign-up, no applications were received from Benton or Washington counties. In Benton County, only 94 acres are currently enrolled in CRP; and in Washington County, only 118 acres are enrolled (USDA FSA 2011a). The FSA has initiated a Conservation Reserve Enhancement Program in the UIRW. Through this program, at least 9,750 acres of cropland and marginal pasture in the UIRW will be enrolled in riparian buffers, and 5,250 acres of marginal pasture will be enrolled in wildlife habitat buffers (USDA FSA 2011b).

In addition to the measures discussed above, pasture renovation is being researched in the UIRW and has the potential to be used in the priority HUC12s in the future.

5.7.2.3 *Livestock Exclusion from Streams*

Through the Illinois River Sub-Basin and Eucha-Spavinaw Lake Watershed Initiative, NRCS is targeting stream fencing and alternate water supply management measures (e.g., NRCS Conservation Practice Standard No. 614, *Watering Facility*) in the UIRW for control of livestock access to streams.

5.7.2.4 *Runoff Control*

David and Haggard (2010) found pathogen concentrations in the UIRW to be correlated strongly with flow. Even with the reductions of poultry litter storage and use in the UIRW, high levels of pathogens are still measured in the Illinois River. All of this suggests that capture and control of runoff from pastures

[17] http://www.litterlink.com/

and areas around AFOs could be important for water quality improvement in the impaired stream reaches.

An ongoing Section 319 project in the UIRW is studying the effects of storing runoff from areas around poultry houses in a farm pond. An ongoing AWRC project in the UIRW is focused on development of nutrient runoff reduction measures for poultry houses. It is possible that these nutrient runoff reduction measures will also reduce pathogens in poultry house runoff. Runoff control measures targeted through the Illinois River Sub-Basin and Eucha-Spavinaw Lake Watershed Initiative include land-forming (NRCS Conservation Practice Standard Nos. 330, *Contouring*; and 600, *Terrace*), vegetation (NRCS Conservation Practice Standard Nos. 412, *Grassed Waterway*; 393, *Filter Strip*; and 601, *Vegetative Barriers*), and structures (NRCS Conservation Practice Standard Nos. 587, *Structure for Water Control*; 410, *Grade Stabilization Structure*; 350, *Sediment Basin*; 356, *Dike*; and 638, *Water & Sediment Control Basin*).

5.7.2.5 *Onsite Wastewater Treatment Systems*

The IRWP is implementing a program for educating septic system users that includes a rebate for septic system pumping. Improved maintenance and functioning of septic systems in rural areas will reduce the potential for pathogens to enter impaired streams. A survey to identify locations of failing septic systems in the priority watersheds would be helpful for targeting this program.

5.8 Watershed Implementation Plans

The process of developing a watershed implementation plan can increase the implementation of voluntary management measures by encouraging stakeholder buy-in and leveraging technical and financial resources. Locally developed watershed implementation plans are envisioned as the mechanism for implementing management measures in the priority watersheds. These plans will include more specific information about pollutant sources that exist and how these sources will be addressed by management measures. There are several active watershed groups in the UIRW who could lead development of watershed implementation plans.

Watershed implementation plans are required under the Clean Water Act for waterbodies for which TMDLs have been completed. If the pathogen monitoring program finds pathogen standards are not being met in Clear Creek, a watershed implementation plan for Clear Creek will be needed to achieve the loads identified in the Clear Creek pathogen TMDL. In addition, watershed implementation plans will be required to address the load reductions identified in the EPA phosphorus TMDL for the Illinois River Watershed, once it is complete.

At least one local watershed management plan has been developed in the UIRW, for Lincoln Lake watershed. This plan was developed as part of a Section 319 project (Chaubey et al. 2005). There are a number of local, regional, and national interest groups active in the UIRW who could initiate and/or assist in development of watershed implementation plans for the priority watersheds.

5.9 Adaptive Management

Watershed conditions will be re-evaluated in July 2017 and the plan modified, as needed. At this time, priorities and ongoing management measures will be evaluated and modified in light of changes in water quality, land use, regulations, public opinion, and scientific understanding that have occurred since this version of the plan was approved. The usefulness of management measures will be determined based on their effectiveness as evaluated against the criteria identified in Chapter 9. This evaluation will involve examination of water quality data collected as part of routine monitoring programs and special studies or projects. The IRWP will take the lead to make sure a current, relevant plan is available for the watershed.

Element 2: Expected Load Reductions 6

6.1 Environmental Goals

The objective of this plan is to reduce target pollutants in impaired streams to achieve Arkansas water quality criteria (Table 6.1). The pollutants targeted for reduction in this watershed-based management plan are nitrate, pathogens, and sediment. Percent reduction goals have not previously been set for any of the target pollutants. TMDLs for pathogens have been developed for Clear Creek, but neither existing loads nor percent reductions are specified in the TMDL report (EPA Region 6 2009). Therefore, the environmental goals discussed below for the targeted pollutants, are based on the Arkansas water quality criteria for these pollutants, which are shown in Table 3.1.

Table 6.1. Target pollutants for priority watersheds.

Pollutant	Sager Creek	Lake Fayetteville – Clear Creek	Little Wildcat – Clear Creek	Lower Muddy Fork – Illinois River	Lake Wedington – Illinois River
Pathogens		X	X	X	X
Turbidity					X
Nitrate	X				

Pathogen indicators monitored by ADEQ are fecal coliforms and *E. coli*. Overall, the pathogen environmental goal for this plan is that less than 25% of fecal coliform and *E. coli* measurements per season exceed the applicable water quality criteria (see Table 3.1). If less than eight measurements are collected in a season, then the goal is that the seasonal geometric mean of the available measurements be less than the applicable criteria (see Table 3.1).

Turbidity data collected from the Illinois River near Savoy by ADEQ were examined to determine a percent reduction target.[18] During the period from 2006 through 2011, 13 of the 78 measurements (17%) exceeded the 17 NTU turbidity criterion. Based on ADEQ's assessment method, the target number of exceedances would be 7 (10%). When turbidity measurements from 2006 through 2011 are reduced 28%, the number of exceedances drops to 7. Based on this analysis, which is similar to an approach used in developing turbidity TMDLs (EPA 2007, FTN 2002), the target for this plan is a 25% reduction in sediment load to the impaired stream reach, assuming suspended sediment concentrations are the predominant source of turbidity.

Nitrate measurements collected from Sager Creek by ADEQ indicate the nitrate criterion has not been exceeded since 2007 (see Figure 4.4). Half of the nitrate measurements during 2006 exceeded 10 mg/L. Siloam Springs upgraded its WWTP and, based on these data, has corrected the nitrate exceedances,

[18] http://www.adeq.state.ar.us/techsvs/water_quality/water_quality_station.asp, accessed 4-10-12

and Sager Creek is likely to be assessed as achieving the nitrate criterion during the 2014 biennial state water quality assessment. Therefore, there is no nitrate reduction goal for this plan.

6.2 Non-Target Pollutants and Issues

Although reduction of nutrient loads and concentrations is not a primary objective of the management measures described in this plan, the majority of these management practices will also reduce nutrients. As noted previously, the intent of this plan is improvement in surface water quality while protecting or improving the quality of other resources in the UIRW, such as groundwater and endangered species.

6.3 Estimated Pathogen Reductions for Management Measures

Identification and elimination of pathogen sources is the most effective management measure. Pathogen monitoring data will be collected from impaired stream reaches starting in the summer of 2012, and will be evaluated to determine if (1) the pathogen water quality criteria are being exceeded, and (2) what sources of pathogens are contributing to the impairment if the pathogen criteria are not being met. Table 6.2 lists the ongoing and planned management measures that would reduce pathogens in the priority watersheds. The implementation of these management measures will be addressed in more detail in the priority watershed implementation plans.

There are very few studies where effectiveness of agricultural BMPs has been measured, rather than modeled (Kröger et al. 2011). Reductions in pathogens resulting from agricultural BMPs are rarely tracked. Pathogen reductions have not been reported for any of the Section 319 projects in the UIRW. There is, however, more than one research project ongoing in the UIRW that is targeted specifically at control of pathogens.[19] It is hoped that these studies will improve understanding of BMP effects and the factors affecting their results.

The load reductions identified below are estimates based on currently available information. Due to our incomplete understanding of the processes at work in the UIRW, and the vagaries of weather and stakeholder participation, the results may differ from what is identified here.

[19] http://www.naa.ars.usda.gov/research/projects/projects.htm?ACCN_NO=413052

Table 6.2. Pathogen management measures for priority watersheds.

Source	Measures	Lake Fayetteville–Clear Creek	Little Wildcat–Clear Creek	Lower Muddy Fork–Illinois River	Lake Wedington – Illinois River
Wastewater	Illicit Discharge Identification and Elimination Programs	X			
	Sewer System Planning, Maintenance, Rehabilitation, and Expansion	X			
	Septic System Identification and Evaluation	X	X	X	X
	IRWP Septic System Pumping Rebate	X	X	X	X
	Maintenance of Sewer Systems	X			
Urban Runoff	NPDES MS4 Stormwater Management Plans	X			
	Rain Gardens	X			
	Riparian buffers	X			
	Fayetteville LID and Drainage Criteria Manual	X			
Poultry Litter	Storage Facility	X	X	X	x
	Composting Facility	X	X	X	X
	Litter Transport	X	X	X	X
	Treatment	X	X	X	X
	Manure Application Training and Nutrient Management Plan	X	X	X	X
Cow Manure	Livestock Exclusion From Streams	X	X	X	X
	Alternate Water Source	X	X	X	X
Pasture/Field Runoff	Prescribed Grazing	X	X	X	X
	Riparian Buffers	X	X	X	X
	Filter Strip	X	X	X	X
	Detention Pond	X	X	X	X

6.3.1 WASTEWATER MANAGEMENT

Untreated or incompletely treated sewage may be a source of pathogens in the impaired stream reaches. Raw sewage typically has a total coliform count of 1×10^7 to 1×10^9 most probable number (MPN) per 100 mL (Novotny et al. 1989). Any raw sewage discharges or leaks that are eliminated will reduce pathogen inputs by 1×10^7 to 1×10^9 MPN per 100 mL.

6.3.1.1 *Illicit Discharge Identification and Elimination Programs*

Illicit discharges to area stormwater systems draining to Clear Creek are a potential source of pathogens to Clear Creek. According to MS4 progress reports submitted to ADEQ, none of the MS4s draining to Clear Creek have identified illicit discharges to their stormwater systems.[20] Continued implementation of the illicit discharge identification and elimination programs outlined in the stormwater management

[20] http://www.adeq.state.ar.us/home/pdssql/pds.asp, accessed April 2012

plans for Springdale, Johnson, and Fayetteville, will ensure that the pathogen load from illicit discharges remains zero.

6.3.1.2 *Sewer System Planning, Maintenance, Rehabilitation, and Expansion*

Sewer system planning ensures that sewage collection and treatment systems are not overloaded, preventing releases of raw or incompletely treated sewage to the environment and surface waters. Expanding sewer service to areas currently served by onsite wastewater treatment systems removes septic systems as a pathogen source.

Maintenance of treatment and collection systems, including routine inspections, also prevents accidental releases of sewage. Rehabilitation and repair of existing or old sewer lines can reduce infiltration and sewage leaks. No sewer overflows have been reported in the Clear Creek watershed.[21] Continuation of existing city sewer inspection and maintenance programs will eliminate this potential source of pathogens to Clear Creek.

6.3.1.3 *Septic System Identification and Evaluation*

Identification of septic systems in the priority watersheds will increase the chances of reaching owners or users of septic systems that could be a source of pathogens in the impaired stream reaches. Evaluating existing systems for malfunction further increases the success of efforts to eliminate septic systems as pathogen sources to impaired streams. If owners/users are not willing to participate in voluntary programs, it is possible to file complaints with the Arkansas Department of Health and ADEQ to initiate regulatory action. Therefore, it is possible, and even likely that pathogen loads from these sources will be decreased.

6.3.1.4 *IRWP Septic System Pumping Assistance Program*

Septic tanks must be occasionally pumped out to maintain system function. Performing this maintenance can help prevent release of pathogens. The IRWP septic system pumping rebate encourages proper maintenance of septic systems in the UIRW, and should be targeted to areas in the priority watersheds identified as having malfunctioning septic systems (see Section 6.3.1.3).

6.3.1.5 *Maintenance of Sewer Systems*

Proper maintenance of lift station and sewer mains along Clear Creek reduce the potential for pathogens to enter Clear Creek.

6.3.2 URBAN RUNOFF MANAGEMENT

6.3.2.1 *NPDES MS4 Stormwater Management Plans*

When a TMDL assigns an individual WLA specifically to a MS4's stormwater discharge, ADEQ's permit specifies that the WLA must be included as a measurable goal for the stormwater management program (SWMP). Total coliform and *E. coli* WLAs were assigned to the MS4s for the cities of Fayetteville,

[21] http://www.adeq.state.ar.us/home/pdssql/complaints_inspections.asp, accessed April 2012

Johnson, and Springdale, and for Washington County. When these MS4s update their stormwater management plans, they will add activities to address pathogens. The most likely activity that will be added is monitoring (EPA Region 6 2009).

6.3.2.2 *Rain Gardens*

There has been some study of pathogen removal efficiency of rain gardens. Reported effects of rain gardens or other bioretention systems on pathogens range from 90% removal to a 58% increase (Prince George's County Department of Environmental Resources 1993; Wright Water Engineers Inc. and Geosyntec Consultants 2010). Rain gardens reduce pathogens in runoff through exposure to drying, and ultraviolet radiation in sunlight, as well as through settling and filtration (Hathaway and Hunt 2008).

6.3.2.3 *Riparian Buffers*

Reforestation of riparian buffers along Clear Creek and its tributaries will contribute to improving Clear Creek water quality to meet water quality standards for pathogens. Forested riparian buffers have been shown to reduce pathogen inputs to streams from urban runoff by up to 60%.[22] However, riparian buffers are generally not adequate on their own to reduce runoff pathogen concentrations to meet water quality standards. Therefore, additional measures may need to be applied in conjunction with the riparian buffer, including measures that reduce the sources of pathogens in runoff (Bentrup 2008). Analysis of aerial images of the Illinois River watershed by CAST determined that approximately 66% of riparian areas in the Lake Fayetteville–Clear Creek priority watershed were un-forested (David and Haggard 2010). Based on initial analysis of correlations between percent forested riparian buffer and water quality, a target of 75% forested riparian buffer is suggested (Haggard and Massey, unpublished).

6.3.3 MANAGEMENT OF PASTURE/FIELD RUNOFF

6.3.3.1 *Riparian Buffers*

Forested riparian buffers have been shown to reduce pathogens in runoff from pastures (Doyle et al. 1975, NRCS 2012). Grassed riparian buffers have been shown to reduce pathogens in pasture runoff by 70% to 95% (Coyne and Blevins 1995, Young et al.1980, Larsen et al. 1994). CAST analysis of riparian cover in the UIRW determined that 27% to 75% of the riparian area in the priority watersheds was not forested (David and Haggard 2010). Implementation of up to 10,000 acres of agricultural riparian buffer is currently planned in the UIRW (FSA 2011). Targeting the areas in priority watersheds will be emphasized. IRWP and its partners will encourage landowners to enroll in the Conservation Reserve Enhancement Program (CREP) program.

6.3.3.2 *Filter Strip*

As of April 2012, there is one NRCS contract that will install filter strips in the UIRW. A number of studies have demonstrated the ability of grass filter strips to trap bacteria from cow manure (Larsen et al. 1994, Young et al. 1980, Coyne et al. 1995, Peterson et al. 2011a, Lim et al. 1998, Klapproth and

[22] http://www.treevitalize.net/RiparianBuffer.aspx

Johnson 2009). They found that, depending on the width of the filter strip, and the type of plant used in the strip, 30% to 100% of fecal coliforms could be removed.

In their literature review, Moore et al. (1988) suggested vegetative filter strips are most reliable for removal of pathogens at high concentrations (at least 105 organisms per 100 mL). In these situations, the pathogen levels in runoff from filter strips seem to equilibrate at about 104 to 105 organisms per 100 mL, regardless of the experimental conditions. Assuming the unit organisms per 100 mL is roughly equivalent to the unit that is used in the Arkansas water quality criteria (colonies per 100 mL), fecal coliform and/or *E. coli* levels of approximately 105 organisms per 100 mL would meet the primary contact criterion.

6.3.3.3 *Detention Pond*

In April 2012, there were currently five NRCS contracts to install ponds in the. In addition, an ongoing Section 319 project is evaluating the water quality benefits (including reduction of pathogens) of trapping and reusing runoff from poultry house sites. Because ponds prevent runoff from reaching streams, and pathogens disappear quickly in the water column, ponds would be expected to remove at least 95% of pathogens in runoff from their drainage area.

6.3.4 MANURE MANAGEMENT

6.3.4.1 *Poultry Litter Storage Facilities*

Two litter storage facilities will be installed in Washington County and one in Benton County through the Illinois River Sub-Basin and Eucha-Spavinaw Watershed Initiative (under contract as of April 2012). Due to NRCS privacy standards, the exact locations of these facilities is not public information.

Using facilities to store poultry litter removes this material as a potential source of pathogens in runoff. Thus, the decrease in pathogen runoff would be expected to correspond to the proportion of waste that is stored.

Storage of waste also results in die-off of indicator pathogens. Kelley et al. (1995) reported that *E. coli* levels in stored litter were less than half of those in fresh litter. Therefore, use of stored litter for application on pastures would be expected to reduce pathogens by at least 50%.

6.3.4.2 *Composting Facility*

When subjected to the proper conditions, poultry litter compost reaches temperatures that kill pathogens (Brake 1992’ Moore et al., no date). While composting facilities are eligible for cost share through the Illinois River Sub-Basin and Eucha-Spavinaw Watershed Initiative, there are currently no NRCS contracts for installation of composting facilities in the UIRW as of April 2012.

6.3.4.3 *Manure Transport*

Manure transport removes pathogens from the watershed. Poultry litter export levels from the Sager Creek and Lower Muddy Fork–Illinois River priority watersheds is expected to remain as at least 80% of produced litter. Export levels from the other priority watersheds are 1% or less (see Table 4.3). The decrease in pathogen runoff from poultry litter transport would be expected to correspond to the proportion of poultry litter that is exported.

6.3.4.4 *Waste Treatment*

Treatment of poultry litter with alum and other acidifying treatments reduces pathogen levels (Moore et al. 1998; Moore 2011; Penn and Zhang, n.d.; Shah, Westerman and Parsons 2006). No information was found describing the amount of pathogen reduction from alum treatment. As of April 2012, there are over 25 NRCS contracts that will implement the practice Amendments for Treatment of Agricultural Waste in the UIRW, which includes alum treatment of poultry litter and cattle manure.

6.3.4.5 *Manure Application Training with Nutrient Management Plan*

In the Eucha-Spavinaw watershed, preparation and implementation of nutrient management plans reduced the amount of poultry litter applied in the watershed by around half (Sharpley et al. 2009). Reducing the amount of poultry litter applied to pastures, reduces pathogens available to be transported to surface waters. Continued implementation of nutrient management plans in the priority watersheds is expected to maintain any reductions in poultry litter application rates that occurred when the plans were first implemented. As of April 2012, there are three NRCS contracts that will implement nutrient management in the UIRW.

How poultry litter and manure are applied to pasture (i.e., how often, timing relative to rainfall, surface application or incorporation into the subsurface, distance to surface water) affects pathogen levels in pasture runoff (Gessel et al. 2004, Larsen et al. 1994, Soupir et al. 2006, Sistani et al. 2010). Therefore, using techniques from nutrient application training (which includes poultry litter application) will affect pathogen loads in runoff.

6.3.5 GRAZING MANAGEMENT

6.3.5.1 *Livestock Exclusion from Streams*

While there has not been much study of the impact of livestock exclusion from streams on stream pathogen concentrations (Agouridis et al. 2005), at least one study concluded that keeping cattle at least 2.5 meters from streams could reduce bacterial loads by 95% (Larsen et al. 1994). Other sources report fecal coliform reductions ranging from 30% to 94% (Peterson et al. 2011b, 2011c; Osmond et al. 2002) NRCS practices associated with this management measure include fencing, water wells, watering facilities, and ponds. The numbers of NRCS contracts in place as of April 2012 that implement each of these practices in the UIRW are shown below:

- Fencing - 39
- Water Wells - 3
- Watering Facilities - 27
- Ponds – 5.

6.3.5.2 *Prescribed Grazing*

As of April 2012, there are 22 NRCS contracts in the UIRW that will implement prescribed grazing. Studies show that rotational grazing can reduce pathogen loads to streams (Sovell et al. 2000) (NRCS 2008). Peterson, Redmon and McFarland (2011d) reported that prescribed grazing has been shown to reduce fecal coliform loads by 90% to 96%, and *E. coli* loads by 66% to 72%. Prescribed grazing practices can also include alternative water sources and livestock exclusion.

6.3.6 VEGETATIVE COVER MANAGEMENT

As of April 2012, there are five NRCS contracts that will implement forage harvest management in the UIRW, and 23 NRCS contracts that will implement forage and biomass planting. No studies were found researching the impacts of these practices on pathogen levels in runoff. However, it has been shown that runoff volumes tend to be lower from pastures with good condition vegetative cover, which would reduce the amount of pathogens carried to streams (Agouridis et al. 2005).

6.3.7 ACHIEVING PATHOGEN TARGETS

It was not possible to develop a percent reduction target for pathogens for this plan. Therefore, it is difficult to prove that these management measures will result in achieving the pathogen targets. However, each of these management measures does reduce pathogen levels in surface waters. Individually, some of these measures might reduce pathogen levels in the impaired stream reaches to meet the targets for this plan. However, when implemented as a suite of practices, as is planned, it should be possible for fecal coliform and *E. coli* levels in the impaired stream reaches to meet their targets.

6.4 Estimated Sediment Load Reductions for Management Measures Addressing Surface Erosion in Lake Wedington–Illinois River Watershed

The actual sources of the sediment/turbidity causing the impairment of Reach 1110103-024 of the Illinois River have not been determined. In a recent Section 319 project, sediment sources were determined for the Blossom Way Creek in Rogers. The sediment export coefficients from that study are shown in Table 6.3 (Formica 2008). These export coefficients were multiplied by areas for potential sources in the watershed of Reach 111010301-024, to develop an estimate of the existing sediment loading rate and relative source contributions to the sediment load in the stream reach (Table 6.3). Export coefficients for roads are taken from other sediment source studies in the Ozark Highlands region of Arkansas. These estimates are for planning purposes only.

The expected load reductions identified below are estimates based on currently available information. Due to our incomplete understanding of the processes at work in the UIRW, and the vagaries of weather and stakeholder participation, the actual results may differ from what is identified here.

Table 6.3. Estimate of existing sediment load and sources for Reach 1111010301-024 of the Illinois River.

Potential Source	Area	Sediment Export Coefficient	Estimated Load (tons)	Proportion of Total Load
Streambank erosion	1.3 miles*	179 tons/mile	232.7	.21
Pasture (heavy use areas, livestock in streams, stormwater runoff)	2,790 acres	0.1 tons/acre	279.0	.25
Forest (roads or trails)	3,685 acres	0.04 tons/acre	147.4	.13
Paved Roads	13 miles	1.1 tons/mile	14.6	.01
Unpaved Roads	23 miles	18.8 tons/mile	432.4	.39
TOTAL			1,106.1	.99

Notes: *Assuming 25% of stream bank is eroding.
(a) From Formica et al. 2004
(b) From Van Eps et al. 2005.

6.4.2 UNPAVED ROADS AND ROADBANK EROSION

6.4.2.1 *Road Bank Planting and Erosion Control Blankets*

Road bank planting and use of erosion control blankets have been shown to reduce sediment loads in the UIRW. The estimated BMP efficiencies for road bank planting with a hydromulcher in the UIRW range from 45% to 75% (Dunigan and Franklin 2005). If eroding road banks contribute 10% of sediment to Illinois River reach 11110103-024, a 45% reduction of sediment from this source will reduce the overall sediment load approximately 2% (0.40 of sediment load from roads * 0.1 of road erosion from roadbanks * 0.45 reduction).

6.4.3 STREAM BANK EROSION

6.4.3.1 *Stream Bank Stabilization*

Restoration of urban stream reaches with eroding banks has resulted in 57% to 96% reductions in sediment load (Arkansas Game and Fish Commission, U of A Watershed Conservation Resources Center, Nelson Engineering, and City of Rogers 2008; www.arkansaswater.org). In the STEPL model, the sediment reduction for stream bank stabilization is 75%. A 75% reduction of sediment from stream bank erosion would result in an overall reduction of around 16% in the sediment load to the impaired stream reach (0.21 of sediment load from stream bank erosion* 0.75 reduction).

6.4.3.2 *Riparian Buffer Conservation and Restoration*

As of April 2012, there are no NRCS contracts for the UIRW that include riparian buffer restoration practices. However, implementation of up to 10,000 acres of agricultural riparian buffer is currently planned in the UIRW (FSA 2011).

CAST analysis of riparian cover in the UIRW determined that 27% of the riparian area in the Lake Wedington – Illinois River HUC12 was not forested. If we assume this percentage for the impaired stream reach, and that the areas of non-forested stream banks contribute 27% of the sediment from stream bank erosion, and that planting these non-forested riparian areas would result in stabilizing the stream banks and reduce the sediment load from these areas by 75%, the result would be about a 4% reduction in sediment from stream bank erosion (0.21 of sediment load from stream bank erosion * .27 of stream bank erosion from non-forested stream banks * 0.75 reduction). This reduction could be in addition to, or part of, the reduction estimated in Section 6.4.2.1.

6.4.3.3 *Alternate Water Source*

Under favorable conditions, providing an alternative water source than a pasture stream has reduced stream bank erosion by 77% (Sheffield et al. 1997). Assuming a 77% reduction in erosion is equivalent to a 77% reduction in sediment, this would result in an overall reduction in the stream sediment load of approximately 16% (0.21 of sediment from stream bank erosion * 0.77 reduction).

6.4.3.4 *Livestock Exclusion from Streams*

Owens et al. (1996) determined that stream fencing decreased sediment loss from stream banks by 40%. Using this reduction, exclusion of livestock from streams would result in an 8% reduction in the overall sediment load to the impaired stream reach (0.21 of sediment from stream bank erosion * 0.4 reduction).

6.4.3.5 *Prescribed Grazing*

Studies have shown that rotational grazing can reduce stream bank erosion (e.g., Sovell et al. 2000, Lyons et al. 2000, Zaimes et al. 2005). A study in Iowa found stream bank erosion was 34% less in streams associated with pastures where intensive rotational grazing was used, and those associated with pastures that were continuously grazed (Zaimes et al. 2005). If we assume a 30% reduction in stream bank erosion associated with rotational grazing, this would result in a 6% reduction in the overall sediment load to the impaired stream reach (0.21 of sediment from stream bank erosion * 0.3 reduction).

6.4.4 PASTURE

The USDA NRCS Illinois River Sub-Basin and Eucha-Spavinaw Lake Watershed Initiative is expected to have the potential to reduce sediment loads in runoff by 17% to 29%.[23]

6.4.4.1 *Critical Area Planting*

In Washington County, 5.3 acres of critical area planting in the UIRW was estimated to reduce sediment load by 76 tons/year (Dunigan and Franklin 2005). An Arkansas agricultural BMP effectiveness tool uses a total sediment reduction of 59% for pasture and hay planting (Merriman, Gitau and Chaubey 2006). A 59% reduction of pasture sediment load to the impaired stream segment would result in an overall 15% reduction in the sediment load to the impaired stream segment (0.25 of sediment load from pasture * 0.59 reduction).

[23] http://www.ar.nrcs.usda.gov/news/2012_illinois_spavinaw_signup.html

6.4.4.2 *Livestock Exclusion from Streams*

Stream fencing and alternative water sources for livestock are recommended activities for the UIRW under the NRCS Illinois River Sub-Basin and Eucha-Spavinaw Watershed Initiative. In the Ballard Creek watershed, installation of just over 50,000 ft of stream fence contributed to reductions in nutrient and sediment loads (Dunigan and Franklin 2005). An Arkansas agricultural BMP effectiveness tool uses a total sediment reduction of 83% for livestock exclusion from streams, based on one study (Merriman, Gitau and Chaubey 2006). Assuming this reduction, this management measure would result in an overall 21% reduction in sediment load to the impaired stream reach (0.25 of sediment from pasture * 0.83 reduction).

6.4.4.3 *Alternative Water Source*

Under favorable conditions, providing an alternative water source than a pasture stream has reduced TSS loads by 90% (Sheffield et al. 1997). An Arkansas agricultural BMP effectiveness tool uses a total sediment reduction of 38% for watering facilities, based on two studies (Merriman, Gitau and Chaubey 2006). Assuming this reduction, providing alternate water sources would result in an overall reduction in the stream sediment load of approximately 10% (0.25 of sediment from pasture * 0.38 reduction).

6.4.4.4 *Riparian Buffer Conservation and Restoration*

As of April 2012, there are no NRCS EQIP contracts for the UIRW that include riparian buffer restoration practices. However, implementation of up to 10,000 acres of agricultural riparian buffer is currently planned in the UIRW (FSA 2011).

An Arkansas agricultural BMP effectiveness tool uses a total sediment reduction of 76% for forested riparian buffer. If we assume that 27% of the riparian buffer associated with pastures is unforested, and that replanting these buffers will result in a 76% reduction in sediment load from their associated pastures, the result would be about a 5% reduction in the overall sediment load (0.25 of sediment from pasture * 0.27 of pasture with unforested buffers * 0.75 reduction).

6.4.4.5 *Prescribed Grazing*

Prescribed grazing was not included in the Arkansas agricultural BMP effectiveness tool (Merriman, Gitau and Chaubey 2006). However, rotational grazing has been shown to reduce sediment loads (Sovell et al. 2000, Pennington et al. 2009). A paired watershed study in northwest Arkansas found that sediment levels in runoff from rotationally grazed pastures were at least half of the levels from overgrazed pastures. In Washington County, use of prescribed grazing on 5,189 acres in the UIRW was estimated to reduce sediment load by 1,078 tons/year (Dunigan and Franklin 2005). If we assume a reduction of 40% in pasture sediment load for rotational grazing, that would result in a 10% reduction in the overall sediment load to the impaired stream reach (0.25 of sediment from pasture * 0.4 reduction).

Prescribed grazing practices can also include alternative water sources and livestock exclusion. Sediment load reductions for these practices are discussed above.

6.4.4.6 *Filter Strip*

In Washington County, installation of 1,379 acres of filter strip in the UIRW was estimated to reduce sediment load by 50 tons/year (Dunigan and Franklin 2005). An Arkansas agricultural BMP effectiveness tool uses a total sediment reduction of 38% for field borders (Merriman, Gitau and Chaubey 2006). Assuming this reduction, this management measure would result in an overall 10% reduction in sediment load to the impaired stream reach (0.25 of sediment from pasture * 0.38 reduction). As of April 2012, there is currently one NRCS contract that will install filter strips in the UIRW.

6.4.4.7 *Ponds*

An Arkansas agricultural BMP effectiveness tool uses a total sediment reduction of 77% for ponds (Merriman, Gitau and Chaubey 2006). Assuming a pond catches runoff from 1 acre of pasture (0.0004 of the pasture) and a 77% sediment reduction, this management measure would result in an overall reduction in sediment load to the impaired stream reach of less than 1% (0.25 of sediment from pasture * 0.0004 of pasture treated* 0.77 reduction). As of April 2012, there are currently five NRCS contracts that will install ponds in the UIRW.

6.4.5 ACHIEVING SEDIMENT/TURBIDITY TARGET

Expected levels of sediment reduction for selected combinations of management measures are shown in Table 6.4. There are several potential management scenarios that would be expected to achieve the 25% sediment reduction target.

Table 6.4. Sediment load reductions for selected management measure combinations.

Practice	Overall Reduction	Combination				
		1	2	3	4	5
Road bank planting, etc.	2%				X	X
Streambank stabilization	16%		X			
Riparian buffer (stream bank)	4%				X	
Livestock exclusion and alternate water source (stream bank)	16%	X		X		
Prescribed grazing (stream bank)	6%		X		X	
Critical area planting	4%				X	X
Livestock exclusion	21%	X				
Alternate water source	10%	X		X		
Riparian buffer	5%	X			X	
Prescribed grazing	10%		X		X	X
Filter strip	10%					X
Ponds	<1%			X		
Total		52%	32%	26%	31%	26%

Element 5: Stakeholder Awareness, Outreach, and Education

7

7.1 Goals and Objectives

Watershed-based management is fundamentally a social activity (Thornton and Laurin 2005). While technical solutions to problems are necessary for effective watershed management, they are not sufficient. Decisions on how to improve water quality, implement management practices and restore streams, are ultimately based on the socioeconomic perceptions, beliefs and values of landowners and stakeholders on how these technical solutions will affect them. The Awareness, Outreach and Education objectives of this watershed-based plan, therefore, are to:

- Increase local landowner and public awareness of the need for, and the benefits of, watershed restoration and protection practices;
- Increase stakeholder support and participation in watershed management activities, and
- Improve the understanding of how water quality and environmental improvements contribute to increased economic and social capital in the community.

Before action will occur, there must be an awareness that there is a problem or issue. During the *Water Issues in Arkansas* project, funded by the Winthrop Rockefeller Foundation, one of the members of the Advisory Committee remarked during a discussion of Outreach and Education, "Before we talk about outreach, I think we need to talk about awareness. Until I became a member of this Advisory Committee, I wasn't even aware we had some of these issues in Arkansas."

Awareness must be an integral part of, and precede, effective outreach and education programs and efforts. Several stakeholder surveys conducted in Northwest Arkansas, discussed in the next section, provide insight into stakeholder awareness of environmental issues. This section is followed by a discussion of past outreach and education activities, which are extensive. Outreach and Education programs and efforts by ANRC, ADEQ, USDA Cooperative Extension Service, NRCS, and the University of Arkansas-Fayetteville have been ongoing in the UIRW for over 20 years. The IRWP has had outreach and education programs ongoing since it was formed in 2005. The section on past outreach and education efforts is followed by a section that discusses ongoing activities. The final section discusses propose future activities.

7.2 Awareness

The first step in developing and implementing effective outreach and education efforts must be an understanding of the awareness of water issues by the target audiences. The 2008 *Water Issues in Arkansas* report found that, overwhelmingly, public officials, government agency personnel, educators, commercial and agribusiness representatives, and public citizens agreed water is absolutely critical for the economy, environment, and quality of life in Arkansas. Yet, the highest priority issue identified by these same people was misperceptions and lack of knowledge and understanding about water (Thornton et al. 2008). Several stakeholder interviews/surveys were recently conducted within Northwest Arkansas that provide insight into the attitudes, beliefs and perception of different stakeholders. These interviews and surveys can inform the development and implementation of effective outreach and education efforts.

7.2.1 UIRW STAKEHOLDER INTERVIEWS

In 2006, Tetra Tech conducted 17 in-depth interviews to elicit stakeholder perceptions of water quality and watershed conditions in the UIRW. The results from these interviews are summarized, by general stakeholder category, in Table 7.1. The majority of interviewed stakeholders stated that a combination of urban nonpoint sources, agricultural nonpoint sources, and wastewater effluent contributed to water quality conditions in the UIRW. However, the perception of water quality conditions within the watershed and the relative contribution of these three sources varied widely among stakeholders. The one common theme among the 17 stakeholders was urban nonpoint sources are a concern for the UIRW.

7.2.2 LINCOLN LAKE STAKEHOLDER SURVEY

A 2006 University of Arkansas survey of agricultural and non-agricultural stakeholders in the Lincoln Lake/Moores Creek/Beatty Branch watershed provided perspective on the perceptions of these two stakeholder groups about water quality and sources of pollutant loadings within the watershed (Popp and Rodriguez, 2007). Both groups were asked to provide their perceptions of water quality in Lincoln Lake, Moores Creek, and Beatty Branch. The survey found:

- Over 50% of the agricultural stakeholders stated all three water bodies had acceptable water quality, while about 20% of the non-agricultural stakeholders agreed that water quality was acceptable.
- In general, a greater percentage of agricultural stakeholders than non-agricultural stakeholders thought the water quality in all three water bodies was suitable for drinking, fishing, and swimming, although less than 50% of agricultural stakeholders thought the water quality in Moores Creek or Beatty Branch was suitable for swimming.
- Over 42% of non-agricultural stakeholders stated that agriculture was a major source of the problems while only 5% of agriculture stakeholders believed agriculture was a major source. Similar percentages were associated with who should be responsible for clean-up.
- The majority of both groups stated that they believed local/county officials best represented their needs and concerns compared with state or federal officials (Popp and Rodriguez 2007).

Table 7.1. Stakeholder perceptions of water quality in the UIRW.

Stakeholder Group	Individual Stakeholder Perceptions
Elected Officials (City Officials, County Quorum Courts, Commissions, etc.)	• Higher phosphorus concentrations and more algae exist in the upper portion of the watershed (upstream of Siloam Springs) • The streams are visually appealing – fairly clean and not muddy; however, some impairment (e.g., phosphorus concentrations) cannot be perceived visually. • Conditions are fairly good but could be improved; the problems are not unique to the Illinois River but are typical of the rivers in the area. • Managers are doing a "pretty good job" with water quality in the watershed.
Professional Policy Practitioners (Municipalities, Counties, Water Utilities, Non-Governmental Organizations, etc.)	• The watershed needs help; some pollutants are getting into streams. • When it rains, the river does not look good; upstream sediment sources decrease water clarity. • Some tributaries are in good condition, but conditions are generally poor; specifically, phosphorus and nitrogen concentrations are relatively high. • Conditions are not as bad as perceived by various litigants. • Water quality is pretty good; algal growth has increased, but the water clarity is pretty good.
General Community (Citizens Affiliated with Various Industries, Businesses, or Non-Governmental Organizations)	• Excessive algal growth exists, but Osage Creek is in pretty good shape. • Trash in the streams has increased; brown foam in the river has decreased. • Osage Creek is much cleaner and supports a good population of small mouth bass, which did not exist 20 years ago. • The river was polluted 20 years ago, especially near the greenhouses; the water has improved, but it is somewhat murky and not as clean as it could be. • After rain events, bare soil upstream causes higher turbidity and levels in the stream sediment. • Water quality is not outstanding, but river can still be used for recreational paddling. • The river appears pretty good, but a detailed and objective data assessment is needed to determine the accurate condition of water quality.

7.2.3 BEAVER WATER DISTRICT SURVEY

A water quality survey was also conducted in the Beaver Water District boundaries by the University of Arkansas-Fayetteville in 2008 (Longstreth and Gillow 2008). Selected survey results are presented here because many residents and businesses throughout the UIRW receive their drinking water from Beaver Water District and their perceptions of water quality, sources, and management practices are likely to carry over to water quality within the UIRW. This survey found:

- Almost 66% of residents and business people stated they are very or fairly concerned about pollution in Beaver lake and the streams that feed it.
- Over 80% of homeowners agreed that water quality affects both their quality of life and their property value. About 60% of businesses agreed that water quality affected the success of their

business, but more business people disagreed/strongly disagreed than agreed/strongly agreed that water quality affected their profitability.

- Half the residents believed their actions can have some effect on water quality while about 25% of business people believe their actions can have some effect on water quality.
- About 60% of residents and over 70% of business people believed city/county government best represented their water needs and concerns (Longstreth and Gillow 2008).

7.2.4 UIRW KNOWLEDGE GAP ASSESSMENT

A Knowledge Gap Assessment (KGA) or cooperative inquiry (Focht 2002) was conducted by the Forrester Group with 35 UIRW stakeholders (i.e., 30 IRWP Board members and 5 general public participants) in 2008 (Grindstaff 2008). The purpose of the KGA was to assess not only the general knowledge of participants about water quality issues, but also the interrelationships among issues, actions, and management options. General areas of inquiry included knowledge of UIRW, aquatic life and its relation to watershed land use and habitat, hydrology and runoff, pathogens or bacteria, water chemistry and quality, and political jurisdictions in the UIRW. The KGA assessment found:

- There were wide and often unpredictable gaps in knowledge about interrelationships among a variety of issues, actions, and management options, such as habitat condition and pathogen transport, hydrology and political jurisdictions.
- In general, stakeholders scored high on topics such as a sense of place, habitat and water chemistry, but low on the topics of industrial and agricultural water use.
- Overall, many stakeholders were strong or moderate systems thinkers, in their understanding of how various human activities had cascading and interconnected effects on stream quality.
- Most of the participants' knowledge was gained from books, classes, friends, and the media.
- Three-fourths of participants believed water quality in the UIRW is better today than it was 5 years ago, but over 50% of the participants believed that water quality is worse today than it was 25 years ago.

7.2.5 SUMMARY

In summary, there is a general understanding among stakeholders that water quality in the UIRW is affected by a combination of sources, including urban stormwater, agricultural nonpoint sources, and wastewater effluent. However, there were significant differences in perception of which sources are most important (and, therefore, warrant implementing management practices). For example, there were significant differences in perspective among agricultural and nonagricultural stakeholders on whether agriculture was a major source of pollutants in the watershed. There were also differences in perspective based on personal vs. professional settings. About half of residents believed they can make a difference in improving water quality while only 25% of these same individuals in a business setting believed they can make a difference in improving water quality. In general, the interrelationships and interconnections among human activities, sources, pollutants, water quality, aquatic life, management practices and quality of life are not well understood. However, these interrelationships and interconnections can be understood from a systems perspective by many stakeholders if they are adequately presented and described. Finally, the media for communication is critical. These insights inform the outreach and education activities ongoing and to be implemented in the future, and reinforce the need to continually gather information on stakeholder perceptions, beliefs, and values.

7.3 Previous Outreach and Education Efforts

There have been extensive outreach and education activities within the UIRW over the past decade. Some of the organizations who have been exceptionally active, and their projects, are briefly summarized below. There have been many activities in addition to these. This brief historical summary is intended to illustrate how active outreach and education efforts have been in the UIRW, not to provide a comprehensive summary of all activities.

7.3.1 ARKANSAS NATURAL RESOURCES COMMISSION

ANRC, for example, has invested over $4.5 million in Section 319 watershed management projects in the UIRW since 2000 (See Appendix B for an annotated list of projects). The general distribution of these funds is shown on Figure 7.1. Over 55% of these funds have been for demonstration or implementation projects, which ultimately, are the most effective forms of outreach and education. About 30% has been spent in modeling and monitoring streams and watersheds in the UIRW, with about 11% of the effort specifically directed to outreach and education efforts. These efforts have included: developing teacher education programs for teachers in Washington County; measuring UIRW residents' awareness, attitudes, knowledge, and actions regarding urban NPS pollution prevention; creating community awareness of urban NPS pollution potential impacts in Mud Creek; creating brochures and a website for the Lake Fayetteville Watershed Partnership to educate the public about NPS pollution; develop NPS educational material for Spanish-speaking residents in the UIRW; developing and using electronic teaching tools to reduce NPS pollution; and sponsoring a green development workshop.

7.3.2 ILLINOIS RIVER WATERSHED PARTNERSHIP

The IRWP, formed in 2005, has also been engaged in extensive outreach and education activities over the past 7 years. These activities are summarized briefly in Table 7.2. These outreach and education efforts have included developing watershed educational materials, in English, Spanish, and Marshallese (the largest population of Marshallese people outside the Marshall Islands proper live in Northwest Arkansas), creating an informational website with educational material and promoting conservation and restoration success stories, planting trees in riparian areas on Arbor Day, conducting workshops and training on building rain barrels and rain gardens, hosting watershed day camps, and having booths at fairs, regional meetings, workshops, and other civic events.

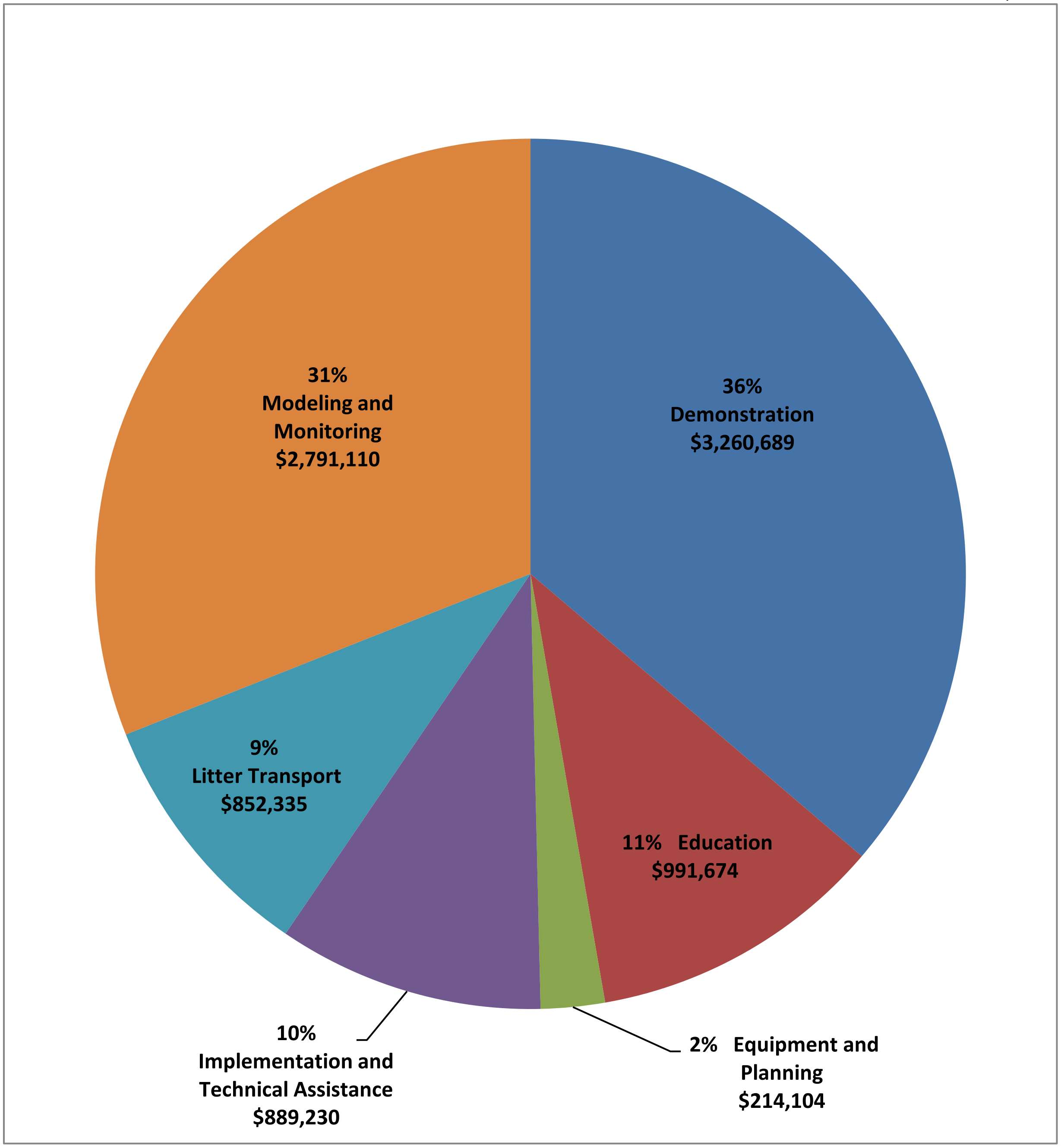


Figure 7.1. Distribution of over $4.5 million in ANRC NPS funds from 2000 to 2010 in UIRW.

Table 7.2. Summary of previous outreach and education efforts of IRWP.

Program	Activities	Period
Partnership	• Board of directors • Membership • Committee meetings	2005 - 2011
Rain Gardens	• 15 rain gardens on public property • Rain gardens on private property	2009-2011
Riparian Projects	• Planting demonstrations • 19,000 tree seedlings planted along Scull Creek, Sager Creek, Illinois River, Blossom Way Creek, Spring Creek, and Flint Creek	2008 - 2011
	• Tree farm at SWEPCO	2011
Creek Clean-ups	• Mud Creek (annual), Osage Creek (annual), Illinois River (annual), Lake Springdale, Spring Creek (annual), Niokaska Creek, Sager Creek tributary, Turtle Creek	2009-2011
Public Education and Community Outreach	• Make a Difference Day • Illinois River Watershed Festival • Watershed Academy • Rain Garden Academy • Watershed Summer Day Camp • Watershed Video Contest	2010, 2011
	• Illinois River Rally • Watershed Photography Contest • Media Campaigns • CREP and EQIP outreach	2011
	• Lectures at civic groups, scout troop meetings, 4-H clubs, interest group meetings, agency meetings, conferences, festivals • Booths at County Fairs, NWA Green Expo, Farmers' Markets, community events • Lead watershed tours for NACAA, Women's shelter kids', Arkansas legislators • Rain garden tours • Website	2009-2011
Clean Water Raingers Kids Club	• Appearances at over 30 schools and public events, over 60 Clean Water Rainger concerts, distribute watershed songs CDs and illustrated books	2010 - 2011
Volunteer Water Quality Monitoring Events	• Secchi Dip-In • World Water Monitoring Day • Stream Team • Volunteer Lake Monitoring	2009 - 2011

7.3.3 UNIVERSITY OF ARKANSAS COOPERATIVE EXTENSION SERVICE

The University of Arkansas Cooperative Extension Service in Washington and Benton Counties has also conducted extensive outreach and education efforts over the past decade. Some of these activities have included the Master Gardner program; Urban*A*Syst, Home*A*Syst, and Farm*A*Syst programs, which provide training on how to manage property ranging from green space, lawns and yards, pastures and fields to protect stream water quality; urban stormwater education; 4-H development, including environmental education training and projects; pamphlets, brochures, and newsletters on a range of environmental topics; and booths and displays at fairs regional meetings, workshops, and other civic events. The Extension Service has also sponsored forage and pasture field demonstration days, conducted grazing management schools, and litter application practices and nutrient management planning workshops for farmers and ranchers in the UIRW in conjunction with NRCS.

7.3.4 NUMEROUS OTHER ORGANIZATIONS

There are numerous outreach and education activities being conducted in Northwest Arkansas that contribute to the UIRW. For example, the Northwest Arkansas Regional Planning Commission coordinates a regional education effort among the 15 small MS4s in Benton and Washington Counties affected by EPA Phase II Storm Water regulations. By contracting with the University of Arkansas Cooperative Extension Service to develop and conduct storm water public education and involvement efforts, the NWA partnership benefits from a comprehensive, cost-effective outreach program that will improve water quality on a watershed-scale. Cooperating entities include the cities of Bentonville, Bethel Heights, Elkins, Elm Springs, Farmington, Fayetteville, Greenland, Johnson, Little Flock, Lowell, Springdale and Rogers along with Benton and Washington Counties and the University of Arkansas.

In addition, the University of Arkansas, Northwest Business Council, Ozark Society, Audubon Arkansas, TNC, Sierra Club, AGFC, Arkansas Forestry Commission, ADEQ, Arkansas Farm Bureau Federation, USDA NRCS, USGS, USFS, and numerous other watershed associations and organizations have, and are, involved in awareness, outreach and education efforts in the UIRW.

7.4 Ongoing Outreach and Education Efforts

Many of the activities listed above are still ongoing, with continued efforts planned for the future. This section discusses some of these activities, and their contributions to stakeholder awareness, outreach and education.

7.4.1 IRWP

The IRWP has a number of ongoing activities that contribute directly to achieving the three objectives stated in Section 7.1, and the IRWP mission of outreach and education, monitoring, and conservation and protection (Table 7.3). Ongoing public awareness and outreach activities are multimedia-based, and targeted at specific audiences through tailored messages. The Watershed Wednesday TV spots, for example, reach the general public, increasing their awareness of the concept of watersheds and selected watershed management and conservation practices that can be implemented at home, in their neighborhood, or in their local community. Outreach and education programs are targeted to all ages from elementary and middle school to junior and senior high school students. Adult outreach and education also occurs through volunteer monitoring programs, CREP education workshops, and stakeholder meetings on the watershed management plan.

Hands-on projects and activities are sponsored by various IRWP partners throughout the year, from the North American Secchi Dip-In to building of home rain gardens, and re-vegetating riparian areas along both urban and rural streams.

All IRWP outreach and education activities are evaluated following each event through a lessons learned session with the activity leaders. This information is used to increase the effectiveness of the activity in subsequent years.

Outreach and education efforts are defined in the broadest sense to include opportunities for stakeholders and citizens to learn about the effects various activities have on streams and stream quality through volunteer monitoring and clean-up projects. Through volunteer monitoring, participants can observe and learn about the effects of seen and unseen activities on water quality. Nutrients and pathogens cannot be seen in the water, but can be detected through sample collection and analysis. In addition, the effects of nutrients or stream bank erosion can be observed through periphyton or algae growth, turbid water, and sedimentation in the stream bed. The adage, “Seeing is believing” can be reinforced through both volunteer monitoring and creek clean-up efforts. Picking paper out of overhanging stream branches, cans, tires, and other trash and litter off stream banks and out of stream beds drives home the need for environmental stewardship, litter campaigns, and recycling programs. These efforts also help identify the need for conservation and protection programs, which is the third major mission of IRWP.

Conservation and protection projects that are ongoing for 2012 include planting seedlings in riparian areas of several subwatersheds throughout the UIRW, growing native riparian species in school greenhouses for subsequent planting in riparian areas, constructing rain gardens in strategic areas of the watershed, and conducting workshops on proper installation and maintenance of septic waste treatment systems. Much of the watershed is rural and the proper installation, and particularly maintenance, of septic systems is critical in reducing the loading of both nutrients and pathogens to receiving waterbodies and groundwater. In addition, the IRWP is assisting with outreach to landowners in the priority UIR watersheds with land eligible for the USDA FSA Arkansas Illinois River Watershed CREP.

Table 7.3. Illinois River Watershed Partnership 2012 Action Plan.

Activity	Description
Clean Water Raingers Program	• School and public event CWR Concerts • Watershed songs, CDs, illustrated books • Illinois River Watershed in AR & OK
Rain Garden Academy	• Spring – professional development hours • Fall – Crystal Bridges national Stormwater BMP Conference • Tours of rain gardens for garden clubs, master gardeners • Kid's Rain Garden Academies with Girl Scout and EAST student facilitators • Install 10 rain gardens per year • Flood Safety Campaign "Stop! Turn Around" • Stormwater education "Only Rain Down the Drain"
Native Plants Project	• "Grow Stations" for native plants and grasses from seedlings for rain garden and riparian projects • Meets new science and engineering education core • Partner elementary & middle schools with high school landscaping and agriculture programs
4-State Watershed Academy	• Co-host with regional watershed groups in Joplin, MO • AR, KS, MO, OK
Watershed Camp	• Summer day camp • 8 – 12 years old • Teachers for professional development credit
Watershed Festival	• Annual Watershed Festival and Secchi Monitoring • Rotation on lakes in the IR Watershed: Fayetteville, Lincoln, Wedington, Springdale, Elmdale, Siloam City Lake, Cave Springs, Tenkiller
Illinois River Rally	• "Paddler's Club" Annual River Rally • 4-H Clubs in 7 counties in AR and OK • Boy Scouts • Girl Scouts • Conduct canoe and kayak lesson, bug-kicking, fish seining, water quality monitoring, geo caching
CREP-EQIP Workshops	• IRWP Conservation Program Coordinator • Partner with USDA FSA, NRCS, ANRC, UA & OSU education and outreach to landowners • Demonstration Jet Stinger willow plantings • Demonstration farms
Water Wise Lawn Care	• Farmer's Market demonstrations with Low/No-Phosphorus lawn fertilizers service
Video, Photography, Coloring Contests	• Elementary, Middle, Junior and Senior High • Partner with Clean Water Rainger schools • Partner with EAST programs and state education conference
Community Events	• Farmer's Markets, county fairs, teacher fairs and conferences, regional and statewide business and environmental conferences

Table 7.3. Illinois River Watershed Partnership 2012 Action Plan (continued).

Activity	Description
Media Outreach Campaign	• TV, radio, newspaper • Promote Rain Garden Academies for kids and adults, Riparian Tree plantings, Stream Teams for volunteer water quality monitoring & cleanups • Tourism maps of watershed rain gardens • Spanish and Marshallese language "Stop! Turn Around" flood waters campaign • Watershed Wednesday TV Spots
Internships	• University of Arkansas • Oklahoma State • Northeastern State • John Brown University • NWACC • Science, education, environmental, engineering, business, agriculture students
Volunteer Stream Teams	• IRWP training for stream teams and individuals • Adopt streams, river reaches
World Water Monitoring Day	• Lincoln Lake Day • Local community festivals • Provide canoes, kayaks, rafts • WWMD monitoring • Post results on IRWP website
Volunteer Lake Monitoring	• Lake Keith; Lake Fayetteville; Lake Elmdale; Springdale, Lincoln, and Bud Kidd Lakes; Lake Tenkiller
Illinois River Education Tours and Cleanups	• "4 Seasons of the River" float and cleanup trips for sponsors/members
Tributary Creek Cleanups	• Osage Creek, Rogers • Spring Creek, Springdale • Mud-Scull Creek, Fayetteville • Sager Creek, Siloam Springs • Town Branch, Tahlequah
Riparian Project	• Streambank Riparian Planting – 3,500 seedlings planted along streams in Fayetteville, Prairie Grove, Gentry, Rogers, Siloam Springs, Springdale, Tahlequah • Flint Creek Tree Farm – 1,000 seedlings in small containers planted with City Partners' Parks Departments • Training city landscape and mowing crews • Tag seedlings with IDs • Riparian Project Signage
Jet Stinger Demonstrations	• Willow cutting demonstrations and landowner plantings to improve riparian buffers and rain gardens
Rain Garden Project	• Rain Garden Resource Specialist (½ time position) • Install 15 rain gardens in 2012 in the Illinois River Watershed • Recruit, educate, train public & quasi-public partners • Girl Scout partners in 2012 • Rain Garden signage

Table 7.3. Illinois River Watershed Partnership 2012 Action Plan (continued).

Activity	Description
Septic Pumping Program	• Workshops in communities with AR and OK Health Departments • County co-sponsors • $50 rebate coupon to landowners for septic pumping with certified pumpers after attending workshop
Watershed Sanctuary at Cave Springs	• Nature Preserve • Trails • Outdoor Pavilion • Amphitheater • Fishing areas • Demonstration of BMPs • Education Center

In addition to the activities listed in Table 7.3, the IRWP also:

- Formally acknowledges its sponsors and partners and their contributions to improving the quality of life in the UIRW,
- Promotes its outreach and educational opportunities within the watershed, and
- Recognizes individuals, businesses, organizations, educational institutions, and agencies for their leadership in successful environmental projects through its annual Golden Paddle Award.

Each of the activities listed above are planned to continue as the watershed-based plan is implemented.

7.4.2 USDA NRCS/FSA

The USDA FSA and the State of Arkansas are instituting the Arkansas Illinois River Watershed CREP in the Illinois watershed. This program was initiated in 2011 and has a goal of enrolling 10,000 acres of eligible marginal pastureland and cropland in 14- to 15-year contracts in the UIRW. The CREP funding is for establishing and restoring riparian forest buffers and wildlife habitat buffers by planting native grasses, forbs, trees, and shrubs. These projects contribute not only to controlling runoff, but also stabilizing stream banks, reducing flood damage impacts, and improving instream habitat.

NRCS is also funding projects to improve water quality throughout the Illinois River Watershed through the Illinois River Sub-Basin and Eucha-Spavinaw Lake Watershed Initiative. This EQIP program, initiated in 2009, will continue for 8 years and improve water quality in the Illinois River Watershed and the ESLW while maintaining the food and fiber production in these watersheds.

7.4.3 ANRC

The ANRC NPS Program is ongoing and is planned through 2016. Some of the projects that are ongoing and planned are listed in Table 7.4. Many of these projects are based on the success of past projects and will be continued over the next four years. For example, GIS tools and models were previously used to characterize the geomorphological attributes of stream systems in both the UIRW and in Northwest AR and identify and target streams needing stream bank stabilization. ANRC has had, has, and will continue to have active partnerships with local nonprofit organizations, municipalities and other entities to develop and implement coordinated environmental education programs with a local emphasis. Several of the projects listed in Table 7.4 illustrate these programs and partnerships.

Table 7.4. ANRC 2011-2016 Nonpoint Source Pollution Management Plan Outreach and Education Activities for the Illinois River Watershed.

Outreach and Education Activities Planned for 2011-2016	
• Continue ongoing education and training programs for poultry and livestock producers to meet regulatory requirements.	• Continue to provide technical/financial assistance in developing and implementing nutrient management plans
• Use GIS and remote sensing to target subwatersheds for additional geomorphic and bioassessment analyses to stabilize streambanks.	• Promote volunteer cleanups, streambank restoration and other activities using the AR Stream Team program and other conservation groups, through water awareness days, Great Secchi Dip-In, and similar activities.
• Conduct comprehensive information and education programs for mayors, county judges, quorum courts, planning boards and commissions on the benefits of clean water and the economics of protection vs. restoration.	• Identify groups for targeted education on high impact activities, such as proper waste disposal methods for boaters and floaters, and proper road maintenance practices for POA and county road departments.
• Review tax codes for possible mechanisms to use tax incentives for water quality BMP implementation.	• Work with primary/secondary educators to prepare lesson plans, teaching modules on water quality protection and conservation.
• Investigate the use of SRF for alternative onsite wastewater treatment systems.	• Cooperate and support NGOs in developing and providing comprehensive environmental education and outreach efforts.
• Continue to develop, coordinate, and conduct comprehensive education programs for city planners, elected officials, developers, contractors and others on stormwater management, stormwater pollution prevention plans, erosion and sediment control, LID, greenway development, and other related topics.	• Continue to support and develop training programs for earth moving contractors and others on construction BMPs through partnership with Northwest Arkansas Regional Planning Commission and University of Arkansas Cooperative Extension.

7.4.4 NUMEROUS OTHER ORGANIZATIONS

The University of Arkansas Cooperative Extensive Service and research scientists and engineers associated with the University are continuing the outreach and education programs discussed in the previous section. The cities of Fayetteville and Rogers have both been developing a system of trails and greenways. A 36-mile regional greenway is being developed that will eventually link Bentonville with Fayetteville, including the trails associated with the recently opened Crystal Bridges Art Museum. In addition to recreation, improving environmental outreach and education is a major objective of the regional greenway project. Eventually, these green trails and proposed blue trails will converge. There is also a regional consortium of municipalities in the UIRW that have, and are, developing outreach and education programs for stormwater management, including training for developers, heavy equipment operators, and others involved in construction activities. Brochures and information fact sheets are also available for the public on the importance of reducing trash and litter and maintaining stormwater facilities.

7.5 Planned Outreach and Education Efforts

Additional activities that are planned to increase the effectiveness of implementing watershed management practices in the HUC12 priority watersheds are listed in Table 7.5. These activities are planned to be implemented over the next 3 to 5 years, in addition to those ongoing and previously discussed activities. These activities include an assessment of the effectiveness of outreach and education activities, and an assessment of management practices. This is part of the adaptive management process.

Table 7.5. Planned awareness, outreach, and education activities supporting WBP implementation.

Awareness and Outreach	Education	Conservation and Restoration Projects
• Build on KGA and stakeholder surveys. Review the KGA ad survey results, identify knowledge gaps and create awareness campaign.	• Ecosystem Services Introduce ecosystem service approaches for quantifying monetary benefits from restoration/protection activities.	• High-Priority HUC12 Restoration Projects Catalysts for bringing funding agencies, landowners, and stakeholders together to implement restoration management practices.
• EPA Nonpoint Source Outreach Tool Box Review and incorporate relevant EPA Outreach tools into IRWP activities.	• Specialty Workshops Continue specialty workshops on LID, LEED green design, Adopt A Stream, etc.	• High-Priority HUC12 Protection Projects Catalysts for bringing funding agencies, landowners, and stakeholders together to implement protection management practices.
• Priority HUC Stakeholder Meetings Outreach to landowners in priority HUC12s for restoration/protection.	• Conservation Daze Collaborate with UAEX on Conservation Demonstration Days to include WRP, WHIP and similar conservation sites for agric, and LID and green design for urban areas.	• Green Entrepreneurs Catalysts for promoting UIRW as an incubator for green entrepreneurs and businesses.
• Expand Partnership Expand interactions with other organizations/private sector businesses in priority HUC12s.	• Watershed Leadership Training Provide training for local stakeholders interested in leading a small group to implement watershed management practices.	

7.5.1 AWARENESS AND OUTREACH

Four activities are planned to reach out to stakeholders and increase their awareness of water issues within the UIRW:

- Increase awareness of the importance of riparian buffers for water quality improvement. The previous stakeholder surveys and KGAs will be evaluated and used to identify areas where additional awareness and outreach information, materials, and tools are needed. Building on this experience, the IRWP will conduct pre-activity, cross-sector stakeholder surveys prior to conducting awareness, outreach and educational activities. Materials and tools developed for, and lessons learned from, previous outreach projects (e.g., Mud Creek) and resources such as the EPA Nonpoint Source toolbox will be utilized in developing an outreach and education program to address these knowledge gaps. Following various media campaigns, specialty workshops on riparian buffers and their importance in water quality improvement, and expanded partnerships with selected organizations, post, cross-sector stakeholder surveys will be conducted to determine the effectiveness of the outreach efforts in creating an awareness of water quality issues and riparian buffers, and an understanding of why riparian buffers are important and the benefits that accrue from revegetating denuded riparian areas or protecting existing forested riparian areas.
- EPA Nonpoint Source Outreach Tool Box. The EPA Nonpoint Source program has created a nonpoint source outreach tool box that will be reviewed and used with the results from the UIRW survey and KGA to increase awareness (http://www.epa.gov/nps/toolbox/). Relevant information and material from the Tool Box will be adapted for stakeholders in the UIRW.
- Priority HUC12 Stakeholder Meetings. The IRWP facilitated stakeholder meetings during the development of this Watershed-based Management Plan. With the identification of high priority HUC12 watersheds for restoration and protection management practices, targeted stakeholder meetings will be conducted in these catchments to increase awareness of specific issues and restoration/protection management practices that are available to address these issues.
- Expand Partnership. Peter Drucker (1999) stated that nonprofit organizations would be the 21st century vehicle for getting things accomplished in civil societies. Nonprofit organizations know their stakeholders, communicate with their stakeholders and provide the bridge between private sector and governmental agencies. The IRWP embodies this paradigm and is a microcosm of the environmental, governmental, agribusiness, and commercial sectors in the watershed. The strength of the IRWP is that it already has a social network established in the UIRW. This network will be expanded to include additional partners who can help facilitate the implementation of management practices within the priority areas. Table 7.6 provides examples of the potential partnerships that might be expanded or established. Specific outreach activities will be based on issues within the priority catchments, and results from the KGA. These partnerships are primarily for Arkansas organizations, but similar outreach partnerships will be considered with Oklahoma organizations.

- Sponsor a conference on stream restoration, Restoration of Our Rivers, at the Crystal Bridges Art Museum in Bentonville on October 4 and 5, 2012, including field trips to demonstration projects highlighting stream restoration in the UIRW.
- Roll out the UIRW Watershed-Based Management Plan at the Crystal Bridges Restoration of Our Rivers Conference in October 2012.

7.5.2 EDUCATION

There are also four additional educational activities planned:

- Ecosystem services. Ecosystem services are the benefits people obtain from nature. Examples include freshwater, timber, water purification, soil regeneration, flood control, pollination, and similar services, many of which are considered "free." The EPA Ecosystem Services Research Program and the USDA Office of Ecosystem Services are developing approaches for quantifying the economic value of some of the non-market services (e.g., waste assimilation, water purification, soil development). Creating a better understanding among stakeholders of the monetary value of these "free" services, as well as potential markets will help inform better decisions.
- Specialty Workshops. The IRWP has a history of conducting or participating in specialty workshops related to environmental issues within the watershed, such as the CREP workshops. These workshops will continue and include, for example, a workshop on ecosystem services – what they are, how they are quantified, and how they can be valued and used to inform management and development decisions. There will also be a workshop on riparian buffers to complement a media campaign on the importance of protecting and restoring riparian buffers in both urban and rural settings.
- Conservation Daze. The IRWP has also conducted and sponsored a number of conservation activities such as revegetating stream riparian areas, demonstrating water jet devices for planting cuttings, and installing rain gardens. Conservation daze are an expansion of these activities by partnering with other educational activities in the UIRW, such as the UAEX Agricultural Demonstration Day, by including visits to CREP, WRP, WHIP and similar sites. In addition, the IRWP can partner with Home and Garden and Home Development exhibitions to showcase green design, LID, and other conservation and restoration practices and activities.
- Watershed Leadership Training. The IRWP will provide leadership training for stakeholders in priority HUC12s so these individuals are equipped and have the confidence to lead restoration and protection activities within their local communities and catchments. This training will include meeting organization and facilitation, public speaking, and similar skills useful in leading small group activities.

Table 7.6. Potential partners that may share common goals for the Upper Illinois River Watershed.

Organization	Affiliation	Common Goal	Resource
All cities in the UIRW	City government/ departments	Water quality protection, education	Potential grant partners and volunteers
Arkansas Game and Fish Commission/ Stream Team	Government agency	Stream conservation, water quality education, volunteerism	Equipment, potential sponsor and technical assistance
Arkansas Forestry Commission	Government agency	Forest and riparian buffer management, Green Infrastructure, urban forestry	Trees, technical assistance, and potential grant partner
Arkansas Natural Resource Commission	Government agency	Water resources planning, grant funding agency	
Arkansas Water Resource Center	Government agency	Water quality monitoring, research, outreach, and education	Water quality research, monitoring, potential grant partner
Benton and Washington County Conservation Districts/NRCS	Government agency	Natural resource conservation	Technical assistance
University of Arkansas Cooperative Extension Service	Government agency	Agricultural production, forest and riparian buffer management, and urban stormwater programs	Educational assistance
Washington County Environmental Affairs	Government agency	Solid waste management, household hazardous waste disposal	Technical help, potential grant partner, outreach and education activity partner
United States Forest Service	Government agency	Forestry education and management	Technical help, potential grant partner
United States Geological Survey	Government agency	Stream gauging, water quality monitoring and modeling	Monitoring, potential grant partner
Audubon Arkansas	Non-governmental organization	Conservation, education and outreach	Technical and education assistance, potential grant partner
Arkansas Canoe Club	Non-governmental organization	Water conservation and recreation	Volunteer resource and potential sponsor
Boy Scouts and Girl Scouts of America	Non-governmental organization	Conservation, outreach and recreation	Volunteer resource
Farm Bureau of Benton and Washington Counties	Non-governmental organization	Agricultural production and water quality interest	Potential grant partner, outreach and education activity partner and sponsor
Fayetteville Natural Heritage Association	Non-governmental organization	Natural resource conservation and recreation	Potential grant partner and volunteer resource
Illinois River Watershed Partnership	Non-governmental organization	Water quality conservation, education, and outreach	Potential grant partner, volunteer resource

Table 7.6. Potential partners that may share common goals for the UIRW (continued).

Organization	Affiliation	Common Goal	Resource
Lake Fayetteville Watershed Partnership	Non-governmental organization	Water quality protection	Potential grant partner, volunteer resource
Multi-Basin Regional Watershed Council	Non-governmental organization	Water quality conservation, education, and outreach	Potential grant partner
Ozark Society	Non-governmental organization	Conservation and recreation	Volunteer resource
Poultry Partners	Non-governmental organization	Agricultural water quality interest	Outreach and education activity partner and potential sponsor
Sierra Club	Non-governmental organization	Conservation and recreation	Volunteer resource
The Nature Conservancy	Non-governmental organization	Natural resource conservation, outreach, and education	Potential grant partner and potential sponsor
Watershed Conservation Resource Center	Non-governmental organization	Water quality conservation, education, and outreach	Potential grant partner
Businesses In the UIRW	Business	Water quality conservation interest	Potential sponsors, grant partners, and volunteers
Schools in the UIRW	Schools	Water quality education	Potential Grant Partners and Volunteers

7.5.3 CONSERVATION AND RESTORATION PROJECTS

The IRWP will serve as a catalyst in advancing conservation and restoration projects in:

- High-priority HUC12 restoration projects,
- High-priority HUC12 protection projects, and
- Green entrepreneurship.

The strength of the IRWP is bringing people together for effective collaboration and partnerships. The planned activities for high-priority HUC12 catchments are bringing funding agencies/organizations together with local landowners and community stakeholders to advance the implementation of restoration or protection management practices. Development of watershed implementation teams for priority HU12s will be encouraged and supported by the IRWP and its partners. These teams will coordinate restoration and conservation projects in their HUC12 watersheds and leverage resources for project implementation.

The IRWP vision is also that the UIRW will serve as an incubator for green entrepreneurs and businesses to create innovative approaches for environmental improvement and management. IRWP can serve as the integrator and facilitator to bring community colleges, university, and technical institute scientists and engineers in contact with venture capitalists and businesses to develop and prototype these innovative procedures.

These activities are consistent with five areas ANRC has established for focusing outreach and education activities to assist in implementing its state watershed management plan:

1. Silviculture,
2. Agriculture,
3. Resource extraction,
4. Surface erosion, and
5. Household and business activities.

Additional targeted and tailored stakeholder awareness, outreach, and education programs will be developed and implemented as watershed implementation plans are prepared for priority subwatersheds in the UIRW.

Element 4: Technical Assistance 8

8.1 Technical Assistance for Management Measures

There are a number of sources for technical assistance related to management measures. Table 8.1 summarizes sources for technical assistance related to management measures for the priority watersheds. Several of these sources for technical assistance and their programs are discussed below.

8.1.1 UNIVERSITY OF ARKANSAS

The University of Arkansas is a valuable source for technical assistance in both urban and rural areas. Research projects provide information about BMP effectiveness, and ideas for new management measures and approaches. In addition, the university is involved in modeling watersheds, evaluating alternative products and markets to utilize poultry litter, designing stream bank restoration projects, geomorphological assessment, and evaluating technologies to improve storm water management. One project at the University developed a tool for evaluating the use and siting of BMPs in both rural and urban settings (Merriman, Gitau and Chaubey 2006). The University of Arkansas Savoy Experimental Watershed in the UIRW is a long-term research site for multi-disciplinary research of animal waste impacts on surface and groundwater quality and hydrogeology. The University works with state and federal agencies, interest groups, and municipalities. Information is disseminated through the agricultural research station, Arkansas Water Resources Center (AWRC), and the cooperative extension service (CES).

The AG Research Station site in the UIRW is the Arkansas Agricultural Research and Extension Center. This Center is a place where farmers can learn about the most recent information available to them on environmental protection and conservation methods. The Research Station research and demonstration farms are used to evaluate the effectiveness of BMPs and to educate farmers and landowners about how they can benefit from BMPs in reducing the loss of sediment, nutrients and organic material from their farms.

AWRC’s mission is: 1) to plan and conduct water resource research, cooperating closely with colleges, universities and other institutes in Arkansas to address the state's water and land-related problems; 2) to promote the dissemination and application of research results; 3) to provide for the training of scientists in water resources; 4) to formulate a research program that is responsive to state water issues; and 5) to work closely with state and federal agencies.

Table 8.1. Technical assistance for management measures for the priority watersheds.

Measures	AWAG	ANRC	Arkansas Forestry Comm.	University of Arkansas	UAE	CAST	AWRC	IRWP	Arkansas Health Dept.	NRCS, FSA	EPA	Consultants	Municipalities	Non-government Org.	County Conservation Dist.
Alternate Water Source				X	X		X			X					X
Composting Facility				X	X					X					X
Critical Area Planting				X	X					X					X
Detention Pond					X		X	X		X					X
Filter Strip					X			X		X					X
Illicit Discharge Identification and Elimination Programs	X										X		X	X	
Litter Transport				X	X					X					X
Livestock Exclusion from Streams				X	X		X			X					X
Low Impact Development		X		X							X	X	X	X	
Maintenance of Sewer Systems													X	X	
Nutrient Application Training and Nutrient Management Plan		X			X					X					
NPDES MS4 Stormwater Management Plans	X			X	X						X	X	X		
Prescribed Grazing				X	X					X					X
Rain Gardens				X	X			X							
Riparian buffers			X	X	X	X	X	X		X	X			X	X
Road Crossings		X				X								X	X
Roadbank Planting & Erosion Control Blankets		X		X	X		X							X	X
Septic System Identification and Evaluation					X				X						
Septic System Maintenance (Pumping)					X			X	X						
Sewer System Planning, Maintenance, Rehabilitation, and Expansion												X	X	X	
Streambank Evaluation		X		X		X	X					X		X	X
Streambank Stabilization		X					X			X	X			X	X
Training Road Graders					X										X
Waste Storage Facility				X	X					X					X
Waste Treatment				X	X					X					X

AWRC provides one of the primary mechanisms in the state for technology transfer. Through these collaborative partnerships with state and federal agencies, AWRC provides technical assistance based on university research that is delivered to land users throughout the state, but especially within the ANRC priority watersheds (the UIRW is an ANRC priority watershed). AWRC's Water Quality Lab provides analytical, field and technical support to the water quality investigative community, which includes university researchers, state and federal agencies, and private groups or individuals.

The CES provides technical assistance through a number of programs and services, including their website, agricultural nutrient management training, agricultural nutrient applicator training, assessment of nonpoint source pollution risk through Washington County Urban*A*Syst, Farm*A*Syst, and Home*A*Syst; and urban stormwater technical support for the MS4s in the UIRW. CES also maintains an extensive library of up-to-date, research-based fact sheets, applied research publications and BMP manuals and guidelines.

Center for Advanced Spatial Technologies (CAST) is another entity affiliated with the University of Arkansas that works with researchers and planners in the UIRW. The CAST has provided remote sensing analysis of riparian buffers in the UIRW (David and Haggard 2010), and could provide similar support for evaluation of streambanks in the UIRW. Oklahoma uses remote sensing in their targeting of streambank stabilization projects (Storm, White and Fox 2008). The CAST also works with the Northwest Arkansas Regional Planning Commission supporting the Northwest Arkansas regional MS4 program.

8.1.2 NRCS

The NRCS offers several programs that provide technical assistance to landowners and conservation districts addressing natural resource concerns, primarily related to agriculture. In addition to the Illinois River Sub-basin and Eucha-Spavinaw Watershed Initiative, there are the Grazing Lands Conservation Initiative, Conservation Stewardship Program, and Wildlife Habitat Incentives Program. The NRCS also provides technical assistance and support of agricultural nutrient management planning and implementation. All owners and managers of private grazing land are eligible to receive technical assistance from NRCS.

8.1.3 EPA

The EPA website provides access to information on a variety of water quality subjects, including management measures.

8.1.4 ANRC

ANRC provides training and certification of nutrient applicators and nutrient management planners. ANRC also provides technical assistance to conservation districts. In addition, research funded through the ANRC nonpoint source program provides technical information and tools that can be useful in applying management measures in the UIRW.

8.1.5 NON-GOVERNMENT ORGANIZATIONS

Non-government, non-profit organizations, such as the IRWP and WCRC; and professional organizations provide technical assistance to their constituents and others. IRWP and WCRC provide technical information to stakeholders through resources on their websites and workshops and conferences. Through its Rain Garden Academy and its website, the IRWP provides technical assistance with rain garden construction. IRWP also works with the ADH to provide technical assistance to septic tank owners, and with the AFC to provide technical assistance with riparian planting projects. The WCRC is a local resource that provides technical assistance and training in the areas of watershed management, watershed assessment, geomorphological assessment, natural channel restoration design and implementation, and development of grants and strategic funding mechanisms for implementing BMPs. The city of Fayetteville is receiving technical assistance with sustainability planning, which includes water quality protection, from the Home Depot Foundation Sustainable Cities Institute. The Resources First Foundation created the Arkansas Conservation Center website to connect people to conservation resources, including technical assistance.

Professional organizations such as the American Public Works Association, Water Environment Foundation and Arkansas Water Works and Waste Water Environment Association, provide technical assistance related to urban stormwater management and wastewater system maintenance to their constituents, who are primarily municipal water and sewer utilities. An example of a useful water quality management and planning tool available from the Water Environment Foundation, is the urban stormwater BMP selection tool, BMP SELECT (www.werf.org/select).

8.1.6 COUNTY CONSERVATION DISTRICTS

Conservation districts are another vehicle for providing technical assistance to agricultural producers for the implementation of best management practices on their farms. Conservation districts establish natural resource priorities at the local level and provide support and input into how soil and water conservation programs are implemented locally, working cooperatively with landowners and federal (e.g., NRCS, FSA) and state (e.g., ANRC, AGFC, Arkansas Forestry Commission) agencies.

8.1.7 ADEQ

ADEQ provides technical assistance to organize watershed groups, facilitates quarterly discussion of voluntary approaches, and hosts an annual water quality conference through their Public Outreach and Assistance Division.

8.2 Technical Assistance for Outreach and Education

Information and assistance with education and outreach activities is available locally through the Illinois River Watershed Partnership, the ADEQ Watershed Outreach and Education Section, Watershed Conservation Resource Center, UAEX, and others. A number of resources are also available from EPA through the Nonpoint Source Outreach Toolbox (http://www.epa.gov/nps/toolbox/).

8.2.1 NORTHWEST ARKNASAS REGIONAL PLANNING COMMISSION

The Northwest Arkansas Regional Planning Commission contracted with UAEX to develop a regional outreach and education program for the MS4s in the Fayetteville-Bentonville corridor.

8.2.2 EPA

EPA maintains the nonpoint source outreach toolbox on their website. This toolbox provides access to a wide variety of materials that can be used for outreach and educational efforts related to nonpoint source pollution.

8.2.3 ADEQ

ADEQ provides technical assistance for outreach and education through the Public Outreach and Assistance Division. ADEQ can provide materials and information useful for education and outreach, and also offers training and assistance to teachers through their Water Education for Teachers (WET) program.

8.2.4 PREVIOUS STUDIES AND PROGRAMS

As discussed in Chapter 7, there have been, and are ongoing, a number of outreach and education programs implemented in the UIRW. Reports and other publications associated with outreach and education projects funded through ANRC with Section 319(h) funds identify lessons learned that could be helpful to new or ongoing outreach and education efforts. In addition, these projects and other ongoing projects in the UIRW may develop materials and information that would be useful for current or planned outreach and education efforts. The IRWP evaluates each outreach and education effort to determine what does and doesn't work, and further refine their outreach and education approaches and programs.

8.3 Technical Assistance for Monitoring

Agencies conducting water quality monitoring generally have their own technical resources. Technical assistance for volunteer water quality monitoring programs is available through the Arkansas Game and Fish Commission Stream Team Program. Technical assistance for MS4 stormwater monitoring activities will be available from ADEQ, the University of Arkansas, and the AWRC, in addition to the EPA.

8.4 Funding Assistance for Management Measures

Estimates of money spent in the UIRW for management measures by the ANRC, NRCS, IRWP, and other funding sources as of the end of 2011 are summarized in Table 8.2. For the most part, funding sources have been identified for ongoing and planned management measures in the UIRW. As of April 2012, over $1.5 million has been allocated to be spent in the UIRW over the next 3 years or so. Table 8.3 lists management measures for the priority watersheds along with their budgets and funding sources. Where funds are currently allocated, and the amount is known, those amounts are included in Table 8.3. The 'X' symbol indicates other potential funding sources. The '$' symbol indicates a source that is known to fund a program; however, information about the amount allocated was not obtained or available.

Table 8.2. Summary of money spent in the UIRW for management.

Agency/Organization	Management Measures/Program	Amount Spent	Time Frame
ANRC & EPA	Section 319(h) program	$5,219,502	2000 - 2011
NRCS	EQIP	$2,935,913 allocated $1,771,228.60 paid	2009 - 2011
IRWP	BMPs	$372,207	2007-2011
Other	BMPs	$1,434,610	2006-2011

8.4.1 NRCS AND FSA

There are eight NRCS programs active in Arkansas that provide funding assistance for development and installation of management measures, primarily in rural or agricultural settings. These programs provide funding to individuals, rather than groups or organizations. This includes the Illinois River Sub-basin and Eucha-Spavinaw Watershed Initiative. There are also four additional programs under the EQIP. NRCS can provide monetary assistance for installation of management measures through the Grassland Reserve Program (Benton, Crawford, and Washington Counties are high priority areas for this program), Conservation Stewardship Program, Environmental Quality Incentives Program, and Wildlife Habitat Improvement Program.

Monetary assistance is also available from the USDA FSA through the Conservation Reserve Program, and the Arkansas Illinois River Watershed CREP. The goal of the Arkansas Illinois River Watershed CREP is to enroll up to 10,000 acres within the UIRW. It is anticipated that $25 million will be spent in the UIRW for installation and maintenance of buffers. Additional information, including contract lengths and payment amounts, is available from the local USDA service center. The FSA also assists with implementing the other NRCS Easement Programs (http://www.ar.nrcs.usda.gov/programs/).

In these programs, a cost-share is usually required. Information about these programs, including cost-share requirements and funding caps, is available online (http://www.ar.nrcs.usda.gov/programs/) or from local USDA service center, local conservation district, or local cooperative extension agents.

8.4.2 OTHER FEDERAL AGENCY GRANT PROGRAMS

EPA has several programs for funding of restoration and conservation projects. US Fish and Wildlife has the Private Stewardship Grants Program. The majority of these programs require matching funds from the grantee. In some cases, these funds cannot be from other federal agencies.

Table 8.3. Funding needs and sources for management measures in the priority watersheds.

Measures	Cost	Budget	IRWP	Illinois River Watershed Conservation Reserve Enhancement Program - FSA	Illinois River Sub-basin and Eucha/Spavinaw Watershed Initiative - NRCS[1]	ANRC – NPS Program, Assistance for Water-related Facilities, Nutrient Mgt Program	Arkansas Game and Fish Commision	Arkansas Forestry Commission	EPA	US Fish and Wildlife	Private foundations	Volunteer work	Donations	Sponsorship	Cooperators	Fees	Tax Incentives	Municipal/county budgets	Other Non-Government Organizations
Illicit Discharge Identification and Elimination Programs	NA	NA																$	
Sewer System Planning, Maintenance, Rehabilitation, and Expansion	NA	NA																$	
Septic System Identification and Evaluation						X							X		X			X	
Septic System Pumping		Part of Education Budget	$50 each								X		$	X	$				
Maintenance of Sewer Systems	NA	NA				X												$	

[1] Values reported are total allocations for UIRW

Table 8.3. Funding needs and sources for management measures in the priority watersheds (continued).

Measures	Cost	Budget	IRWP	Illinois River Watershed Conservation Reserve Enhancement Program - FSA	Illinois River Sub-basin and Eucha/Spavinaw Watershed Initiative - NRCS[1]	ANRC – NPS Program, Assistance for Water-related Facilities, Nutrient Mgt Program	Arkansas Game and FishCommision	Arkansas Forestry Commission	EPA	US Fish and Wildlife	Private foundations	Volunteer work	Donations	Sponsorship	Cooperators	Fees	Tax Incentives	Municipal/county budgets	Other Non-Government Organizations
NPDES MS4 Stormwater Management Plans	NA	NA				X												$	
Rain Gardens	$3 to $12 per sq ft	$370,915	$160,627			$210,288			X		X	$	$	$	X			$	
Riparian Buffers	$0.15 to $0.60 per tree seedling, $125 to $300 per acre herbaceous		X	$25 million	75%	$200 per acre		$		X	$	$	$	$	25%		$		
LID	NA	NA				X			X		X							$	
Waste Storage Facility	$860 - $27,000 per facility				$64,784										$16,196 (25%)				
Composting Facility	$13 per sq ft	0$			75%										25%				
Litter Transport	$0.19 per mi				X	X									$	$			

Table 8.3. Funding needs and sources for management measures in the priority watersheds (continued).

Measures	Cost	Budget	IRWP	Illinois River Watershed Conservation Reserve Enhancement Program - FSA	Illinois River Sub-basin and Eucha/Spavinaw Watershed Initiative - NRCS[1]	ANRC – NPS Program, Assistance for Water-related Facilities, Nutrient Mgt Program	Arkansas Game and Fish Commission	Arkansas Forestry Commission	EPA	US Fish and Wildlife	Private foundations	Volunteer work	Donations	Sponsorship	Cooperators	Fees	Tax Incentives	Municipal/county budgets	Other Non-Government Organizations
Waste Treatment	Alum: $438.6 per ton, P205: $1.47 per lb				$801,552	X									$200,388 (25%)				
Nutrient Application Training and Nutrient Management Plan	NA	NA				$							$		$	$30 to $100 per trainee			
Livestock Exclusion from Streams	Fence: $0.75-$1.82/ft	$94,768			$75,814	X									$18,954 (25%)				
Alternate Water Source	Facility: $0.40 to $2 per gal; Pond: $2 per cubic yard; pipeline: $1.50 to $2 per ft	$74,859			$59,887	X									$14,972 (25%)				

Table 8.3. Funding needs and sources for management measures in the priority watersheds (continued).

Measures	Cost	Budget	IRWP	Illinois River Watershed Conservation Reserve Enhancement Program - FSA	Illinois River Sub-basin and Eucha/Spavinaw Watershed Initiative - NRCS[1]	ANRC – NPS Program, Assistance for Water-related Facilities, Nutrient Mgt Program	Arkansas Game and Fish Commission	Arkansas Forestry Commission	EPA	US Fish and Wildlife	Private foundations	Volunteer work	Donations	Sponsorship	Cooperators	Fees	Tax Incentives	Municipal/county budgets	Other Non-Government Organizations
Prescribed Grazing	Fence, grazing: $9 to $64 per acre	$421,932			$337,546	X									$84,386 (25%)				
Filter Strip	$150 to $200 per acre	$45			$36	X									$9 (25%)				
Detention Pond	$2 per cubic yard	$29,485			$23,588[2]	X									$5,897 (25%)				
Pasture Planting	$100 to $190 per acre	$406,894			$325,515	X									$81,379 (25%)				
Roadbank Erosion Control	NA	NA				X							X					X	
Training Road Graders	NA	NA											$					$	
Road Crossings	NA	$69,231				X	$34,616 to $45,000											X	$24,231 to $34,616

[2] This amount also included in alternate water sources

Table 8.3. Funding needs and sources for management measures in the priority watersheds (continued).

Measures	Cost	Budget	IRWP	Illinois River Watershed Conservation Reserve Enhancement Program - FSA	Illinois River Sub-basin and Eucha/Spavinaw Watershed Initiative - NRCS[1]	ANRC – NPS Program, Assistance for Water-related Facilities, Nutrient Mgt Program	Arkansas Game and Fish Commission	Arkansas Forestry Commission	EPA	US Fish and Wildlife	Private foundations	Volunteer work	Donations	Sponsorship	Cooperators	Fees	Tax Incentives	Municipal/county budgets	Other Non-Government Organizations
Streambank Evaluation	NA	NA	X			X	X				X		X					X	
Streambank Stabilization	NA	NA	X		75%	X	X				X		X		25%			X	

8.4.3 ANRC

ANRC manages the state Section 319 grant program. This program provides grants to non-profit groups, organizations and academic institutions for projects related to reduction, control or abatement of nonpoint source pollution. Matching contributions are required for these grants. The ANRC also manages seven financial assistance programs that use the state's bonding authority to assist local government to finance water supply and wastewater treatment facilities and projects. Some of these are grant programs, while others provide low-interest loans.

8.4.4 OTHER ARKANSAS STATE AGENCY GRANT PROGRAMS

There are at least two other state agencies that provide funding for activities included in the management measures of this Plan. The AGFC Stream Team Mini-Grants can be used to fund stream clean-up and stream bank stabilization projects. State Wildlife Grants can be used to address habitat issues, such as erosion and sedimentation, that impact species in greatest need of conservation. AFC provides grants to communities, educational institutions, non-federal government agencies, and non-profit organizations for urban forestry projects through a cooperative agreement with USFS.

8.4.5 PRIVATE FOUNDATIONS

There are a number of private foundations that fund environmental activities and projects. The ArkansasWater.org website lists nine private foundations that can fund restoration and conservation projects in Arkansas. The Walton Foundation has contributed funding for a number of projects in the UIRW.

8.4.6 MUNICIPAL AND COUNTY BUDGETS

Activities such as sewer maintenance and planning are primarily funded through municipal budgets, and at least partly supported through collection of utility fees. Maintenance of unpaved roads, such as grading, is primarily funded through county budgets.

8.4.7 OTHER NON-GOVERNMENT ORGANIZATIONS

TNC and WCRC are two additional non-government organizations that fund projects in the UIRW that implement best management practices.

8.4.8 NON-MONETARY SUPPORT

Agencies, organizations, and even individuals, can support implementation of management measures in ways other than providing funds. One way is through the loan of equipment. For example, the Washington County Conservation District has a hydromulcher that is available for use by four county road departments (Dunigan and Franklin 2005). The Washington and Benton County Conservation Districts also have a pasture aerator and no-till drill available to rent.

Another way to support management measures in the UIRW is through donation of equipment or services. In 2002, the Washington County Conservation District donated a hydromulcher to the Washington County Road department (Dunigan and Franklin 2005). The Arkansas Forestry Commission grows native saplings available for purchase to the IRWP for their riparian tree-planting program. Numerous organizations and agencies sponsor the IRWP rain garden academies and stream clean-up days, and have donated materials and services for these projects.

Many individuals support management measures in the UIRW through volunteering their time. IRWP tracks volunteer hours for their programs (e.g., riparian tree planting, stream clean-up days). They estimate that the work provided by volunteers for all of their activities in 2011 was equivalent to $390,694 (Table 8.4).

Table 8.4. Summary of IRWP volunteer hours from 2009 to 2011.

IRWP	2009 Hours	2010 Hours	2011 Hours
Board of Directors, Membership, Committee Meetings	328	588	468
Public Education and Community Outreach Programs, Conferences	1,565	8,106	12,173
Clean Water Rainger Programs	0	5,558	5,675
Riparian Projects, Tree Farm, Rain Gardens, Creek Cleanups	960	3,383	3,166
CREP &EQIP Outreach	0	0	1,260
Water Quality Monitoring	367	224	240
TOTAL HOURS	3,220	17,859	22,982
VOLUNTEER OUTREACH*	$54,740	$303,603	$390,694

*$17 per hour per ADEQ valuation

8.4.9 TAX INCENTIVES

Tax incentives are a slightly different financial mechanism for encouraging the use of management measures. The Arkansas Private Wetland Riparian Zone Creation and Restoration Incentive Act of 1995 created a system for allowing a tax credit against Arkansas Income Tax to taxpayers restoring wetlands or riparian zones. In 2009, this program was modified to allow similar tax credits to taxpayers donating land to eligible conservation groups or programs. This tax credit program is administered by ANRC.

The ANRC is also in the process of reviewing state tax code to determine other possible mechanisms for the use of tax incentives to encourage water quality BMP implementation in nutrient surplus areas. Of particular interest is encouraging practices that minimize the direct impact of cattle on streams (Arkansas Natural Resources Commission 2011).

8.5 Funding Assistance for Outreach and Education

Outreach and education efforts in the UIRW have been funded by a range of sources. Estimates of money spent in the UIRW for outreach and education by selected organizations, as of the end of 2011, are summarized in Table 8.5. Funding Sources have been identified for the majority of the on-going and planned outreach and education activities in the UIRW. Table 8.6 summarizes funding sources for on-going and planned outreach and education activities in the UIRW. The 'X' symbol indicates other potential funding sources. The '$' symbol indicates a source that is known to have allocated funds for a program.

Table 8.5. Summary of money spent in the UIRW for outreach and education.

Agency/Organization	Amount Spent	Time Frame
ANRC & EPA	$179,983	2000 - 2011
IRWP	$226,274	2006-2011
Other	$266,667	2010-2011

Some funding programs focus only on education and outreach related to water quality. Some of the same programs that fund management measures can also fund education and outreach (e.g., Arkansas NPS Program). Also, management measures that are funded through other programs are used as demonstrations and examples in outreach and education programs (e.g., demonstration projects funded through Arkansas NPS Program, and NRCS and FSA cost-share and easement programs).

There are several private foundations that fund education, and which may fund environmental education. The EPA also provides grants for environmental education.

At least part of the IRWP outreach and education projects are funded by the IRWP itself. These projects are also funded and otherwise supported through sponsorships and donations from agencies, interest groups, corporations, and schools; private foundations; and volunteer hours (Table 8.4).

All projects funded through the ANRC NPS Program (Section 319(h) funds) are required to include and education and outreach component. This program has also funded projects that are purely outreach and/or educational in nature (see Appendix B). Projects funded through USDA NRCS and FSA cost-share and easement programs are often used as demonstrations in NRCS and Conservation District outreach and education programs. The MS4 communities in the UIRW are providing funding for the regional stormwater education and outreach program through the Northwest Arkansas Regional Planning Commission contract with UAEX.

Table 8.6 Funding sources for outreach and education activities ongoing in the UIRW.

Program	IRWP	Private Foundations	Municipal & County Budgets	Arkansas Department of Parks & Tourism	ANRC NPS Program (319(h) funds)	Arkansas Game and Fish Commission	Sponsorship	Donations	EPA
Clean Water Raingers Program	$	X	X						
Rain Garden Academy	$	X					X	X	
Native Plants Project	$	X						X	
4-State Watershed Academy	$	X					X	X	
Watershed Camp	$	X					X	X	
Watershed Festival	$						X	X	
Illinois River Rally	$						X	X	
CREP-EQIP Edu. & Demo. Workshops	$						X	X	
Water Wise Lawn Care	$						X	X	
Video/Photo/Coloring Contests	$						X	X	
Community Events	$		X				X	X	
Media Outreach Campaign	$	X			X		X	X	
Internships	$								
Paddler's Path and Blue Trail	$		X	X			X	X	
Poultry and Livestock Producer Training							X	X	

Table 8.6. Funding sources for outreach and education activities ongoing in the UIRW. (continued)

Program	IRWP	Private Foundations	Municipal & County Budgets	Arkansas Department of Parks & Tourism	ANRC NPS Program (319(h) funds)	Arkansas Game and Fish Commission	Sponsorship	Donations	EPA
Education on Benefits of WQ Protection & Restoration for Mayors, Judges, Planning Boards					X				
LID, Stormwater Mgt Practices & Plans for Mayors, Judges, Planners, Developers					X				
Construction BMP training for earth-moving contractors and others			X		X				
Env. education lesson plans and modules for primary/secondary ed. teachers	$	X			X		X	X	X
Outreach to riparian landowners in priority watersheds	$							$	
Watershed Sanctuary at Cave Springs	$	$				$		X	X

8.6 Funding Assistance for Monitoring

In addition to ADEQ and USGS, ANRC, IRWP, and ARWC have also funded monitoring projects in the UIRW (Table 8.7). Table 8.8 shows funding sources for the monitoring ongoing in the UIRW. Where funds are currently allocated, and the amount is known, those amounts are included in the Table. The '$' symbol indicates the monitoring is funded, however, information about the amount allocated was not obtained or available. The 'X' symbol indicates other potential funding sources for a monitoring program.

Table 8 7. Summary of money spent in the UIRW for monitoring.

Agency/Organization	Amount Spent	Time Frame
ANRC	$1,055,340	2000-2010
IRWP	$399,049	2006-2010
AWRC	$243,934	2002-2010

Table 8.8. Funding of ongoing monitoring in the UIRW, including sites in the priority watersheds.

Monitoring program	ADEQ	USGS	ANRC NPS Program (Section 319 (h) funding)	IRWP	AWRC	AGFC	Illinois River Sub-basin and Eucha/Spavinaw Watershed Initiative - NRCS	Volunteers, cooperators	U of A	Donations	Private Foundations	City Budget
USGS		$150,000	$250,000	$192,301								
AWRC			$364,000		$310,598							
ADEQ	$											
Volunteer		X	X	X	X	X	75%	X	X	X	X	
Studies	X	X	X	X	X		75%	X	X		X	
MS4			X	X	X			X	X		X	X

8.6.1 ADEQ MONITORING

The ADEQ routine monitoring program is self-funded.

8.6.2 USGS MONITORING

Much of the funding for the USGS monitoring program is provided by state and local cooperators.The IRWP has committed to assisting with funding for three flow gages in the UIRW that would otherwise have to be abandoned due to lack of funds (Table 8.8). In addition, the IRWP is partnering with ANRC to fund a USGS biological monitoring assessment project in the UIRW.

The USGS has proposed additions to its monitoring program, and several studies for the UIRW. Implementing these proposed activities would require funding assistance from outside the USGS. These activities are described in Section 11.4. Estimated budgets for these activities are shown in Table 8.9. These numbers are rough estimates. Actual implementation budgets will differ slightly.

Table 8.9. Estimated funding needs for proposed USGS activities in the UIRW.

Activity	Estimated Budget
Additional stream water quality monitoring	$68,000
Study to determine nutrient loads from groundwater	$30,000
Lake sampling	$25,000
Follow Up of Current USGS Biological Assessment of Illinois River	$26,000
Total	$149,000

8.6.3 AWRC MONITORING

Funding for the AWRC monitoring program must be renewed annually through ANRC's Section 319 grant program. The Northwest Arkansas monitoring project is being funded through ANRC using Section 319(h) funds, with matching funds provided by AWRC (these are the amounts shown in Table 8.8).

8.6.4 VOLUNTEER MONITORING

Volunteer water quality monitoring programs can be supported through a number of funding sources. The AGFC Stream Team program can provide funding for monitoring through mini-grants. Water quality monitoring is eligible for cost-share funding through the Illinois River Sub-basin and Eucha-Spavinaw Watershed Initiative. A one-year monitoring study in the UIRW that utilized volunteer samplers was funded by ANRC Section 319(h) funds, with funding contributions provided by AWRC. Volunteer programs can also be supported through donations (from individuals, agencies, or universities or schools) of sampling equipment and analytical services. In the UIRW volunteer monitoring study, AWRC contributed sample analysis services to the project.

8.6.5 STUDIES

There are water quality studies ongoing and planned in the UIRW, and water quality sampling is a part of most of them. Monitoring of changes in water quality after installation of agricultural BMPs could be funded through the Illinois River Sub-basin and Eucha-Spavinaw Watershed Initiative. ANRC uses Section 319(h) allocations to fund projects and studies that include water quality sampling to track impacts of nonpoint source pollution management measures. IRWP also contributes funding to studies with water quality monitoring in the UIRW. USGS, ADEQ, AWRC, and University of Arkansas can provide sample collection and analysis services for studies in the UIRW.

8.6.6 MS4

If the MS4s in the UIRW decide to address achieving their allocated pathogen loads in the Clear Creek pathogen TMDL by initiating water quality monitoring, they may be able to obtain funding or in-kind services from a number of sources. Since the MS4s have not yet incorporated their pathogen load allocations from the Clear Creek TMDL into their Stormwater Management Plans, it is not clear if this monitoring will occur or what costs would be associated with such a program. It is expected that detailed budgets would be prepared by the municipalities if and when they decide to add water quality monitoring to their stormwater management programs.

Element 8: Evaluation Criteria 9

9.1 Water Quality Evaluation Criteria

The primary goal of this WBP is that impaired waterbodies in the UIRW be evaluated as attaining their designated uses identified in Chapter 3. Interim water quality targets related to achieving this goal are described in Section 6.1. These waterbodies are assessed every two years to develop the Arkansas integrated report, which includes the 303(d) list of impaired waterbodies. Progress toward achieving the goal will be evaluated during the Arkansas biennial integrated water quality assessment. The criterion for determining if progress is being made toward achieving the goal will be reduction in the percentage of exceedances of the pathogen and turbidity criteria in the waterbodies in the priority watersheds identified as impaired on the 2008 303(d) list. Note that the time period required to see significant changes in water quality is a function of how close to management activities water quality is measured.

9.2 Implementation Evaluation Criteria

Goals for implementation of education and outreach, management measures, and monitoring have been identified in the chapters discussing these elements of the WBP. Milestones for evaluating implementation progress are indicated in the schedule and milestones chapter (10). In addition, a TMDL watershed implementation plan will have been developed and implemented for at least one priority watershed by 2017.

9.3 Plan Evaluation Criteria

Implementation of this plan will be considered successful if:

- A watershed implementation plan has been developed and implemented for at least one priority watershed by 2017, and
- The percentage of pathogen and/or turbidity criteria exceedances has decreased from the percentage during the 2008 integrated water quality assessment by 2017.

If these criteria are not met, the management approaches, scientific knowledge, and stakeholder knowledge and opinions in the priority watersheds will be re-evaluated and management elements adjusted accordingly. This evaluation will take into account the fact that it can take more than five years, or even decades, before water quality improvements resulting from implementation of management measures become apparent (Meals et al. 2010). A revised plan will be developed and begin implementation by 2019.

Elements 6 & 7: Schedule and Milestones

10

As has been shown in Chapters 5 through 7, there are numerous ongoing and planned activities in the UIRW that will contribute to achieving the goals of this plan. Table 10.1 summarizes the schedules and milestones associated with the activities previously identified for the priority watersheds. These are activities known and planned as of April 2012. It is anticipated that additional projects and activities, other than those identified here, that will contribute to the plan goals will be initiated in the UIRW over the next five years. In particular, completion of the phosphorus TMDL is expected to generate new projects and activities in the UIRW. However, many of the activities already ongoing and planned are reducing nutrient loads now, as well as addressing the plan target pollutants.

Table 10.1. Schedule and milestones associated with ongoing and planned activities.

Activity	Action (lead)	Start	Interim Goal to Attain (3-5 yr)	Evaluation Criteria for Activity Changes	Long-term Goal to Attain
Education and Outreach	Clean Water Raingers Program	Ongoing	Integrated into 4 schools in both OK and AR	Declining participation by schools over 3 consecutive years	Clean water and environmental stewardship ethic integral part of school curriculum.
	Rain Garden Academy	Ongoing	Accredited for professional development hours	Declining implementation of rain gardens in the IRW over 5 consecutive years	Rain gardens considered standard urban stormwater management practice
	Native Plants Project	Ongoing	Four "grow stations" in UIRW for plants used in riparian habitat restoration & landscaping	Non-native species used in more than 25% of riparian areas or habitat restoration projects	Native plants part of nursery stock and first choice for land/home owners in landscaping
	4-State Watershed Academy	Ongoing	Established in AR, KS, MO, OK	Declining participation in any state	Clean water and environmental stewardship ethic for all 4-H activities
	Watershed Camp	Ongoing	Professional development hours accredited for teachers	Summer participation declines for 3 consecutive years	Student participation from 50% of schools in the UIRW
	Watershed Festival	Ongoing	Participation by at least 100 people each year	Less than 100 people attend for 3 consecutive years	Individual festival for each lake in the watershed
	Illinois River Rally	Ongoing	4-H, Boy Scouts & Girl Scouts in 7 counties in AR, OK	Declining participation in Rally over 3 consecutive years.	Illinois River recreation supported by at least one canoe livery and local recreation industry
	CREP-EQIP Ed & Demo. Workshops	Ongoing	At least one workshop & field day in Benton & Washington Counties each year	Declining participation of landowners	Establishment of Master Farmer certification similar to Master Gardener
	Water Wise Lawn Care	2012	Farmer's Market demonstrations throughout Benton, Washington counties	Stakeholder behavior unchanged in fertilizer application over 5 years	Demonstrations and information at outlets for fertilizer (from Farm Coops to Walmart) on smart lawn care
	Video/Photo/Coloring Contests	Ongoing	Partner with EAST and State Education conference	Contests in less than 40% of school districts	Illinois River scenes wallpaper on cell phones and Facebook pages on 15% of phones
	Community Events	Ongoing	Participation in at least 7 fairs, markets, conferences per year	Participation at less than 10% of IRWP or partnership events	Participation at 75% of partnership events

Table 10.1. Schedule and milestones associated with ongoing and planned activities. (continued)

Activity	Action (lead)	Start	Interim Goal to Attain (3-5 yr)	Evaluation Criteria for Activity Changes	Long-term Goal to Attain
Education and Outreach ***(continued)***	Watershed Sanctuary and Education Center	2012	Secure funds, complete Phase I development, monthly forums, 12,000 students/yr, 6 public events/yr, 4,500 local visitors/yr	Participation consistently lower than expected, surveys indicate no increase in knowledge	Increased educational opportunities and improved quality of life and habitat
	Media Outreach Campaign	Ongoing	"Stop – Turn Around" floodwater signs in Spanish, Marshallese at 50% of low water bridges, flooding locations	Stakeholder awareness of environmental issues declining based on 5 year stakeholder survey	IRW Index of Quality announced with weather forecasts on TV, internet similar to pollen count or UV index
	Internships	2012	One internship at U of A, OSU, NSU, JBU and NWACC	Less than one internship per university	Internships sustained and competitive at each IHE
	Paddler's Path and Blue Trail	2013	Initiation of Paddler's Path and Blue Path Development	Continued progress on Blue Trail	Educational/historical markers & stops on Blue Trail similar to MS Delta Blues Trail
	Poultry and Livestock Producer Training	Ongoing	At least one training workshop each year	Declining participation in training	Participation in at least one workshop required for certification of Nutrient Management Plan
	Education on Benefits of WQ Protection & Restoration for Mayors, Judges, Planning Boards	2012	At least one workshop each year	Declining participation	Ecosystem services valuation integrated into benefits estimation
	LID, Stormwater Management Practices & Plans for Mayors, Judges, Planners, Developers	2012	At least one workshop each year	Declining participation in training	95% of all development uses LID and appropriate stormwater management practices
	Construction BMP training for earth-moving contractors and others	2012	At least one workshop each year	Declining participation in training	95% of all construction sites use appropriate BMPs

Table 10.1. Schedule and milestones associated with ongoing and planned activities. (continued)

Activity	Action (lead)	Start	Interim Goal to Attain (3-5 yr)	Evaluation Criteria for Activity Changes	Long-term Goal to Attain
	Environmental education lesson plans and modules for primary/secondary education teachers	2012	At least one lesson plan or module prepared and provided each year	Lesson plans, modules not incorporated into curriculum	Environmental education part of AR core testing
Watershed Implementation Plans	Prepare and implement watershed implementation plans in priority watersheds	2012	Watershed implementation plan developed for at least one priority watershed	Impaired stream reaches in the UIRW, completed TMDLs	All water quality criteria met in 2008 impaired stream reaches
Implement Management Measures	Update MS4 stormwater management plans (Washington County, Springdale, Fayetteville, Johnson)	2012	Incorporate targets from Clear Creek pathogen TMDL and practices to address the targets	Compliance with MS4 requirements	Pathogen criteria met in Clear Creek
	Identification of malfunctioning septic systems in priority watersheds	2015	Project designed, funding source(s) identified, initiated in at least one priority watershed	Method for identification of malfunctioning septic systems is proven 90% successful	Identify 90% of septic systems with potential to contribute pathogens to impaired stream reaches
	Septic pumping assistance program (IRWP)	Ongoing	Provide rebates to 10 people with malfunctioning septic systems in priority watersheds	Pathogen criteria met in impaired stream reaches, or all malfunctioning septic systems adjacent to impaired Stream reaches pumped out	Septic systems eliminated as a source of pathogens in impaired stream reaches
	Maintenance of sewer lines and lift stations (Springdale and Fayetteville wastewater utilities)	Ongoing	Zero releases of raw sewage	Pathogen criteria met at Clear Creek station AR00010C, or zero reported releases of raw sewage for 2 years in a row	Municipal sewage systems eliminated as a source of pathogens in Clear Creek
	Rain gardens (IRWP)	Ongoing	30 rain gardens installed in public areas in UIRW, and 10 rain gardens installed on private property	Declining implementation of rain gardens on appropriate sites	Rain gardens accepted as std. stormwater management. practice
	Riparian tree planting program (IRWP)	Ongoing	5,000 seedlings planted each year	Volunteer participation declining for 3 consecutive years	Restoration of urban riparian areas on public lands

Table 10.1. Schedule and milestones associated with ongoing and planned activities. (continued)

Activity	Action (lead)	Start	Interim Goal to Attain (3-5 yr)	Evaluation Criteria for Activity Changes	Long-term Goal to Attain
	Identification of sediment sources in Illinois River reach 11110103-024	2013	Project designed, funding obtained, data collection initiated	Turbidity criterion exceeded in < 10% samples in a 5-year period at ARK0040	Identify sediment sources and relative contributions to reduce so turbidity criteria are met at ARK0040
Implement Management Measures ***(continued)***	County road grader training (U of A Extension)	2012	Road grader(s) working in Lake Wedington – Illinois River watershed trained	Washington County roads in Lake Wedington – Illinois River priority watershed properly graded	Erosion of county roads reduced
	Erosion control for rural road crossings with severe erosion sediment, road bank erosion (ANRC)	2014	Identify rural road crossings with severe erosion in Lake Wedington – Illinois River watershed	Rural road crossings with severe erosion found in Lake Wedington – Illinois River watershed	Severe erosion at rural road crossings eliminated as sediment/turbidity source in Lake Wedington – Illinois River watershed
	08-600: Demonstrating Runoff Capture from Poultry Houses to Improve Water Quality in 12-Digit HUCs of the Illinois River Watershed (U of A, ANRC)	2008	Project complete	Runoff capture shown to reduce sediment & pathogen loads to streams	Turbidity and pathogen criterion met in impaired stream reaches
	Illinois River sub-basin and Eucha-Spavinaw Watershed Initiative Conservation Reserve Enhancement Program (NRCS, IRWP)	2011	IRWP identifies and contacts riparian landowners along impaired stream reaches about enrolling riparian lands, particularly unforested riparian areas	75% of riparian buffers along impaired stream reaches are restored, or 15,000 acres of buffer enrolled, or CRP authority expires	Turbidity and pathogen criterion met in impaired stream reaches
	Illinois River sub-basin and Eucha-Spavinaw Watershed Initiative	2010	Currently contracted BMPs implemented, 25% of new EQIP contracts for farms in priority watersheds	50% reduction in incidences of turbidity and/or pathogen criteria exceedences in impaired streams,and/or 50% of farms in priority watersheds with EQIP BMPs	Turbidity and pathogen criterion met in impaired stream reaches

Table 10.1. Schedule and milestones associated with ongoing and planned activities. (continued)

Activity	Action (lead)	Start	Interim Goal to Attain (3-5 yr)	Evaluation Criteria for Activity Changes	Long-term Goal to Attain
Implement Management Measures ***(continued)***	Conduct targeted geomorphological and bio-assessment to identify and target implementation of streambank stabilization projects for high-impact sites (ANRC)	2011	Initiate assessment in Lake Wedington – Illinois River watershed	Assessment of streambanks in Lake Wedington – Illinois River watershed complete	Streambanks eliminated as significant source of sediment/turbidity in Lake Wedington – Illinois River watershed
	Poultry litter transport/export (BMP Inc, NRCS)	Ongoing	Export at least 80% of poultry litter produced annually in Lower Muddy Fork – Illinois River, Lake Fayetteville – Clear Creek, Little Wildcat – Clear Creek, and Sager Creek watersheds	Export at least 80% of poultry litter produced annually in Lower Muddy Fork – Illinois River, Lake Fayetteville – Clear Creek, Little Wildcat – Clear Creek, and Sager Creek watersheds	Pathogen criterion met in impaired stream reaches
	Nutrient management plan implementation and updates (ANRC, NRCS, County Conservation & Extension Agents)	Ongoing	100% of regulated farms have updated NMPs	Regulatory requirements	Pathogen criterion met in impaired stream reaches
	Nutrient management training (UAEX)	Ongoing	90% of nutrient applicators in priority watersheds trained	Pathogen Criteria not met in impaired streams	Pathogen criteria met in impaired streams
	Tributary Creek Clean-ups	2012	Osage Creek (Rogers), Spring Creek (Springdale), Mud-Scull Creek (Fayetteville), Sager Creek (Siloam Springs) and Town Branch (Tahlequah)	Increasing amounts of trash in creeks	Little or no trash in UIRW creeks
Monitor Water Quality	AWRC – ANRC 11-500 NW AR monitoring	2012	Monitoring completed and data analyzed	Pathogen sources and water quality impairments identified	Remove impaired streams from 303(d) list
	IRWP Volunteer Stream Team Monitoring	2012	At least 2 active stream teams per county	Participation in Stream Teams declining	Stream Teams participating on every major stream in UIRW
Monitor Water Quality	MS4 pathogen monitoring programs	2013	Pathogen monitoring in Clear Creek watershed initiated in two MS4s	Clear Creek evaluated as impaired due to pathogens	Pathogen criteria met in Clear Creek

Table 10.1. Schedule and milestones associated with ongoing and planned activities. (continued)

Activity	Action (lead)	Start	Interim Goal to Attain (3-5 yr)	Evaluation Criteria for Activity Changes	Long-term Goal to Attain
(continued)	World Water Monitoring Day	2012	One other lake added in addition to Lincoln Lake in the UIRW	Declining participation in lake monitoring	Every lake monitored at least once per year
	Volunteer Lake Monitoring	2012	Volunteers monitoring Lakes Keith, Fayetteville, Elmdale, Springdale, Bud Kidd, Lincoln, and Tenkiller	Any decline in the number of lakes monitored	Ongoing and active volunteer lake monitoring
TMDLs	Phosphorus TMDL (EPA Region 6)	2010	TMDL completed	TMDL approved	Achieve TMDL phosphorus allocations
	Pathogen TMDLs (EPA Region 6, ADEQ)	2016	Determine if pathogen criteria being met in stream reaches with no data since 2006	TMDLs required if UIRW stream reaches classified as category 5a in 2014 biennial assessment	Remove impaired streams from 303(d) list

Element 9: Monitoring 11

11.1 Goals

The objectives of monitoring efforts in the UIRW are to:

1. Identify areas where water quality does and doesn't support designated uses,
2. Identify sources of pollution impairing designated uses, and
3. Track changes in water quality resulting from land use changes, development, land and water management practices, and other factors.

11.2 Routine Monitoring

There are several agencies and groups conducting routine monitoring programs in the UIRW.

11.2.1 ADEQ

ADEQ has been monitoring selected reaches of the Illinois River and its tributaries since the early 1990's. ADEQ currently maintains nine ambient water quality monitoring stations in the UIRW. A few of these monitoring stations are located in priority watersheds (see Figure 5.3 and Table 11.1). Locations of these stations and the year sampling was initiated are shown in Table 11.1. The majority of the parameters AEDQ monitors are measured monthly at these stations. Metals are measured bi-monthly. The list of parameters monitored at these stations is shown in Table 11.2. The following target pollutants for this plan (see section 5.2) are monitored by ADEQ: turbidity, TSS, and nitrate. Pathogen indicators are not.

Table 11.1. ADEQ ambient monitoring program.

Station ID	Start Year	Stream	Location	Priority Watershed
ARK0007A	1998 (1990 as ARK0007)	Baron Fork	Dutch Mills	
ARK0010C	1994	Clear Creek	Hwy 112	Lake Fayetteville–Clear Creek
ARK0040	1990	Illinois River	Savoy	Lake Wedington–Illinois River
ARK0141	1998	Cincinnati Creek	Cincinnati	
ARK0006	1997	Illinois River	Siloam Springs	
ARK0041	1990	Osage Creek	Elm Springs	
ARK0082	2008	Osage Creek	Logan	
ARK0005	1990	Sager Creek	Siloam Springs	Sager Creek
ARK0004A	1990	Flint Creek	Siloam Springs	

Table 11.2. Parameters monitored in the UIRW.

Parameter	ADEQ Ambient Monitoring	USGS Routine Monitoring	AWRC Monitoring	Project 11-500, Northwest Arkansas Monitoring
Temperature	X	X		
Dissolved Oxygen	X	X		
Turbidity	X		X	X
Conductivity		X		X
pH	X	X		
TDS	X	X		
TSS	X		X	X
Total Nitrogen		X	X	X
Organic Nitrogen		X		
Ammonia	X	X	X	
Nitrate		X	X	X
Nitrite		X		
Inorganic Nitrogen (NO_3+NO_2)	X	X		
TKN	X	X		
Dissolved Orthophosphate		X		
Soluble Reactive Phosphorus			X	X
Total Orthophosphate	X			
Dissolved Phosphorus		X		
Total Phosphorus	X	X	X	X
Total Organic Carbon	X			
Hardness	X	X		
Silica	X			
Calcium	X	X		
Magnesium	X	X		
Sodium	X	X		
Potassium	X	X		
Other Metals	X			
Chloride	X	X	X	X
Sulfate	X	X	X	
Fluoride	X	X		
E. coli		X		X
Fecal coliform		X		
Total coliform				X
Suspended Sediment		X		

11.2.2 US GEOLOGICAL SURVEY

USGS monitors surface water flows and water quality, and groundwater levels routinely in the UIRW.

11.2.2.1 *Surface Water Flow*

USGS monitors flow daily at 10 flow gages in the UIRW. Locations of the flow gages and the years that monitoring was initiated at the sites are shown in Table 11.3. Some of these gages have long periods of record. There are USGS flow gages in the Lake Wedington–Illinois River priority watershed (07194800) and the Sager Creek priority watershed (07195865). Daily flow data allows more accurate estimates of loads.

Table 11.3. Information about USGS daily flow monitoring stations.

Station ID	Start Year	Stream	Location	Priority Watershed
07195000	1950	Osage Creek	Elm Springs	
07195430	1995	Illinois River	Siloam Springs	
07194800	1979	Illinois River	Savoy	Lake Wedington–Illinois River
07196900	1958	Baron Fork	Dutch Mills	
07195865	1996	Sager Creek	Siloam Springs	
07195855	1979	Flint Creek	Siloam Springs	Sager Creek
07195800	1961	Flint Creek	Springtown	
07194809	1996	Niokaska Creek	Fayetteville	
07194906	2011	Spring Creek	Springdale	
07195400	1979	Illinois River	Hwy 16	

11.2.2.2 *Surface Water Quality*

USGS monitors surface water quality at eight ambient monitoring stations in the UIRW. Locations of the USGS surface water quality monitoring stations and the years that monitoring began at the sites are shown in Table 11.4. There are USGS water quality stations in the Lake Wedington–Illinois River priority watershed (07194800) and the Sager Creek priority watershed (07195865).

Field, in situ parameters, nutrients, minerals, pathogen indicators, suspended sediment, and other constituents are currently monitored at these sites. Samples are collected six times a year. The list of parameters monitored at the USGS stations is provided in Table 11.2. Note that not every parameter has been monitored over the entire period of record. Turbidity and TSS are not monitored at these sites, although suspended sediment is. Pathogen indicators are also measured at these sites. Daily flow data are also collected at a number of these water quality monitoring stations (see Table 11.3), making it easier to estimate loads at these sites.

Table 11.4. Information about USGS routine water quality monitoring stations.

Station ID	Start Year	Stream	Location	Daily Flow Gage	Priority Watershed
07194880	2012	Osage Creek	Cave Springs		
07194933	2009	Spring Creek	Hwy 112		
07195000	1975	Osage Creek	Elm Springs	X	
07195430	1997	Illinois River	Siloam Springs	X	
07194800	1974	Illinois River	Savoy	X	Lake Wedington–Illinois River
07196900	1973	Baron Fork	Dutch Mills	X	
07195865	1991	Sager Creek	Siloam Springs	X	Sager Creek
07195855	1991	Flint Creek	Siloam Springs	X	

11.2.2.3 *Groundwater Level*

USGS monitors groundwater level every 3 years at three wells the UIRW in Washington County.

11.2.3 ARKANSAS WATER RESOURCES CENTER

Historically, the AWRC has collected water quality samples at two sites in the UIRW—Ballard Creek and Illinois River South of Siloam Springs. In 2009, the AWRC began collecting data at seven other sites. Several of these sites are also monitored by ADEQ or USGS (Table 11.5). The AWRC collects samples at least once a week during base flow and samples selected storm events, dependent upon funding availability. The AWRC analyses water samples for nitrate, sulfate, chloride, soluble reactive phosphorus, total phosphorus, dissolved ammonia, total nitrogen, total suspended solids, and turbidity (Table 11.2).

Table 11.5. AWRC historical monitoring locations in the UIRW.

Monitoring Site Location	ADEQ Station	USGS Station	AWRC Station
Illinois River at Highway 59, south of Siloam Springs	ARK0006	07195430	Illinois River at AR Hwy 59
Illinois River near Savoy	ARK0040	07194800	Illinois River-Savoy
Flint Creek near West Siloam Springs	ARK0004A	07195855	Flint Creek-W. Siloam Springs
Osage Creek near Elm Springs	ARK0041	07195000	Osage Creek
Baron Fork at Dutch mills		07196900	Baron Fork
Niokaska Creek at Township at Fayetteville		07194809	Mud Creek Tributary
Flint Creek at Springtown		07195800	Flint Creek-Springtown
Ballard Creek at County Road 76			Ballard Creek

11.3 Special Study

In addition to the routine monitoring described above, there is also a Section 319 project ongoing in the UIRW that includes water quality monitoring. Through Project 11-500 NWA Monitoring, water quality will be monitored at 10 sites in the UIRW (Table 11.6) over a 4-year period (2012 through 2016). The purpose of this monitoring project is to identify water quality and loading impacts of Section 319 projects and other management activities. Sites to be monitored include existing water quality monitoring sites. Parameters that will be monitored include nutrients, chloride, conductivity, TSS, and turbidity (Table 11.2). These data will be used to estimate annual loads for the monitored parameters.

Table 11.6. Project water chemistry monitoring sites.

Stream	Location	Site ID
Niokaska Creek	Township Road	USGS Station No. 07194809
Osage Creek	Elm Springs	USGS Station No. 07195000
Ballard Creek	County Road 76	AWRC Discharge Station
Baron Fork	Dutch Mills	USGS Station No. 07196900
Flint Creek	West Siloam Springs	USGS Station No. 07195855
Flint Creek	Springtown	USGS Station No. 07195800
Sager Creek	Siloam Springs	AWRC Discharge Station
Illinois River	Arkansas Highway 5	USGS Station No. 07195430
Illinois River	Savoy	USGS Station No. 07194800
Illinois River	Watts	USGS Station No. 07195500

In addition, pathogen indicators will be monitored for 3 years at three sites on each of the nine stream reaches listed for pathogen impairment on the 2008 303(d) list. Eight samples will be collected from each site during the primary contact season (May through September). This number of samples will be adequate to determine if the state primary contact water quality standard is being achieved and assess attainment of the primary contact recreation use. The samples will be analyzed for total coliforms and *E. coli*.

This project will track target pollutants for this plan (Section 5.2) in the priority watersheds.

11.4 Other Monitoring Opportunities

Existing water quality monitoring efforts are described above. However, there are opportunities for expanding water quality monitoring in the UIRW and the priority watersheds.

11.4.1 VOLUNTEER MONITORING

The agencies that traditionally have conducted water quality monitoring in Arkansas face budgetary constraints that make it difficult to expand, or even maintain existing, water quality monitoring networks. Trained stakeholder volunteers are one option for expanding water quality monitoring while working within budgetary constraints. The AGFC Stream Team program is active in the UIRW for training and guiding water quality monitoring volunteers. In addition, water quality monitoring is an authorized conservation practice under the Illinois River Sub-basin and Eucha-Spavinaw Lake Watershed Initiative.[24]

In 2008, a one-year water quality monitoring project was conducted in the UIRW, where local Stream Team volunteers collected water quality samples and measured in-situ water quality parameters quarterly at 37 sites (Massey and Haggard 2009). The samples were analyzed at the AWRC water quality lab. The resulting data met project QA/QC criteria, providing known quality data for analysis of water

[24] http://www.ar.nrcs.usda.gov/programs/illinois_spavinaw_initiative_practices.html

quality conditions and changes in the UIRW. This project proved that volunteer water quality monitoring programs can effectively contribute to evaluation of water quality in the UIRW.

11.4.2 STORMWATER MONITORING

MS4s in the Clear Creek watershed are required to incorporate in their stormwater management plans, the pathogen loads allocated to the MS4s in the Clear Creek TMDL (EPA Region 6 2009). Monitoring of pathogen levels in stormwater is an activity that the MS4s can add to their stormwater management plans to address meeting their allocated pathogen loads.

11.4.3 US GEOLOGICAL SURVEY

USGS has proposed the following water quality monitoring projects. These projects are not currently funded, but they would improve tracking of changes in water quality in the UIRW, as well as improve understanding of factors affecting water quality in the watershed.

11.4.3.1 *Additional Stream Water Quality Monitoring*

Previous monitoring and load calculation efforts in the UIRW have indicated that stormwater flows contribute the majority of pollutant loads. To better capture this phenomenon in their data, USGS proposes to add three stormwater sampling events to all of their routine water quality monitoring sites in the UIRW. In addition, USGS proposes to add routine (and stormwater) water quality monitoring at their gage on the Illinois River at Highway 16 (07195400). Adding the stormwater sampling is expected to make it possible to more accurately estimate constituent loads in the UIRW.

11.4.3.2 *Study to Determine Nutrient Loads from Groundwater*

A large component of flow in the Illinois River through the year is derived from groundwater. The BMPs established for land uses are primarily developed to address surface water runoff and overland transport of sediment and nutrients that can degrade water quality. However, these management practices may be largely ineffective where a major transport pathway for nutrients is movement through the subsurface and into the groundwater, where delivery is through springs, seeps, and filtration into the river. This groundwater contribution to flow in the Illinois is largely unknown. A study to quantify the portion of nutrient loading from groundwater in a major stream basin within the Illinois watershed would greatly improve understanding of nutrient inputs from groundwater.

For such a study, groundwater nutrient concentrations would be determined by sampling up to 25 springs in an urban land use dominated subwatershed and an agriculture land use dominated watershed. These data would ultimately be used in conjunction with stream gaging data and land use data to generate weighted mean groundwater concentration relating spring nutrient concentrations to land use in the target basin. At the gaging station, baseflow contributions would be calculated to determine the groundwater nutrient load, as a percentage of the total nutrient load at the gaging station. Subtracting the groundwater load from the total load at the gaging station provides a calculation of overland nutrient loads, and will reveal what percentage of nutrient loads are derived from groundwater contributions. This information is critical to future land-use planning and development of BMPs within the Illinois River watershed to achieve nutrient load targets from the EPA Region 6 phosphorus TMDL.

11.4.3.3 *Lake Sampling*

USGS proposes to sample three lakes (e.g., Fayetteville, Keith, Bob Kid Lakes) to examine seasonal baseline conditions four times annually (winter, spring, summer, fall). Samples would be analyzed for nutrients, chlorophyll a, fecal coliform and E. coli, and phytoplankton enumeration and biovolume.

11.4.3.4 *Follow-Up of Current USGS Biological Assessment of the Illinois River*

Data from the NAQWA study in the Ozarks showed seasonal differences in the biological communities of Ozark streams. To assess the seasonal differences in the Illinois River basin, four stream sites (two on the Illinois River and two on tributaries) will be sampled for biological (periphyton, macroinvertebrate, and fish) communities and nutrient concentrations. These sites will be sampled in the spring and compared to the current study which samples were collected in the summer.

11.4.4 PRIORITY WATERSHED IMPLEMENTATION PLANS

Additional monitoring sites will be added in priority watersheds as watershed implementation plans are developed and implemented. These monitoring sites will be established to assess the effectiveness of management practice in reducing pollutant concentrations and loading in the priority watershed.

11.5 Integrated Monitoring Network

There are multiple agencies and organizations monitoring water quality in the UIRW. While each agency and organization has its own specific needs and requirements for monitoring, a comprehensive review of constituents, locations, monitoring dates, and needs could likely identify opportunities for leveraging monitoring resources and personnel. This would result in time savings for all monitoring entities, and could improve the usefulness of the resulting information. This comprehensive review could permit the implementation of an integrated monitoring network and program that would satisfy the specific objectives of each agency and organization while providing additional information to document the effectiveness of management practices in restoring and protecting waterbodies in the UIRW.

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Summary of Section 319(h) Projects in the UIRW

Appendix B

Illinois River Basin Meeting
319(h) funded Projects 2000 - 2011

00-152: Benton County Bermuda King Planter Project
Federal: $7,312
Non Federal: $5,516
Total: $12,828
Project Activities: Purchasing Equipment & Implementation

Project Summary: The goal was to decrease the soil test phosphorus levels in soils. In addition, to reduce the runoff potential of phosphorus from fields where nutrients are applied and increase phosphorus uptake by 25%.

Results: It was estimated that the projects would reduce phosphorus loading into streams by 90,000 lbs. per year.

00-154: Washington County Teacher Education Program
Federal: $3,356
Non Federal: $2,531
Total: $5,887
Project Activities: Outreach and Education

Project Summary: Provide nine Washington County elementary, middle, and high school teachers with an educational program that addresses conservation of natural resources (soil, water, air, plants, people, and animals).

Results: No load reduction estimates or final report associated with this project.

00-155: Washington County Erosion Control Project
Federal: $11,532
Non Federal: $8,700
Total: $20,232
Project Activities: Implementation

Project Summary: The goal was to install approximately 10,000 linear feet (avg 50ft width) of coconut or straw wattle erosion control blankets (with hydromulching) throughout the Illinois and White River watersheds on small critically eroding roadside sites, and to install approximately 400,000 square feet of hydromulching on similar (typically less than 0.5 acre) sites.

Results: No load reduction estimates or final report associated with this project.

<u>00-400: Expansion and Implementation of the Mud Creek Urban Project</u>
Federal: $116,776
Non Federal: $78,263
Total: $195,039
Project Activities: Implementation, Demonstration, Outreach & Education

Project Summary: The goal was to create community awareness of urban non-point source pollution potential impacts through public education and demonstration and document successes for use in other urban communities.

Project Results: As a result of the media coverage and educational displays and booths at local festivals and events, the public responded with an interest in using the Urban Home*A*Syst guidebook and requests for additional urban water quality presentations at schools, libraries, and civic club meetings. Signage was installed in Spring 2004. Education programs were developed through the two Mud Creek projects and youth activities along with listings of educational tools and resources were prepared for an Urban Water Quality Education Resource Guide.

<u>01-160: Nutrient Management in Washington County</u>
Federal: $30,000
Non Federal: $0
Total: $30,000
Project Activities: Implementation, Technical Assistance

Project Summary: The objective of this project was to implement BMP's in Washington County, to control the amount, timing, and placement of soil nutrients for the purpose of reducing nonpoint source of soil nutrients.

Project Results:

<u>01-1100: Optimizing BMPs, Water Quality, and Sustained Agriculture in the Lincoln Lake Watershed</u>
Federal: $272,713
Non Federal: $206,120
Total: $478,833
Project Activities: Demonstration, Hire Staff, Monitoring, Technical Assistance, Outreach, and Education

Project Summary: The goal was to develop an integrated watershed management plan by incorporating a process of public participation, issue identification, and consensus building; collect chemical and biological stream and water quality data to determine the improvement in water quality as a result of previously implemented BMPs and to indicate problems that should be focus of future BMP implementation.

Project Results:

Total Load and Discharge Data for 2000 to 2003 at Moores Creek.

Parameter	2000	2001	2002	2003
Discharge (m3)	2,184,249	2,689,187	3,339,859	4,609,255
NO3-N (kg)	4,364	5,724	5,094	5,450
TP (kg)	1,452	1,419	1,257	1,080
Nh3-N (kg)	227	267	306	217
TKN	3,316	3,086	3,204	3,336
PO4-P (kg)	613	660	609	499
TSS (kg)	455,827	369,532	377,356	190,141

Flow-Weighted Water Quality Monitoring Data During 2001 and 2004 from Upper Moores Creek.

Parameter	2000	2001	2002	2003
Discharge (m3)	2,184,249	2,689,187	3,339,859	4,609,255
TSS (mgL-1)	208.69	137.41	112.99	41.25
NH4-N (mgL-1)	0.10	0.10	0.09	0.05
PO4-P (mgL-1)	2.00	2.13	1.53	1.18
TKN (mgL-1)	1.44	1.15	0.96	0.72
TP (mgL-1)	0.66	0.53	0.38	0.23

<u>02-100: Water Quality Monitoring for Ballard Creek</u>
Federal: $58,835
Non Federal: $10,454
Total: $69,289
Project Activities: Monitoring

Project Summary: The goal was to sample, analyze, and compute loadings for nutrients and sediment at Washington County Road 76 Bridge on Ballard Creek.

Project Results:

<u>02-100: Water Quality Monitoring for the Illinois River</u>
Federal: $44,695
Non Federal: $7,942
Total: $52,637
Project Activities: Monitoring

Project Summary: The goal was to sample, analyze, and compute loadings for nutrients and sediment on the Illinois River at the Hwy 59 Bridge.

Project Results:

Results for Illinois River at AR59 for Calendar Year 2003.

Parameter	Total Discharge (m3/yr)	Total Load (kg/yr)	Average Discharge (m3/s)	Mean Concentrations (mg/l)
Flow	289,188,131		9.1	
NO3-N		590,943		2.04
TKN		144,041		0.50
TP		64,854		0.22
TSS		11,845,136		41

-Comparison between the loads and discharge for 2003 to previous years indicate a decline in all parameters.

Comparison between 1997 to 2003 Loads.

Parameters	1997 Loads	1998 Loads	1999 Loads	2000 Loads	2001 Loads	2002 Loads	2003 Loads
Discharge (m3)	458,460,000	588,000,000	635,000,000	536,000,000	532,000,000	531,000,000	289,188,131
NO3-N (kg/yr)	1,020,000	1,390,000	1,560,000	1,100,000	1,520,000	1,340,000	590,943
TKN (kg/yr)	301,000	481,000	514,000	462,000	447,000	294,000	144,041
TP (kg/yr)	127,000	232,000	267,000	283,000	256,000	218,000	64,854
TSS (kg/yr)	18,400,000	72,600,000	77,100,000	63,600,000	70,800,000	39,000,000	11,845,000

The total phosphorous load significantly decreased in 2003 as compared to 2002 (70%). This decrease can be attributed to two primary factors. Storm loads were reduced by 82% which is probably the result of the reduction in storm flows by 80%. Base-flow loads were reduced by 51% which can be attributed to the reduction in WTTP phosphorus discharges by over 70%.

<u>02-500: Ballard Creek Implementation Project</u>

Federal: $436,470

Non Federal: $109,118

Total: $545,588

Project Activities: Implementation, Monitoring, Hire Staff, Technical Assistance, Demonstration

Project Summary: The objective was to provide cost-share to implement BMPs such as streambank stabilization, alternative water supplies, cross fencing, and warm season grass establishment.

Project Results: Ballard creek BMP Implementation project was successful in reducing the risks of NPS pollution from nitrogen, phosphorus, and sediment in both the Ballard Creek and other sub watersheds of the Illinois River, Washington County, Arkansas. The NPS load reductions within the Illinois River were 8,460 lb phosphorus/year, 28,731 lb nitrogen/year, and 7,552 Tons sediment/year.

02-900: Demonstration of Greenway Development to Protect Ecological Services in Urban Streams
Federal: $490,000
Non Federal: $378,000
Total: $868,000
Project Activities: Demonstration, Hire Staff, Monitoring, Outreach & Education, Implementation, Technical Assistance

Project Summary: The goal was to demonstrate methods and technologies for protecting critical ecological services in urban streams.

Project Results:
Mean Concentration Project Results.

Storm Concentrations (mg/L)						
year	**NO3-N**	**T-P**	**NH4**	**TKN**	**PO4**	**TSS**
2003	0.38	0.25	0.06	1.36	0.13	176.3
2004	0.47	0.30	0.08	1.29	0.12	258.5
2005	0.66	0.27	0.07	0.86	0.18	216.8
2006	0.47	0.13	0.07	0.64	0.08	66.6
Base-Flow Concentrations (mg/L)						
2003	0.63	0.07	0.01	0.69	0.04	32.9
2004	1.03	0.04	0.02	0.38	0.04	8.9
2005	1.29	0.04	0.04	0.11	0.02	10.7
2006	0.71	0.06	0.03	0.25	0.04	16.1

The success for this project was the adoption by the City of Rogers of a greenway approach for preservation and restoration of ecological integrity of urban streams. This project demonstrated the greenways approach in the Blossom Way Creek Greenway, and became the anchor of a 45 km greenways trail system adopted by the city. Under current urban stream management practices, Blossom Way Creek would have been managed for increased flood flow throughput at the exclusion of other ecological services. The channel would have been straightened, lined with riprap or concrete, the riparian zone removed, and the streamside reduced to graded levies. The City of Rogers' City Council approved a greenways ordinance in 2005.

02-1400: Illinois River Nutrient Modeling
Federal: $30,347
Non Federal: $20,346
Total: $50,693
Project Activities: Technical Assistance, Outreach & Education, Planning

Project Summary: The goal of this project is to develop a Soil and Water Assessment Tool (SWAT) model for the Illinois River watershed and calibrate/validate the model for low flow and high flow conditions.

Project Results: Available mineral P load of 2000 to 2001 was used for the calibration and 2002 results for validation. Measured mineral P load varied from 120x103 kg/year to 128x103 kg/year. Predicted annual Mineral P values were within 6 to 48% of the measured values. Since mineral P results are not available on daily basis, calibration and validation were performed on a monthly time scale.

02-1600: Illinois River Monitoring
Federal: $67,518
Non Federal: $46,998
Total: $114,516
Project Activities: Monitoring

Parameter	1997 Loads	1998 Loads	1999 Loads	2000 Loads	2001 Loads	2002 Loads	2003 Loads	2004 Loads
Discharge (m3)	458,460,000	588,000,000	635,000,000	536,000,000	532,000,000	531,000,000	289,188,131	565,760,000
NO3-N (kg/yr)	1,020,000	1,390,000	1,560,000	1,100,000	1,520,000	1,340,000	590,943	1,207,000
TKN (kg/yr)	301,000	481,000	514,000	462,000	447,000	294,000	144,041	512,000
TP (kg/yr)	127,000	232,000	267,000	283,000	256,000	218,000	64,854	281,000
TSS (kg/yr)	18,400,000	72,600,000	77,100,000	63,600,000	70,800,000	39,000,000	11,845,000	92,080,000

Project Summary: The goal of this project was to sample, analyze, and compute loadings for nutrients and sediment on the Illinois River at the Hwy 59 Bridge.

Project Results: Comparisons between 1997 to 2004 Loads:

Results for Illinois River at AR59 for Calendar Year 2004.

Pollutant	Total Discharge (m3/yr)	Total Load (kg/yr)	Average Discharge (m3/s)	Mean Concentrations (mg/L)
Discharge	565,760,474		17.8	
NO3-N		1,207,335		2.13
TKN		512,358		0.91
TP		281,425		0.5
TSS		92,080,737		163

Results for Illinois River at AR59 for Calendar Year 2005.

Pollutant	Total Discharge (m3/yr)	Total Load (kg/yr)	Average Discharge (m3/s)	Mean Concentrations (mg/L)
Discharge	390,894,159		12.3	
NO3-N		1,018,744		2.61
T-P		106,979		0.27
NH4		20,602		0.05
TN		1,170,851		3.00
PO4		44,123		0.11
TSS		33,560,475		85.86

2005 Loads and Concentrations During Storm and Base-flows.

	Storm Loads (kg)	Base Loads (kg)	Storm Concentrations (mg/L)	Base Concentrations (mg/L)
Discharge	155,440,681	233,952,444		
NO3-N	417,016	601,703	2.68	2.57
T-P	83,998	22,980	0.54	0.10
NH4	11,943	8,659	0.08	0.04
TN	541,306	629,539	3.48	2.69
PO4	26,859	17,353	0.17	0.07
TSS	31,627,581	1,932,864	203.47	8.26

Results for Illinois River at AR59 for Calendar Year 2006.

Pollutant	Total Discharge (m3/yr)	Total Load (kg/yr)	Average Discharge (m3/s)	Mean Concentrations (mg/L)
Discharge	256,585,770		8.10	
NO3-N		513,847		2.00
T-P		96,596		0.38
NH4		29,870		0.12
TN		575,412		2.24
PO4		33,837		0.13
TSS		33,054,951		128

2006 Loads and Concentrations During Storm and Base-flows.

	Storm Loads (kg)	Base Loads (kg)	Storm Concentrations (mg/l)	Base Concentrations (mg/l)
Discharge	107,602,614	148,983,156		
NO3-N	195,226	318,621	1.81	2.14
T-P	77,314	19,282	0.72	0.13
NH4-N	21,657	8,214	0.20	0.06
TN	244,722	330,691	2.27	2.22
PO4	20,114	13,723	0.19	0.09
TSS	31,752,053	1,302,898	295	9

02-1900: Illinois River Urban Outreach
Federal: $56,847
Non Federal: $42,885
Total: $99,732
Project Activities: Outreach and Education, Implementation

Project Summary: The goal of this project was to measure Illinois River Watershed residents' awareness, attitudes, knowledge, and actions regarding urban nonpoint source pollution prevention.

Project Results: The results has increased awareness of such concepts as watershed, storm water, storm drain and consequences of phosphorous pollution and has led to greater understanding of the destination of treated wastewater, urban runoff, and storm drain water. The IRWP gained recognition among IRW residents and, along with it, increased residents' awareness of such demonstration projects as rain gardens. The education has helped to change or reinforce attitudes about impacts on water quality of population growth, the idea that individuals are ultimately responsible for protecting and improving water quality and that individuals are capable of affecting water quality.

02-2000: Washington County Nutrient Management
Federal: $30,000
Non Federal: $0
Total: $30,000
Project Activities: Implementation, Outreach & Education, Technical Assistance

Project Summary: The objective was to implement BMP's in Washington County, to control the amount, timing, and placement of soil nutrients for the purpose of reducing nonpoint source of soil nutrients.

Project Results: 60 nutrient management plans for poultry waste were written.

03-113: Ballard Creek Monitoring
Federal: $42,654
Non Federal: $7,579
Total: $50,233
Project Activities: Monitoring

Project Summary: The goal of this project was to sample, analyze, and compute loadings for nutrients and sediment at Washington County Road 76 Bridge on Ballard Creek.

Project Results:

2003 Annual Loads and Mean Concentrations:

Parameter	Loads (kg)	Mean Concentrations (mg/L)
Nitrate-N	75,164	2.07
Total Phosphorus	10,124	0.28
Ammonia-N	2,605	0.07
TKN	30,365	0.84
Phosphate-P	4,146	0.11
TSS	1,787,176	49.31

Storm and Base-flow Loads and Mean Concentrations 2003:

	Storm Loads (kg)	Base Loads (kg)	Storm Concentrations (mg/L)	Base Concentrations (mg/L)
Volume (m3)	6,303,299	29,972,775		
NO3-N	12,353	62,911	1.96	2.10
T-P	3,878	6,254	0.62	0.21
NH4	386	2,220	0.06	0.07
TKN	9,208	21,180	1.46	0.71
PO4	1,267	2,882	0.20	0.10
TSS	948,111	840,366	150.42	28.04

03-400: Urban Nutrient Management in the Illinois River Landscape
Federal: $33,508
Non Federal: $24,753
Total: $58,261
Project Activities: Implementation, Hire Staff, Technical Assistance, Demonstration, Outreach & Education

Project Summary: Implement BMP's in the urban areas of the Illinois River watershed in Washington County, to control the amount, timing, and placement of soil nutrients for the purpose of reducing NPS particularly phosphorus.

Project Results: This project was successful in reducing the risks of NPS pollution from phosphorus in small subwatersheds of the Illinois River, Washington County. The estimated, NPS load reductions (using combined data) within the Illinois River was 1.05 lb phosphorus/year (using STEPL) and 0.81 lb phosphorus/year (using P Index). While these load reductions appear to be very small (roughly 0.04 lb per urban lot), the potential for substantial reductions in urban runoff is very high when considering that there are approximately 165,000 residential and commercial lots in Washington County.

<u>03-800: Demonstration of On-Farm Litter Combustion</u>
Federal: $142,500
Non Federal: $107,500
Total: $250,000
Project Activities: Demonstration, Technical Assistance, Outreach & Education, Implementation

Project Summary: Implementation of on-farm litter combustion as an alternative to land application within the Illinois River watershed:

- Litter incineration and ash export that could remove 1,500-2,200 tons of P per year out of the watersheds (based on 20% adoption of the technology and 75% of litter combusted).
- Litter combustion furnaces designed to incinerate litter could also be utilized to heat broiler houses.

Project Results: Litter combustion may be an alternate use for poultry manure. Furnace manufacturers must improve their equipment so that systems will be economically feasible. Growers will be able to justify investment in the improved equipment based on projected fuel savings for space-heating. The method has the potential to consume the majority of poultry manure produced on any farm that adopts the technology. Need to find a market for ash which contains mineral nutrients originally found in the manure. Further testing is needed to document costs and benefits of an improved furnace design. Air quality emissions also need to be assessed to insure that water quality benefits are not achieved at the expense of poorer air quality.

<u>03-900: Feasibility Assessment of Establishing the Ozark Poultry Litter Bank</u>
Federal: $192,400
Non Federal: $170,620
Total: $363,020
Project Activities: Hire Staff, Outreach & Education, Planning

Project Summary: Determine the feasibility of establishing and operating the Ozark Poultry Litter Bank (OPLB) to coordinate one or more the following:

1. Raw poultry litter export
2. Palletizing
3. On-farm energy production
4. Centralized facility energy production.

Project Results: Final results indicate the optimal locations for OPLB sites receiving raw litter from Arkansas poultry farms with three or more houses and processing the litter into bales for shipment to the nine target markets are at Decatur and Lincoln. These sites are not the absolute least-cost locations, but are economically *and* politically feasible. Per ton costs for litter at these locations is not sustainable at the current market prices and requires a subsidy of $.07 per ton mile. Prices equal to the intrinsic value of litter, that is the value of the nutrients in litter priced at a commercial ingredient level, will result in a profit from OPLB operations

<u>03-1000</u>: <u>A Demonstration of Process Technology for Converting Poultry Waste to Energy and Chemical Products</u>
Federal: $800,000
Non Federal: $585,000
Total: $1,385,000
Project Activities: Demonstration

Project Summary: The goal of this project was to demonstrate the effectiveness of proprietary, advanced thermal/chemical/biochemical process technology for cost-effective conversion of poultry waste (poultry litter and caged layer manure) into commercially viable energy and chemical products (on a commercial scale). The demonstration was to establish the technology as a Best Management Practice (BMP) for control of nonpoint source pollutants that emanate from the poultry industry.

Project Results: Numerous delays and uncertainties cause Arkansas to withdraw for this project.

<u>03-1100</u>: <u>Poultry Litter Transport from Nutrient Surplus Watersheds in Northwest Arkansas</u>
Federal: $500,000
Non Federal: $333,384
Total: $833,384
Project Activities: Technical Assistance, Demonstration

Project Summary: This project provided a subsidy ($10/ton total per ton; a maximum of $8.00/ton paid to the transport party {at a maximum rate of $0.05/mile/ton not to exceed $8.00 or 160 miles} for litter pick-up at the farm in NWA and transported outside of the Surplus Nutrient Areas as defined by ANRC and a minimum of $2.00/ton paid to the contract poultry producer supplying litter to the program) for the export of litter from contract grower operations within the Eucha/Spavinaw and Illinois River watershed in Arkansas to row crop, pasture, forage, grass and forest lands of Arkansas outside the surplus nutrient watersheds as defined by ANRC.

Project Results: The overall objective of this project was to build a sustainable poultry litter export program. Efforts reduced the quantity of litter land applied in the Eucha/Spavinaw and Illinois River watersheds by 58,435 tons, thereby removing greater than 1.7 million pounds of phosphorus from potential runoff.

<u>03-1101: Poultry Litter Transport from Nutrient Surplus Watersheds in Northwest Arkansas Phase II</u>
Federal: $227,335
Non Federal: $151,557
Total: $378,892
Project Activities: Implementation, Technical Assistance, Demonstration

Project Summary: The goal is to provide the method(s) for the export of litter from poultry production farms within the Eucha/Spavinaw and Illinois River (ES/IR) watershed in northwest Arkansas (NWA) to "selected areas" outside of the Nutrient Surplus watersheds.

Project Results: In the three year period of our original project, we exported 57,223 tons. With funding under this project, we exported 47,649 tons in a one-year period. Arkansas began a new state-funded cost share program in September 2007, which paid poultry litter exporters $0.05 per ton per mile to export from a nutrient surplus watershed into other watersheds in the state.

04-101: Benton County No Till Drill Project:
Federal: $18,112
Non Federal: $20,957
Total: $39,069
Project Activities: Outreach and Education, Implementation

Project Summary: The goal was to reduce phosphorus runoff and phosphorus levels in the soil by planting 1,000 acres of cool season annual and perennials.

Project Results: Usage of the drill was minimal due to dry weather patterns.

04-113: Ballard Creek Monitoring
Federal: $42,647
Non Federal: $7,578
Total: $50,225
Project Activities: Monitoring

Project Summary: The goal of this project was to do water quality sampling, analysis and annual load determinations for nutrients and solids at the Washington County Road 76 Bridge on Ballard Creek.

Project Results: Using the RUSLE calculations of 1 ton/acre soil lost because of improper cover during the time that warm season grasses are dormant; the project calculated that 706 tons of soil was lost. By having cool season grasses and legumes inter-seeded with warm season grasses the cool season grasses had an uptake of at least 167 lbs/acre of N, 27lbs/acre of P, and 142 lb/acre of K, according to the U of A Cooperative Extension Service.

04-180: Ballard Creek Monitoring
Federal: $45,765
Non Federal: $34,524
Total: $80,289
Project Activities: Monitoring

Project Summary: The goal was to do water quality sampling, analysis and annual load determinations for nutrients and solids at the Washington County Road 76 Bridge on Ballard Creek.

Project Results: Discharge and constituent concentrations were variable throughout the year (Figure 1) showing the effects of episodic rainfall events on stage and the chemograph of the various constituents. The increased discharge following rainfall-runoff events increased the concentrations of all the measured constituents (i.e., Cl, SO_4, NH_3, NO_3-N, SRP, TN, TP, and TSS). Total discharge during the sampling period was approximately 58,800,000 m^3 with 27% attributed to base flow and 73% attributed to storm events. The greatest percentage of the constituent load was transported during storm events for all measured parameters. Thus, it is important to collect water samples across the discharge regime in smaller basins like the Upper Ballard Creek Watershed because more than 59% of the load for all parameters was transported during high flow events. It is extremely critical to samples storm events when estimating loads of NH_3-N, SRP, TP and TSS as 95%, 92%, 95%, and 99%, respectively, of these constituents is transported during storm flow regime at Ballard Creek.

04-300: Benton County Cost Share
Federal: $330,673
Non Federal: $249,455
Total: $580,128
Project Activities: Cost Share, Technical Assistance, Implementation, Planning

Project Summary: Improve water quality in the Illinois River Priority Watershed by implementing BMPs through 75 CNMPs, therefore reducing nutrients and sediment loss in the Illinois River Watershed.

Project Results:

	Soil Tons/Saved	**"P" Reduction**
(313) Waste Storage Structures		127,566 lbs "P"
(378) Ponds, including (614) Watering Facilities (516) Pipeline (561) Heavy Use Area Protection	2,080 tons	
(382) Fence		277,400 lbs "P"
(512) Pasture and Hayland Planting	849 tons	
(786) Alum Treatment		26,970 lbs "P"

04-700: Developing Resource Management Systems for Golf Courses in Washington County, Arkansas: Phase I
Federal: $16,756
Non Federal: $12,640
Total: $29,396
Project Activities: Implementation, Hire Staff, Technical Assistance, Outreach & Education

Project Summary: The goal was to produce up to 13 golf course and 5 driving range comprehensive nutrient management plans, which will contain up to seven uniquely tailored BMPs for the reduction of nutrient runoff from the golf course landscape and to also develop a resource inventory that will provide information concerning current environmental problems, needed BMPs, and future monitoring designs.

Project Results: Washington County Conservation District was successful in accomplishing our goal of determining the risk of runoff pollution from golf courses. The project developed resource inventories and Nutrient Management Plans for each golf course and driving range within the county. The information from the resource inventory was used to plan the needed BMPs and may possibly be used to design future monitoring regimes that will quantify NPS loads and measure nonpoint source pollution. While BMPs were planned and suggested for each golf course, managers did not want to be legally bound to implement the NMP. Golf course managers also were not satisfied with soil test recommendations from the Cooperative Extension Service. These plans were voluntary, because golf course managers can legally follow the protective rates published in Title 22. As a result, golf courses did not install BMPs or utilized a Nutrient Management Plan.

<u>05-110: Ballard Creek Monitoring</u>
Federal: $42,993
Non Federal: $17,351
Total: $60,344
Project Activities: Monitoring

Project Summary: The goal was to do water quality sampling, analysis, and annual load determinations for nutrients and solids at the Washington County Road 76 Bridge on Ballard Creek.

Project Results: The results for the five watersheds show TSS, total phosphorus, and total nitrogen as total annual storm-flow loads per watershed hectare, as base-flow loads per watershed hectare, and as base-flow concentrations. Normalizing storm and base-flow loads to a per hectare basis allows comparison between watersheds of differing sizes. The total loads indicate the mass of TSS or P that are being transported to a receiving water body. The Ballard Creek watershed has below average TSS loads compared to the others. Like the others, most of the TSS is transported during storm events. The P load for Ballard creek is significantly higher than the other watersheds. Total nitrogen loads per hectare were also greater than the average. Base-flow nitrogen transport was much higher than any of the other watersheds studied. The high base-flow transports may be the result of significantly higher discharge. The annual discharge per watershed hectare was 5,234 m^3/ha versus 2,625 m^3/ha for the Illinois River. The base-flow concentrations show relative levels of TSS, T-P, and TN that are impacting in-stream biological activity during most of the year. These are the values that are of greatest interest for determining impacts to in-stream biological habitat and nuisance algae production. The base-flow concentration of TSS was low compared to the other sites. The T-P concentration was very high considering there was no point-source discharge. The nitrate concentration was high compared to the White River sites, but average for Illinois River sites where groundwater levels are high.

2005 Annual Loads and Mean Concentrations.

Parameter	Load (kg)	Mean Concentrations (mg/L)
Discharge	37,191,500 (m3/yr)	1.2 (m3/s)
Nitrate-N	68,000	1.83
Total Phosphorous	9,700	0.26
Ammonia-N	5,490	0.15
TN	85,200	2.3
Phosphate-P	5,500	0.15
TSS	1,170,000	31.4

2005 Storm-flow Loads and Mean Concentrations.

	Storm Loads (kg)	Base Loads (kg)	Storm Concentrations (mg/L)	Base Concentrations (mg/L)
Volume (M3)	6,957,000	30,251,00		
NO3N	12,200	55,800	1.76	1.85
T-P	5,300	4,300	0.77	0.14
NH4	1,100	4,400	0.16	0.15
TKN	18,400	66,800	2.65	2.21
PO4	2,600	2,800	0.39	0.09
TSS	991,000	179,000	142.5	5.9

<u>05-120: 11 Watershed Response Modeling in 11-digit Priority Watersheds in Arkansas</u>
Federal: $75,124
Non Federal: $57,036
Total: $132,160
Project Activities: Hire Staff, Planning, Technical Assistance, Outreach & Education, Implementation

Project Summary: The goal was to calibrate and validate the SWAT model at 11 digit HUCs for the following watersheds: Lake Conway – Point Remove, Bayou Bartholomew, Illinois River, Lower Little River, Poteau River, and Upper Saline River.

Project Results: This project was aimed at calibrating and validating the SWAT model for water quality response predictions at 11-digit HUCs within each 8-digit priority watershed where monitoring data are available and, subsequently, providing a ranking of all 11-digit subwatersheds within each 8-digit watersheds based on their contribution to flow, sediment, and nutrients to the major watershed outlet. Rankings were performed for each 11-digit HUC within the calibrated and validated watersheds. These rankings served to show areas from which flow, sediment and nutrient losses were high and most likely to cause a threat to water quality, and thus areas in which BMP efforts should be focused.

<u>05-190: Illinois River Watershed Activity Coordination</u>
Federal: $8,500
Non Federal: $5,000
Total: $13,500
Project Type:
Project Activities: Implementation, Planning

Project Summary: This project goal was to further the efforts of IRWP in coordinating, developing, and assembling group activities of the Partnership in development of a watershed plan.

Project Results: Coordination:

<u>05-191: Lake Fayetteville Outreach and Education</u>
Federal: $7,600
Non Federal: $5,388
Total: $12,988
Project Activities: Outreach and Education

Project Summary: The goal was to create a brochure and website for the Lake Fayetteville Watershed Partnership, design signs for public information about the environment around the lake, and educate with the signs about NPS pollution.

Project Results: The brochure and the signage have made a difference in watershed residents' and park users' habits. The project managers will examine the riparian areas being affected by bicyclists and disk golf users to see if the habitat is recovering and has less damage than the prior year.

<u>05-400: Demonstration of Best Management Practices for Stream Bank Protection</u>
Federal: $315,761
Non Federal: $237,735
Total: $553,496
Project Activities: Monitoring, Technical Assistance, Outreach & Education, Implementation

Project Summary: The project was the reduction of sediment transfer in the Blossom Way reach of the Osage Creek in Rogers, through the use of conservation practices that are unique in urban environments.

Project Results: An average of 1,658 tons/year of sediment was estimated to enter Blossom Way from the sources evaluated. Blossom Way watershed is a rapidly urbanizing and it is reasonable that sediment from construction had the highest average sediment contribution of 822 tons/year or 49% of the total load. The second highest contributor was urban areas with an average of 413 tons/year or 25% of the total load; the third highest was streambank erosion with 186 tons/year of sediment or 11% of the total load. Construction had the highest estimated loading rate per acre of land at 3.2 tons/ac. Pastures, barren lands, farmsteads, undeveloped lands, and highways had similar loading rates ranging from 0.1 tons/ac for pastures to 0.23 tons/ac for highways. Forest lands had the lowest sediment loading rate of all the sources evaluated at 0.04 tons/ac. It is difficult to compare streambank erosion's estimated loading rate to the other sources because it is based on length of streambanks showing signs of accelerated erosion. The sediment loading rate for streambank erosion based on stream length was estimated to be 179 tons/mi.

<u>05-1000: Urban NPS Hispanic Outreach and Education</u>
Federal: $300,000
Non Federal: $245,000
Total: $545,000
Project Activities: Outreach and Education

Project Summary: The goal was to generate Hispanic community awareness of urban nonpoint source pollution and elicit pollution prevention BMP implementation through public education programs targeting Spanish-speaking residents throughout the Beaver Lake and Illinois River Watersheds.

Project Results: Several fact sheets were developed on topics including household hazardous waste, stormwater, automobile maintenance, and lawn and garden chemicals:
What is Household Hazardous Waste? Provided a definition of Household Hazardous Waste, location and contacts for disposal of HHW in Benton, Carroll, Madison and Washington counties, recognizing the warnings on labels and warning symbols, as well as reducing risks associated with HHW.
What is Stormwater? Provided general information on stormwater, where is goes after a storm, how it impacts area water quality, and tips for pollution prevention and awareness.
Automóvil Verdads (Car Facts) Provided information on caring for automobiles while keeping stormwater in mind and how automobiles can affect water quality.
Lawn and Garden Chemicals Provided information on using and storing lawn/garden chemicals. Tips for applying fertilizers properly and calibrating home application equipment.

Posters were developed for educational/informational displays. Informational topics included proper and alternative practices around the home and garden to maintain and/or improve water quality and water conservation; a “Top 10 List” including 10 actions for preventing or improving runoff water quality around the home and yard; information on storm drains and tips for preventing stormwater pollution to protect water quality and general tips for proper lawn maintenance to protect water quality.

Brochures and counter-top displays were developed as complementary educational items. Information provided in these materials includes general information on storm drains and tips for protecting stormwater drainage and runoff.

05-1100: Demonstration of Low Impact Development BMPs
Federal: $69,998
Non Federal: $127,608
Total: $197,606
Project Activities: Demonstration, Outreach & Education, Implementation, Planning

Project Summary: The goal was to demonstrate LID methods and technologies for protecting critical ecological services in urban systems from nonpoint source (NPS) pollution.

Project Results: The primary measure of success for this project will be the increased implementation of LID technologies in NW Arkansas. Technology transfer to local engineers and developers was accomplished through tours, workshops, and meetings. A manual for LID design was developed and distributed locally and nationally. The demonstration project designed through this grant project will continue to be a focal point of local and regional LID workshops and tours.

05-1300: Edge of Field Water Quality Monitoring from Various Management Practices in the Ozark Highlands.
Federal: $298,347
Non Federal: $224,971
Total: $523,318
Project Activities: Monitoring, Outreach & Education, Implementation, Demonstration

Project Summary: The goal was to establish edge of field monitoring sites to evaluate the effectiveness of various management practices on edge of field nutrient loss.

Project Results: Drought conditions and variability in runoff volume occurred between the years and between watersheds within the same year, thus limiting the ability to clearly demonstrate treatment effect. During the years of 2006-2007 only two runoff events occurred, while in 2008 numerous events occurred to measure the amount of runoff. Right after the application of animal litter, dissolved P accounts for 70-90% of total runoff. With sound grazing management TP can be reduced by 50% or more depending on the specific management practice effect on soil properties. Total P are 3 to 4 times higher when litter is applied above that contributed from STP alone, regardless of whether runoff is occurring on soils is high or low in STP.

05-1600: ANRC Litter Transport from designated Nutrient Surplus Area (NSA) in Arkansas
Federal: $125,000
Non Federal: $125,000
Total: $250,000
Project Activities: Implementation/Transportation

Project Summary: The goal was to provide subsidy payments for the export of Poultry Litter from within the NSA in Arkansas to row crop, pasture, forage, and grass and forest lands outside the NSA and buffer watersheds as defined by the ANRC.

Project Results: Our goal was to remove 16,666 tons of litter from the NSA and approximately 1,033,292 lbs of phosphorus and 949,962 lbs. of nitrogen. At the end of the project we had moved 17,018 tons of litter. A ton of litter will yield around 62 lbs of phosphorus and about 57 lbs of nitrogen. Approximately 1,055,116 lbs of phosphorus and 970,026 lbs. of nitrogen were removed.

06-110: Ballard Creek Monitoring
Federal: $43,037
Non Federal: $25,860
Total: $68,897
Project Activities: Monitoring

Project Summary: The goal was to do water quality sampling, analysis, and annual load determinations for nutrients and solids at the Washington County Road 76 Bridge on Ballard Creek.

Project Results: The total loads indicate the mass of TSS or P that are being transported to a receiving water body. Storm loads per hectare may be used to represent relative impacts from non-point sources. The Ballard Creek watershed has below average TSS loads compared to the other streams. Like the other streams, most of the TSS is transported during storm events. The P load for Ballard Creek is higher than the larger Illinois River watershed, but lower than a similar sub-watershed, Moores Creek. A significant portion of the P transport occurred during base-flow. This situation is most typical of point-source dominated systems. Since there are no permitted point-sources in the watershed, another non-runoff based source must be the origin of the elevated P levels. Total nitrogen loads per hectare were also greater than the average. Base-flow nitrogen transport was much greater than any of the other watersheds studied.

2006 Annual Loads and Mean Concentrations.

Parameter	Loads (kg)	Mean Concentrations (mg/L)
Discharge (m3)	28,514,177	0.90 (m3/s)
NO3-N	46,901	1.64
T-P	11,368	.040
NH3-N	4,404	0.15
TN	58,717	2.06
PO4-P	5,348	0.19
TSS	1,862,308	65

2006 Storm-Flow and Base-Flow and Mean Flow-Weighted Concentrations.

	Storm Loads (kg)	Base Loads (kg)	Storm Flow-Weighted Concentrations (mg/L)	Base Flow-Weighted Concentrations (mg/L)
Discharged (m3)	5,324,420	23,196,443		
NO3-N	7,972	38,941	1.50	1.68
T-P	6,604	4,767	1.24	0.21
NH4-N	1,713	2,692	0.32	0.12
TKN	11,729	47,002	2.20	2.03
PO4-P	2,436	2,913	0.46	0.13
TSS	1,675,873	186,914	314	8

06-600: Demonstration of a Natural Channel Design to Restore a Stream Reach Draining an Urbanized Sub-Watershed
Federal: $121,000
Non Federal: $141,200
Total: $262,200
Project Activities: Demonstration, Outreach & Education, Implementation

Project Summary: The goal was to restore the channel of a tributary of Hamstring Creek to a morphologically stable form utilizing a natural channel design approach.

Project Results: The success of this project was to be measured through the documented reduction of streambank erosion and channel enlargement. A 75% reduction in sediment produced by streambank erosion, as determined by and evaluation of erosion potential, prior to and following restoration will be considered success. The sediment reduction from the restoration was estimated to be 96% and this was based on data collected following three major storm events including two tropical systems.

07-110: Ballard Creek Monitoring
Federal: $42,169
Non Federal: $24,399
Total: $66,568
Project Activities: Monitoring

The project was to do water quality sampling, analysis, and annual load determinations for nutrients and solids at the Washington County Road 76 Bridge on Ballard Creek.

Project Results: The P load for Ballard Creek is higher than the larger Illinois River watershed, but lower than a similar sub-watershed, Moores Creek. A significant portion of the P transport occurred during base-flow. This situation is most typical of point-source dominated systems. Since there are no permitted point-sources in the watershed, another non-runoff based source must be the origin of the elevated P levels. Total nitrogen loads per hectare were also greater than the average. Base-flow nitrogen transport was much greater than any of the other watersheds studied. The high base-flow transport of nitrogen also suggests a non-runoff based source of nutrients in the watershed. The base-flow concentrations show relative levels of TSS, T-P, and TN that are impacting instream biological activity during most of the year. These are the parameters that are of greatest interest for determining impacts to in-stream biological habitat and nuisance algae production. The base-flow concentration of TSS was low compared to the other sites. The T-P concentration was very high considering there was no point-source discharge. The nitrate concentration was high compared to the White River sites, but average for Illinois River sites, where groundwater levels are high. The high concentrations of nutrients during base-flows as well as elevated levels of sulfate and chloride, suggest that septic systems may be impacting this creek.

Result Summary:

2007 Annual Loads and Mean Concentrations.

Parameter	Total Discharge (m3/yr)	Total Load (kg/yr)	Average Discharge (m3/s)	Mean Concentration (mg/L)
	23,317,564		.074	
SO4		361,447		15.50
Cl-		288,264		12.36
NO3-N		68,118		2.92
T-P		5,874		.025
NH4		1,640		0.07
TN		77,456		3.32
PO4		3,344		.014
TSS		737,512		31.63

2007 Storm-flow and Base-flow Loads and Mean Flow-weighted Concentrations:

Parameter	Storm Loads (kg)	Base Loads (kg/yr)	Storm Concentrations (mg/L)	Base Concentrations (mg/L)
Discharge (M3)	3,250,622	20,066,942		
SO4	20,066,942	329,775	9.74	16.43
Cl-	21,969	266,295	6.76	13.27
NO3-N	5,218	62,900	1.61	3.13
T-P	3,212	2,662	0.99	0.13
NH4	852	788	0.26	0.04
T-N	7,989	69,467	2.46	3.46
PO4	1,676	1,668	0.52	0.08
TSS	657,032	80,481	202.12	4.01

07-111: Illinois River Monitoring
Federal: $42,169
Non Federal: $24,399
Total: $66,568
Project Activities: Monitoring

Project Summary: The ultimate intent of the project was to perform water quality sampling, analysis, and annual load determinations for nutrients and solids at the Illinois River at the Arkansas Highway 59 Bridge.

Project Results:

Results for Illinois River at AR59 for Calendar year 2007.

Parameter	Total Discharge (m3/yr)	Total Load (kg/yr)	Average Discharge (m3/s)	Mean Concentration (mg/L)
	389,134,727		12.28	
SO4		5,939,974		15.26
Cl-		5,452,600		14.01
NO3-N		961,509		2.47
T-P		78,955		0.20
NH4		19,637		0.05
TN		1,080,305		2.78
PO4		35,270		0.09
TSS		21,257,957		55.40

2007 Loads and Concentrations During Storm and Base-Flows.

Pollutant	Storm Loads (kg)	Base Loads (kg)	Storm Concentrations (mg/L)	Base Concentrations (mg/L)
Discharge (M3)	**115,365,022**	**273,769,705**		
SO4	**1,319,426**	**4,620,549**	**11.44**	**16.88**
Cl-	**985,812**	**4,466,788**	**8.55**	**16.32**
NO3-N	**267,589**	**693,920**	**2.32**	**2.53**
T-P	**52,168**	**26,787**	**0.45**	**0.10**
NH4-N	**15,260**	**4,377**	**0.13**	**0.02**
T-N	**321,366**	**758,939**	**2.79**	**2.77**
PO4	**16,216**	**19,054**	**0.14**	**0.07**
TSS	**19,608,214**	**1,949,743**	**169.97**	**7.12**

07-113: Osage Creek Monitoring
Federal: $23,508
Non Federal: $16,504
Total: $40,012
Project Activities: Monitoring

Project Summary: The intent of the project was to perform water quality sampling, analysis, and annual load determinations for nutrients and solids at the Washington County Road 70 Bridge on Osage Creek.

Project Results:

Results for Osage Creek Near Elm Spring for Partial Calendar Year 2007.

Parameter	Total Discharge (m3/yr)	Total Load (kg/yr)	Average Discharge (m3/s)	Mean Concentration (mg/L)
	118,919,331		3.75	
SO4		1,298,527		10.92
Cl-		1,243,112		10.45
NO3-N		163,433		1.37
T-P		13,069		0.11
NH4		2,343		0.02
TN		181,098		1.52
PO4		5,950		0.05
TSS		3,540,746		29.77

Loads and Concentrations During Storm and Base-Flows Partial Calendar year 2007.

Pollutant	Storm Loads (kg)	Base Loads (kg)	Storm Concentrations (mg/L)	Base Concentrations (mg/L)
Discharge (M3)	22,274,991	96,644,340		
SO4	132,402	1,166,126	5.94	12.07
Cl-	117,438	1,125,674	5.27	11.65
NO3-N	16,480	146,953	0.74	1.52
T-P	6,949	6,120	0.31	0.06
NH4	1,587	756	0.07	0.01
T-N	22,146	158,952	0.99	1.64
PO4	1,483	4,466	0.07	0.05
TSS	3,046,202	494,545	136.75	5.12

07-200: Utilizing Water Treatment Residuals to Reduce Phosphorus Runoff from Biosolids.
Federal: $167,412
Non Federal: $146,898
Total: $314,310
Project Activities: Demonstration, Hire Staff, Monitoring, Outreach & Education

Project Summary: This project demonstrated the efficacy, cost effectiveness, practicality and sustainability of treating biosolids (sewage sludge) with water treatment residuals (alum sludge).

Project Results: Total Phosphorus reduction was 30%.

07-600: Implementation of Low Impact Development Best Management Practices to Remediate Sediment from Urban Development in Fayetteville, Arkansas
Federal: $464,000
Non Federal: $1,207,000
Total: $1,671,000

Project Activities: Implementation, Technical Assistance, Outreach & Education, Planning

Project Summary: The goal was to implement urban LID methods and technologies for restoring water quality impacted from sediment in the White River, and for protecting critical ecological services in urban systems.

Project Results: TSS decreased by 39% to 2.4 million pounds/year
Runoff reduction 27% to 9,450 acres/feet

<u>07-900: Sager Creek Urban Stream Restoration</u>
Federal: $199,240
Non Federal: $150,327
Total: $349,567
Project Activities: Streambank Restoration, Implementation

Project Summary: The goal was to restore the natural hydrology, stream channel geomorphology and habitat to a reach of Sager Creek in downtown Siloam Springs. The project will resulted in improved in-stream aquatic habitat, reduction in temperature and periphyton biomass, improved aesthetics and a reach level reduction in sediment and nutrient loading.

Project Results:

Outcomes	Measured Results
a. Improved time of travel b. Improved aquatic habitat c. Improved water quality	a. Impoundment eliminated, velocity increased b. Aquatic life improvement (macroinvertebrates) c. Monitoring data show decreases in nutrients
a. Reduction in sediment, nitrate and phosphorous loading to creek from NPS displayed through monitoring b. Continued bank stability measured as bank dimension remaining in prescribed range	a. Reductions demonstrated at base flow for nutrients and during storm event for nutrients and sediment. b. Survey data proves channel stability
a. Reduction in sediment, nitrate and phosphorous loading to creek from NPS displayed through monitoring. b. Reduction in periphyton biomass as new canopy produces shade. c. Reduction in water temperature as new canopy produces shade. Demonstrated through monitoring	a. Reductions demonstrated at base flow for nutrients and during storm event for nutrients and sediment. b. Reduction yet to be demonstrated as riparian canopy needs several years to mature and provide necessary shading. c. Reduction yet to be demonstrated as riparian canopy needs several years to mature and provide the necessary shading.

<u>07-1400: Illinois River Watershed Management Plan Phases II and III</u>
Federal: $150,000
Non Federal: $150,000
Total: $300,000
Project Activities: Management Plan

Project Summary: The goal is a comprehensive Watershed Management Plan meeting the 9 elements established by EPA. Specific objectives include:

Project Results: The management plan was submitted to ANRC, it did not meet all requirements standards for an EPA 9 element plan. Several comments made by the ANRC staff and EPA staff to guide the plan towards meeting all the requirements for a 9 element plan.

<u>08-110: Illinois River Monitoring</u>
Federal: $45,765
Non Federal: $34,524
Total: $80,289
Project Activities: Monitoring

Project Summary: The project was to perform water quality sampling, analysis, and annual load determinations for nutrients and solids at the Illinois River at the Arkansas Highway 59 Bridge.

Project Results:
Summary of calculated loads (kg) for each parameter at the Illinois River at Highway 59 Bridge separated into base flow and storm events for the period, January through December 2008.

Parameter	Base Load (kg)	Storm Load (kg)	Total Load (kg)
Chloride (Cl)	5,100,000	3,610,000	8,710,000
Sulfate (SO_4)	5,210,000	5,570,000	10,800,000
Ammonia (NH_3-N)	4,770	106,000	111,000
Nitrate (NO_3-N)	1,150,000	1,360,000	2,510,000
Soluble Reactive Phosphorus (SRP; PO_4-P)	25,800	108,000	134,000
Total Nitrogen (TN)	1,180,000	1,740,000	2,920,000
Total Phosphorus (TP)	34,700	391,000	426,000
Total Suspended Solids (TSS)	2,410,000	165,000,0000	167,000,000

Summary of average flow weighted concentration (FWC, mg L^{-1}) for each parameter at the Illinois River at Highway 59 Bridge separated into flow regimes representing January through December 2008.

Parameter	Base FWC (mg L^{-1})	Storm FWC (mg L^{-1})	Overall FWC (mg L^{-1})
Chloride (Cl)	13.71	5.65	8.61
Sulfate (SO_4)	14.02	8.71	10.66
Ammonia (NH_3-N)	0.01	0.17	0.11
Nitrate (NO_3-N)	3.09	2.12	2.48
Soluble Reactive Phosphorus (SRP; PO_4-P)	0.01	0.17	0.13
Total Nitrogen (TN)	3.18	2.71	2.89
Total Phosphorus (TP)	0.09	0.61	0.13
Total Suspended Solids (TSS)	6.5	257	165

08-112: Osage Creek Monitoring
Federal: $45,765
Non Federal: $34,524
Total: $80,289
Project Activities: Monitoring

Project Summary: The project was to perform water quality sampling, analysis, and annual load determinations for nutrients and solids at the Washington County Road 70 Bridge on Osage Creek.

Project Results:
2008 Summary: Results for Osage Creek near Elm Springs for 2008.

Pollutant	Total Discharge (m3/yr)	Total Load (kg/yr)	Average Discharge (m3/s)	Mean Concentrations (mg/L)
	267,579,708		8.44	
SO4		4,292,595		16.04
Cl-		3,953,843		14.78
NO3/NO2-N		968,054		3.62
T-P		81,774		0.31
NH4-N		15,287		0.06
sPO4-P		28,025		0.10
TSS		44,506,092		166.63

Summary: Results for Osage Creek near Elm Springs for First Half of 2009.

Pollutant	Total Discharge (m3/yr)	Total Load (kg/yr)	Average Discharge (m3/s)	Mean Concentrations (mg/L)
	116,825,501		7.39	
SO4		1,615,343,		13.83
Cl-		1,540,002		13.18
NO3/NO2-N		409,203		3.50
T-P		22,865		0.20
NH4-N		11,930		0.10
T-N		497,949		4.26
sPO4-P		12,553		0.11
TSS		13,406,510		114.76

08-300: A Comprehensive Watershed Response Modeling for 12-digit Hydrologic Unit Code "HUC" in Selected Priority Watersheds in Arkansas.
Federal: $169,106
Non Federal: $127,571
Total: $296,677
Project Activities: Modeling, Technical Assistance, Planning

Project Summary: The goal was to calibrate the SWAT model at the 12-digit HUC scale so that sub-watersheds within the 8-digit HUCs of Lake Conway Point Remove (PR), Bayou Bartholomew, Beaver Reservoir, and Illinois River watersheds are assessed and ranked based on their contribution to non point source (NPS) pollution.

Project Results: For prioritizing 12-digit HUC subwatersheds, a calibrated and validated SWAT model at multiple monitoring sites was used. The SWAT model should be recognized as a "watershed-scale" long-term estimation tool and not a field-based deterministic system for allocating sediment and nutrients loads and sources. Fully recognizing the uncertainties inherent in modeling process, a fairly rigorous multi-site and multi-objective calibration and validation methodology was employed in this study to minimize uncertainties in simulation of flow, sediment, TP, and NO3-N. However, an unknown degree of uncertainty continues to exist within modeling simulations. Its presence may affect the ranking of priority subwatersheds. Hence, monitoring is needed in conjunction with modeling to reliably prioritize.

08-400: Illinois River Volunteer Monitoring
Federal: $25,650
Non Federal: $19,350
Total: $45,000
Project Activities: Monitoring, Outreach & Education

Project Summary: The goal was to collect quarterly grab samples using trained volunteer sample collectors in 37 sub-watersheds of the Illinois River sub-basin to prioritize sub-watersheds for future efforts and to compare to past results to ascertain trends in water quality.

Project Results: Overall, total phosphorus and soluble reactive phosphorus concentrations significantly increased at 14% and 11% of the sampled sites, respectively, between the previous and current studies, while respective concentrations significantly decreased at 8% and 16% of sampled sites. The greatest reductions in phosphorus concentrations occurred at sites downstream of effluent discharges, and both total phosphorus and soluble reactive phosphorus concentrations were positively correlated to pasture and urban land use within the catchment ($R2= 0.11$, $P=0.045$; $R2= 0.16$, $P=0.015$, respectively). Similarly, both total nitrogen and nitrate-nitrogen concentrations were positively correlated to urban and pasture land use ($R2= 0.38$, $P <0.0001$; $R2=0.29$, $P=0.0006$, respectively), and 5% and 14% of the sampled sites significantly increased in total nitrogen and nitrate nitrogen concentrations, respectively, between the two study periods.

<u>08-600: Demonstrating Runoff Capture from Poultry Houses to Improve Water Quality in 12-Digit HUCs of the Illinois River Watershed</u>
Federal: $199,351
Non Federal: $150,403
Total: $349,754
Project Activities: Demonstration, Monitoring, Implementation

Project Summary: This project was to demonstrate the effectiveness of BMPs that impound runoff from poultry houses to reduce phosphorus (P), nitrogen (N), sediment, and bacteria loss in runoff.

Project Results: This project is not yet completed.

<u>09-400: NW Arkansas Water Quality Trends</u>
Federal: $54,357
Non Federal: $41,016
Total: $95,373
Project Type: Monitoring

Project Summary: This project is to organize water quality data from projects funded by the ANRC 319 Program and determine if selected flow-weighted constituent concentrations are changing with time.

Project Results: This project has not been completed.

<u>09-600: Upper Illinois River Monitoring</u>
Federal: $161,823
Non Federal: $122,055
Total: $283,878
Project Activities: Monitoring

Project Summary: The goal was to collect and analyze weekly to more frequent grab samples at eight sites in the Upper Illinois River Basin in Arkansas, and estimate annual constituent loads at all sites where continuous discharge data is available.

Project Results:

Summary of calculated total loads (kg) for each parameter at the sampled sites in the Upper Illinois River Watershed for the period, January through December 2009.

Site	Cl	SO_4	NH_3-N	NO_3-N	SRP	TN	TP	TSS
Ballard Creek	461,000	767,000	5,300	119,000	21,000	139,000	29,000	6,492,000
Baron Fork	258,000	748,000	2,800	81,000	6,100	117,000	9,800	1,290,000
Flint Creek (W. Siloam)	521,000	1,201,000	1,300	116,000	2,400	130,000	5,300	1,852,000
Flint Creek (Springtown)	101,000	92,000	1,300	56,000	1,700	62,000	2,600	447,000
Illinois River @ AR59	8,011,000	9,546,000	31,000	1,740,000	82,000	1,970,000	236,000	111,961,000
Illinois River @ Savoy	1,656,000	3,144,000	21,000	392,000	39,000	530,000	72,000	20,556,000
Mud Creek Tributary	14,000	18,000	100	900	60	1,600	300	1,342,000
Osage Creek	3,200,000	3,310,000	16,500	607,000	15,300	670,000	40,700	24,900,000

Summary of calculated flow weighted concentrations (FWC, mg L^{-1}) for each parameter at the sampled sites in the Upper Illinois River Watershed for the period, January through December 2009.

Site	Cl	SO_4	NH_3-N	NO_3-N	SRP	TN	TP	TSS
Ballard Creek	7.61	12.67	0.09	1.97	0.34	2.29	0.49	107
Baron Fork	4.63	13.45	0.05	1.46	0.11	2.10	0.18	23
Flint Creek (W. Siloam)	9.56	21.93	0.02	2.12	0.04	2.37	0.10	34
Flint Creek (Springtown)	5.76	5.21	0.07	3.18	0.10	3.52	0.15	322
Illinois River @ AR59	10.93	13.02	0.04	2.37	0.11	2.69	0.32	153
Illinois River @ Savoy	6.97	13.24	0.09	1.65	0.16	2.23	0.30	87
Mud Creek Tributary	8.53	11.14	0.07	0.56	0.04	0.95	0.16	824
Osage Creek	16.25	16.81	0.08	3.08	0.08	3.40	0.21	126

<u>09-1200: Clear Creek Riparian Management Education & Demonstration Project</u>
Federal: $250,000
Non Federal: $188,598
Total: $438,598
Project Activities: Outreach and Education, Demonstration, Implementation

Project Summary: The goal is to raise Clear Creek Sub-Basin residents' awareness and knowledge of the importance of riparian areas and incite individual management actions through public outreach, education, and demonstration programs.

Project Results: This project has not been completed.

<u>09-1300: Sager Creek Phase II</u>
Federal: $300,441
Non Federal: $240,351
Total: $540,792
Project Activities: Streambank Restoration, Monitoring, Implementation

Project Summary: The goal is to restore the natural hydrology, stream channel geomorphology and habitat to a reach of Sager Creek in downtown Siloam Springs and to reduce sediment and nutrient transport in the system during storm flows.

Project Results: This project has not been completed yet.

<u>09-1700: Nutrient E Education</u>
Federal: $240,000
Non Federal: $181,792
Total: $422,722
Project Activities: Hire Staff, Implementation, Demonstration, Outreach & Education

Project Summary: Develop and use electronic teaching tools to reduce nutrient nonpoint source pollution in watersheds of the Arkansas' Nutrient Surplus Area (NSA)

Project Results: This project has not been completed.

<u>09-1800: IRWP Outreach</u>
Federal: $250,000
Non Federal: $188,596
Total: $438,596
Project Activities: Technical Assistance, Monitoring, Planning

Project Summary: This project is to describe biological communities (periphyton, macroinvertebrates, and fish) and relate the communities to nutrient concentrations, land use, nutrients and other environmental factors in the Illinois River Basin of Arkansas.

Project Results: This project has not been completed.

<u>10-500: Green Development Workshop</u>
Federal: $8,595
Non Federal: $7,625
Total: $16,220
Project Activities: Planning, Outreach & Education

Project Summary: Provide guidance for those who make decisions, provide recommendations or want to learn more regarding the planning, project implementation, supervision, public education or other roles that may have an impact on their community's natural resources.

Project Results: The workshop provided educational enhancement opportunities and an array of concepts including; vegetation not only restores streams, but helps manage storm water more effectively than conventional methods such as expensive concrete storm drains; traditional neighborhood design can be tweaked to incorporate state-of-the-art conservation design practices. Another presentation discussed how to design landscapes for urban storm water runoff and showed examples from a new publication titled “Low Impact Development – A Design Manual for Urban Areas.” The book offers ideas for property owners, professionals in the development arena and for municipal governments that regulate infrastructure.

11-200: Botanical Gardens
Federal: $38,680
Non Federal: $33,403
Total: $72,083
Project Activities: Planning

Project Summary: To hire a team of planning consultants to develop a detailed plan to reduce sedimentation rates and establish a healthy riparian zone along Hilton Creek and two other smaller watercourses as they pass through the Botanical Garden of the Ozarks on their way to discharge into Lake Fayetteville which eventually flows into the Illinois River.

Project Results: This project has not started.

11-400: IRWP Rain Gardens
Federal: $210,288
Non Federal: $160,627
Total: $370,915
Project Activities: Hire Staff, Monitoring, Technical Assistance, Outreach & Education, Implementation, Demonstration

Project Summary: The goal is to reduce nutrient and sediment load into the Illinois River watershed and to improve water quality, and enhance aquatic and terrestrial habitat. The project objectives are:

1. Train 150 persons in rain garden design and implementation,
2. Implement 30 Demonstration Rain Gardens in Public/Quasi-public locations in the Illinois River Watershed, and
3. Institutionalize rain gardens as a nonpoint source best management practice in Northwest Arkansas.

Project Results: This project has not yet started.

11-500: NWA Monitoring
Federal: $728,000
Non Federal: $621,197
Total: $1,349,197
Project Activities: Monitoring

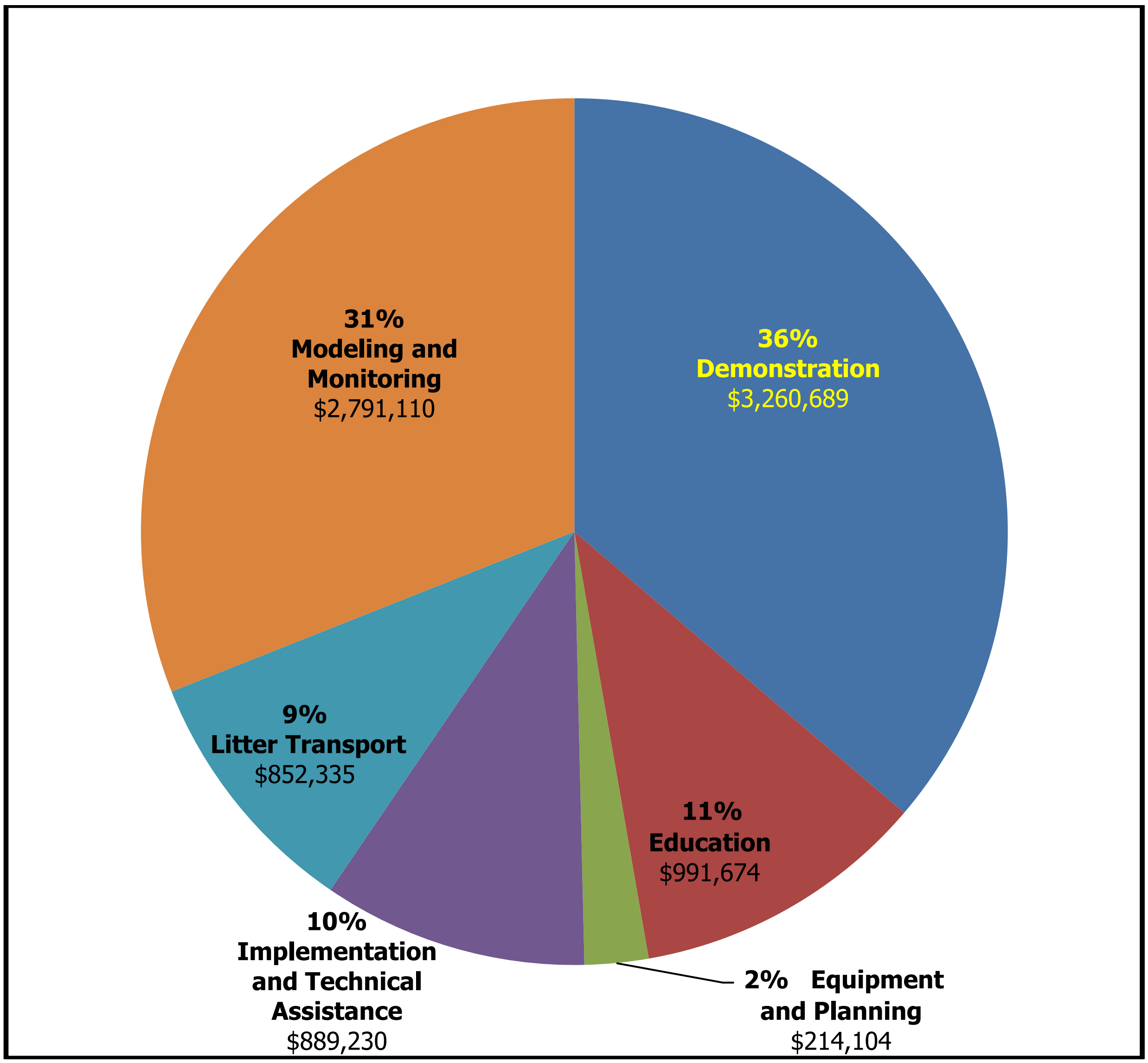
Project Summary: Collect and analyze 46 water samples on average at 19 sites annually in the Upper Illinois Watershed and Upper White River Basin and to estimate annual constituent loads and trends. Excessive nutrients and sediments have been cited as NPS pollution. This project will monitor these constituents and others which will add to the water quality database used by policy and decision makers. This project will also collect water samples and measure physico-chemical properties in stream reaches on the 303(d) list to address impairment by pathogens and dissolved oxygen.

Project Results:
This project has not yet started.

<u>**Totals**</u>

Federal:	**$8,999,142**
Non Federal:	**$7,545,101**
Total:	**$16,544,243**

By category:



Project #	Federal $'s	Non-Federal $'s	Total $'s	Project Type 1
02-900	490,000	378,000	868,000	Demonstration
03-800	142,500	107,500	250,000	Demonstration
03-900	192,400	170,620	363,020	Demonstration
03-1000	800,000	585,000	1,385,000	Demonstration
05-1100	6,998	127,608	134,606	Demonstration
05-1300	298,347	224,971	523,318	Demonstration
07-200	167,412	146,898	314,310	Demonstration
07-600	464,000	1,207,000	1,671,000	Demonstration
07-900	199,240	150,327	349,567	Demonstration
08-600	199,351	150,403	349,754	Demonstration
09-1300	300,441	240,351	540,792	Demonstration
	$3,260,689	**$3,488,678**	**$6,749,367**	
00-154	3,356	2,531	5,887	Education
00-400	116,776	78,263	195,039	Education
02-1900	56,847	42,885	99,732	Education
05-190	8,500	5,000	13,500	Education
05-191	7,600	5,388	12,988	Education
05-1000	300,000	245,000	545,000	Education
09-1200	250,000	188,598	438,598	Education
09-1700	240,000	181,792	421,792	Education
10-500	8,595	7,625	16,220	Education
	$991,674	**$757,082**	**$1,748,756**	
00-152	7,312	5,516	12,828	Equipment
04-101	18,112	20,957	39,069	Equipment
11-200	38,680	33,403	72,083	Planning
07-1400	150,000	150,000	300,000	Illinois River WMP
	$214,104	**$209,876**	**$423,980**	
00-155	11,532	8,700	20,232	Implementation
01-160	30,000	-	30,000	Implementation
03-400	33,508	24,753	58,261	Implementation
04-300	330,673	249,455	580,128	Implementation
05-400	315,761	237,735	553,496	Implementation
06-600	121,000	141,200	262,200	Implementation
02-2000	30,000	-	30,000	Technical Assistance
04-700	16,756	12,640	29,396	Technical Assistance
	$889,230	**$674,483**	**$1,563,713**	

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Project #	Federal $'s	Non-Federal $'s	Total $'s	Project Type 1
03-1100	500,000	333,384	833,384	Litter Transport
03-1101	227,335	151,557	378,892	Litter Transport
05-1600	125,000	125,000	250,000	Litter Transport
	$852,335	**$609,941**	**$1,462,276**	
01-1100	272,713	206,120	478,833	Monitoring
02-100	58,835	10,454	69,289	Monitoring
02-100	44,695	7,942	52,637	Monitoring
02-500	436,470	109,118	545,588	Monitoring
02-1600	67,518	46,998	114,516	Monitoring
03-113	42,654	7,579	50,233	Monitoring
04-113	42,647	7,578	50,225	Monitoring
04-180	45,765	34,524	80,289	Monitoring
05-110	42,993	17,351	60,344	Monitoring
06-110	43,037	25,860	68,897	Monitoring
07-110	42,169	24,399	66,568	Monitoring
07-111	42,169	24,399	66,568	Monitoring
07-113	23,508	16,504	40,012	Monitoring
08-110	45,765	34,524	80,289	Monitoring
08-112	45,765	34,524	80,289	Monitoring
08-400	25,650	19,350	45,000	Monitoring
09-400	54,357	41,016	95,373	Monitoring
09-600	161,823	122,055	283,878	Monitoring
09-1800	250,000	188,596	438,596	Monitoring
11-500	728,000	621,197	1,349,197	Monitoring
02-1400	30,347	20,346	50,693	Modeling
05-120	75,124	57,036	132,160	Modeling
08-300	169,106	127,571	296,677	Modeling
	$2,791,110	**$1,805,041**	**$4,596,151**	