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Arkansas WATERplan
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ARKANSAS WATER PLAN UPDATE
TASK NO. 6 - NORTH ARKANSAS WATER RESOURCES PLANNING REGION

AUGUST 11, 2014

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WATER RESOURCES PLANNING REGION

Prepared for

Arkansas Natural Resources Commission
101 East Capitol Avenue, Suite 350
Little Rock, AR 72201-3813

Prepared by

FTN Associates, Ltd.
3 Innwood Circle, Suite 220
Little Rock, Arkansas 72211

FTN No. 03015-0003-001

AUGUST 11, 2014

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

ACS	American Community Survey
ADEQ	Arkansas Department of Environmental Quality
ADH	Arkansas Department of Health
ADPCE	Arkansas Department of Pollution Control and Ecology (now ADEQ)
AGFC	Arkansas Game and Fish Commission
AHTD	Arkansas State Highway and Transportation Department
ANHC	Arkansas Natural Heritage Commission
ANRC	Arkansas Natural Resources Commission
APCEC	Arkansas Pollution Control and Ecology Commission
ASWCC	Arkansas Soil and Water Conservation Commission (now the ANRC)
AWAG	Arkansas Watershed Advisory Group
AWP	Arkansas Water Plan
BCE	Before the common era
BMP	Best management practice
CERCLA	Comprehensive Environmental Response and Liability Act
CRP	Conservation Reserve Program
CSP	Conservation Stewardship Program
CWA	Clean Water Act
DO	Dissolved oxygen
E. coli	Escherica coli
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
cfs	Cubic feet per second
GCGW	Governor's Commission on Global Warming
gpm	Gallons per minute
HUD	United States Department of Housing and Urban Development
IRWP	Illinois River Watershed Partnership
MBHI	Migratory Bird Habitat Initiative
MCL	Maximum contaminant level
mg/L	Milligrams per liter
mgd	Million gallons per day
MS4	Municipal separate storm sewer system
NAWRPR	North Arkansas Water Resources Planning Region
n.d.	No date
NCDC	National Climatic Data Center
NEPA	National Environmental Policy Act
NFH	National Fish Hatchery
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
NPS	Non point source

LIST OF ACRONYMS (CONTINUED)

NRCS	United Stated Department of Agriculture Natural Resources Conservation Service
NTU	Nephelometric Turbidity Unit
NWR	National wildlife refuge
NWS	National Weather Service
PCB	Polychlorinated biphenyl
PCP	Pentachlorophenol
PDSI	Palmer Drought Severity Index
RCRA	Resource Conservation and Recovery Act
RSWMD	Regional Solid Waste Management District
SDWA	Safe Drinking Water Act
SGCN	Species of greatest conservation need
SFHA	Special Flood Hazard Area
SPL	State Priority List
Su	Standard units
TCE	Trichloroethene
TDS	Total dissolved solids
TMDL	Total maximum daily load
TOC	Total organic carbon
TSS	Total suspended solids
U of A	University of Arkansas
US	United States
USACE	United States Army Corps of Engineers
USDA	United Stated Department of Agriculture
USDI	United States Department of the Interior
USFS	United States (USDA) Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WIP	Western Interior Plains
WMA	Wildlife management area
WRDA	Water Resources Development Act

1.0 INTRODUCTION

The Arkansas Natural Resources Commission (ANRC) is responsible for preparing and periodically updating a statewide water resources planning document. The previous update of the Arkansas Water Plan (AWP) was completed in 1990. In 2012, ANRC initiated an update of the 1990 AWP to be completed in 2014.

This document was prepared as part of the 2014 update of the AWP (Project Task 6). This document provides background information about the North Arkansas Water Resources Planning Region (NAWRPR) that will be used in the 2014 AWP update. The NAWRPR is one of five state water resources planning regions being addressed in the 2014 AWP update. The information in this document will serve as background for updated discussion and analysis of state water supplies, water demand, and alternatives for meeting the water resources needs in the NAWRPR. This background information includes a description of the history of the planning region, its physical characteristics, natural resources, water resources, demographics, and economy. Finally, the regulatory and institutional framework for water resources management in this planning region is outlined.

2.0 GEOGRAPHY AND HISTORY

This section provides a general description of the geography of the NAWRPR, a brief history of the regional culture, and an overview of historical water resources management.

2.1 Geography

The NAWRPR encompasses approximately 12,400 square miles in northern Arkansas (Figure 2.1). This region is bounded on the west by Oklahoma and on the north by Missouri. The eastern boundary roughly follows the fall line, the division between the Coastal Plain and the Interior Highlands. The southern boundary roughly follows the hydrologic boundary of the White River Basin and the Little Red River watershed. In general, the planning region boundary follows county boundaries to facilitate the use of data (e.g., economic, census, and water use data) aggregated at the county level.

All or part of 19 counties are located within the planning region. Table 2.1 lists these counties, the area of each county that is in the planning region, and the corresponding percentage of the county in the planning region. Major cities in the planning region include Bentonville, Rogers, Springdale, and Fayetteville.

2.2 History

This section summarizes the history of the NAWRPR, including the culture of the region from several thousand years ago to present. The history of water resource development in the region is summarized separately.

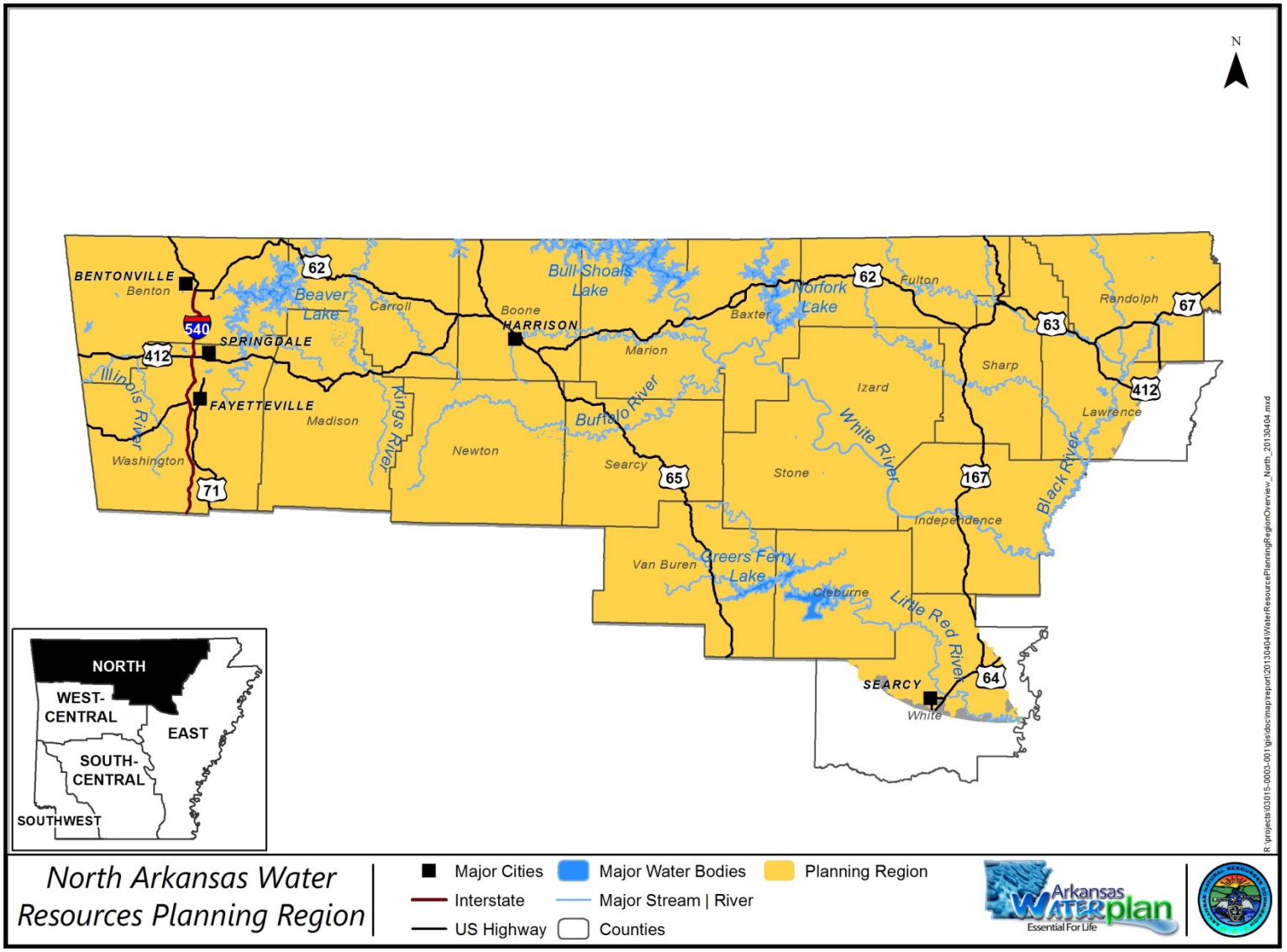

Figure 2.1. Map of the NAWRPR.

Table 2.1. Counties in the NAWRPR (US Census Bureau 2012a).

County	County Area in Planning Region (square miles)	Percentage of County Area in Planning Region
Independence	763.95	100%
Lawrence	375.10	64%
Randolph	652.19	100%
Sharp	604.44	100%
Washington	941.97	100%
Madison	834.26	100%
Newton	820.90	100%
Fulton	618.19	100%
Izard	580.58	100%
Stone	606.41	100%
Baxter	554.28	100%
Marion	597.01	100%
Boone	590.23	100%
Carroll	630.09	100%
Benton	847.36	100%
Cleburne	553.69	100%
Van Buren	708.14	100%
White	416.82	39%
Searcy	666.10	100%
Total	**12,361.71**	

2.2.1 Cultural

Archeological evidence indicates that humans inhabited bluff shelters in the NAWRPR as much as 13,500 years ago. Sometime around 6,000 BCE, native people began to mine and trade chert and other stones and minerals from the planning region. Around 2,500 years ago, people in the region began to practice agriculture, growing squash and gourds, as well as other native plants. It is believed that this is one of the first areas in the state where corn was grown. However, by the time Europeans came to Arkansas, it appears there were few Native American settlements in the region. The extreme eastern portion of the planning region was considered Quapaw territory, while the western portion of the planning region was claimed by the Osage as hunting grounds (Key 2012).

There was no significant European exploration or settlement of northern Arkansas until after the War of 1812. The first settlers in the region came from southwest Missouri, travelling

along the Southwest Trail. Batesville was one of the first settlements in the region, being strategically located on the White River along the Southwest Trail and other early roads (Bolton 2012, Lankford 2013). In 1817, all land in the planning region south of the White River was granted to the Cherokee. However, roughly ten years later, the Cherokee gave up claim to this land and moved to Oklahoma (Stewart-Abernathy 2011a). In 1819, the War Department cut a road along the White River from the Mississippi River to North Fork, then east to around current-day Rogers. The original purpose of this road was to facilitate movement of eastern Native American tribes to the West; however, it was also used by whites to settle the region (McLeod 1978, Berry 1977). This road is one of the Trail of Tears routes in the state (Arkansas Department of Parks and Tourism 2013a).

The survey of land in Arkansas began in 1815, and one of the original land sales offices in the state was located in Batesville in 1822. Shortly thereafter, a few additional land offices were established, one in Fayetteville. The influx of settlers from the eastern states increased dramatically in the 1830s. Around 1840, the majority of the white population in the state lived in the northern region. However, twenty years later, the agricultural productivity of the eastern and southern parts of the state had resulted in these areas becoming more populated than the northern areas of the state. Politics and culture in the northern region of the state tended to differ from that of the regions of plantation agriculture in the east and south. A significant number of residents in the northern region of the state opposed the secession of Arkansas from the union. (Bolton 2012, DeBlack 2012).

During the early years of the Civil War, a number of battles were fought in the northern region of the state (DeBlack 2012). Around 1868, a public university, forerunner of the University of Arkansas (U of A), was established in Fayetteville.

After Reconstruction, the railroad moved into the region. In 1881 a major railroad line was constructed in northwest Arkansas, spurring rapid economic growth in the region.

Overtime, Northwest Arkansas has become a major hub of the food and commercial industries, with large companies like Wal-Mart and Tyson calling it home. Also, immigration rates to the area are high, and the region is a popular vacation area in the state (Department of Arkansas Heritage 2013).

2.2.2 Water Resources Development

A range of water resources development activities have occurred in this region throughout its history, as attitudes and policies have changed. Historically, human activities that have affected water resources in this planning region have included river transportation and navigation, development of industries including tourism, fisheries, and hydroelectric power, and the development of manmade reservoirs along rivers in the region.

2.2.2.1 Navigation

During the early years of European settlement in Arkansas, rivers were important transportation corridors, because travel over land in this region was so difficult. In the 1820s, steamboats began traveling the White River. By the 1830s, steamboats were active also on the Black River. Steamboat travel also eventually occurred along the Buffalo River (Stewart-Abernathy 2011b). Keelboat travel was also popular along rivers in north Arkansas. Keelboat posts were established near Sylamore, which is near the Buffalo River, and in Marion County on the White River (Huddleston, Rose and Wood 1998). Steamboats were able to travel much of the White River, though some parts of the section north of the confluence with the Buffalo River was considered more challenging.

None of the rivers in north Arkansas are still used for commercial transportation. The lower White River still allows for navigation, but only from Newport (in Jackson County) to the Mississippi River (Arkansas Waterways Commission 2012).

Several ferrying locations also existed along the White River. Even portions of the White River in Northwest Arkansas had ferries, including near War Eagle Creek and Eureka Springs. Many other ferries existed along the White River in portion upstream of Jacksonport to the Missouri state line. Some of these ferries were in use as late as the 1970's.

2.2.2.2 Pearl Industry

Freshwater pearls found in both the White River and Black River set off a "pearl rush" in northeast Arkansas in the late 1880s (Shoults 2011). A pearl button factory was established in northeast Arkansas around 1900 to take advantage of the large freshwater mussel populations in

the White River and Black River. This was a thriving industry in the area until the late 1940s (Cavaneau 2012).

2.2.2.3 Aquatic Habitat Conservation

Just after the turn of the Twentieth Century, preservation of migratory waterfowl game birds became a national priority. The first wildlife management areas (WMAs) established by the Arkansas Game and Fish Commission (AGFC) in the NAWRPR during the 1950s were for the protection of habitat for migratory waterfowl (Table 2.2). The US Fish and Wildlife Service (USFWS) established a national wildlife refuge (NWR) in the planning region in 1993 to protect additional habitat for migratory waterfowl. A number of recent Farm Bill programs encouraged conservation and enhancement of waterfowl habitat in the region with economic incentives for activities such as setting up wetland conservation easements, and flooding fields in the winter. These programs are available in Independence, White, Randolph, and Lawrence Counties (NRCS 2010) (NRCS 2013a).

Table 2.2. History of aquatic habitat conservation in the NAWRPR.

Name	Type	Area (acres)	Counties	Year Established	Management	Purpose
Jones Point Wildlife Management Area	WMA	1,200	Marion	--	AGFC	--
Wedington Wildlife Management Area	WMA	16,000	Benton, Washington	--	USFS	Hunting, fishing
Beaver Lake	WMA	7,781	Benton, Carroll, Madison	--	USACE	Hunting, fishing
Shirey Bay-Rainey Brake Wildlife Management Area	WMA	10,711	Lawrence	1950s	AGFC	Waterfowl habitat, hunting
Dave Donaldson Black River Wildlife Management Area	WMA	25,000	Randolph	1957	AGFC	Preserve bottomland habitat
Henry Gray/Hurricane Lake Wildlife Management Area	WMA	17,000	White	1958	AGFC	Bottomland hardwood, waterfowl habitat
Gene Rush/Buffalo River Wildlife Management Area	WMA	17,652	Newton, Searcy	1966	AGFC	Wildlife habitat conservation

Table 2.2. History of aquatic habitat conservation in the NAWRPR (continued).

Name	Type	Area (acres)	Counties	Year Established	Management	Purpose
Piney Creeks Wildlife Management Area	WMA	176,000	Newton	1967	AGFC	Protect species, provide recreation
Greers Ferry Lake	WMA		Cleburne, Van Buren	1968	USACE	Fishery habitat
Sweden Creek Falls	WMA, natural area	136	Madison	1977	ANHC	Ecosystem preservation, rare plants
Big Creek	Natural area	1,508	Cleburne	1978	ANHC	Protect river habitat
Kings River Falls	Natural area	1,059	Madison	1979	ANHC	Kings River Falls access
Slippery Hollow	WMA, natural Area	1,155	Marion	1985	ANHC	Ecosystem preservation
Cave Springs Cave	Natural area	57	Benton	1985	ANHC	Ozark cavefish habitat
Hell Creek	Natural area	211	Stone	1985	ANHC	Protect cave habitat, endangered cave species
Logan Cave National Wildlife Refuge	NWR	123	Benton	1989	USFWS	Refuge of endangered species
Rock Creek	Natural area	415	Sharp	1991	ANHC, AGFC	Protect rare plant habitat
Cow Shoals Riverfront Forest	Natural area	63	Cleburne	1992	ANHC, AGFC	Protect riverfront forest
Bald Knob National Wildlife Refuge	NWR	14,800	White	1993	USFWS	Protect, provide feeding/resting area for migratory waterfowl
Pine Hollow	Natural area	132	Newton	1998	ANHC	Protect Buffalo River water quality
Foushee Cave	WMA, natural area	2,725	Independence	2011	ANHC	Protect cave habitat and species
Devil's Eyebrow	Natural area	1,726	Benton	2012	AGFC, ANHC	Rare plant habitat

In 1972, the Buffalo River was designated as the first National River in the country. The Flood Control Act of 1938 authorized damming of the Buffalo River for hydropower. In the 1960's opposition to damming one of the few unpolluted free-flowing rivers in the lower 48 states became well organized. In 1966, after Arkansas Governor Faubus denied support for damming the Buffalo River, the USACE withdrew the plans for developing hydropower on the river. Legislation to establish the Buffalo River National Park was first introduced to the US Congress in 1967. The legislation naming the Buffalo River as a National River was passed in 1972 (Rogers 2010).

Late in the 20th Century, preservation of cave habitats and associated rare and endangered species became a priority at the state and national level. The Arkansas Natural Heritage Commission (ANHC) established several natural areas centered around caves where endangered cave species were present. The US Fish and Wildlife Service (USFWS) established a National Wildlife Refuge (NWR) to protect the Logan Cave ecosystem in 1989 (Table 2.2).

In 1968, the US Congress created the National Wild and Scenic Rivers System to preserve free-flowing rivers with outstanding recreational, cultural, and/or natural features. In 1979, the Arkansas legislature created the Arkansas Natural and Scenic Rivers System to protect selected rivers from damming and channel alterations (ANHC 2012). In 1992, portions of three rivers in the NAWRPR were added to the National Wild and Scenic Rivers System (Table 2.3). A section of the Strawberry River was listed in the Arkansas Natural and Scenic Rivers System in 1985 (Arkansas Code 15-23-313).

Table 2.3. History of wild/natural and scenic rivers in the NAWRPR (ANHC 2012, Interagency Wild and Scenic Rivers Council n.d.).

River	System	Length (miles)	County	Year designated	Agency
Strawberry River	State	43	Fulton, Izard	1985	ANHC
Buffalo River	National	15.8	Newton	1992	USFS
North Sylamore Creek	National	14.5	Stone	1992	USFS
Richland Creek	National	16.5	Searcy	1992	USFS

2.2.2.4 Aquaculture

There are three National Fish Hatcheries (NFH) located in the NAWRPR. The Norfork NFH is home to cold water production of trout that are used to restock the tailwaters downstream of dams, including Norfork and Bull Shoals (USFWS 2010a). Mammoth Spring NFH is one of the oldest fish hatcheries in the country and is the location of interjurisdictional fish restoration, endangered and threatened species recovery, restoration of fish in the White River Watershed, and production of recreational fish for NWRs (USFWS 2010b). The Greers Ferry NFH provides trout for streams in both Arkansas and Oklahoma. It also participates in research on threatened and endangered aquatic species (USFWS 2013).

2.2.2.5 Flood Control

In 1938, US Congress enacted the Flood Control Act, and the White River basin was chosen as one of the candidates for flood control. Several reservoirs have been created in the White River Basin. Beaver Lake in Benton and Carroll Counties is the most upstream reservoir, stretching from near Fayetteville to Eureka Springs, Arkansas. Other reservoirs along the White River are Lake Taneycomo in Missouri and Table Rock Lake and Bull Shoals Lake in both Arkansas and Missouri. In 2004, the USACE estimated that lakes along the White River helped to prevent over $67 million in flood loss (Branyan 2013).

Flood control reservoirs have also been constructed on White River tributaries in the NAWRPR. Greers Ferry Lake on the Little Red River, and Norfork Lake on North Fork River, were also constructed to provide flood control. Norfork Dam was built in the 1940s. Greers Ferry Dam was completed in 1962.

2.2.2.6 Hydropower

Arkansas has the potential to produce a significant amount of its electrical energy from hydroelectricity, however only 3% of the electricity produced in 2006 was from hydroelectric sources. In the NAWRPR the four USACE reservoirs constructed on the White River and its tributaries for flood control are also authorized for hydropower (Table 2.4). Three hydropower

dams were constructed on the White River in the 21st century (Table 2.4). These new dams were built at the locations of abandoned locks upstream of Newport.

Table 2.4. Hydroelectric plants in the NAWRPR (Reynolds, Hydroelectricity 2012).

Plant	County	River	Year Completed	Agency
Norfork	Baxter	North Fork	1944	USACE
Bull Shoals	Marion/Baxter	White	1952	USACE
Greers Ferry	Cleburne	Little Red	1964	USACE
Beaver	Carroll	White	1965	USACE
Marcella	Stone	White	2006	IC
Earnhardt	Independence	White	2007	IC
Batesville	Independence	White	2007	IC

USACE United States Army Corps of Engineers
IC Independence County

2.2.2.7 Arkansas River Basin Compact

In 1955, the US Congress authorized Oklahoma and Arkansas to begin negotiating a compact to resolve disputes over rights to water in the Arkansas River and its tributaries. In 1970, after 15 years of negotiations, the states of Arkansas and Oklahoma signed an agreement concerning water apportionment in the Arkansas River Basin along the Arkansas-Oklahoma border. Two subbasins in the NAWRPR, the Spavinaw Creek Watershed and Illinois River Watershed, are discussed as part of the compact. The two states are in agreement that Arkansas has the rights to water in both subbasins within the state's borders, with the limitation that annual yield does not deplete more than 50% in the Spavinaw Creek Watershed and 60% in the Illinois River Watershed (Arkansas River Compact Committee 1970). This compact is described in greater detail in Section 6.1.7.

3.0 PHYSICAL CHARACTERISTICS

This section summarizes the physical and biological characteristics of the North Arkansas Water Resources Planning Region. This includes the physiographic, geology, climate, and land use, as well as descriptions of the ecological, surface water, and groundwater resources within the planning region.

3.1 Physiography

The NAWRPR is located primarily in the Interior Highlands physiographic region. A small area of this planning region is located in the Gulf Coastal Plain (Figure 3.1). Physiographic provinces of the Interior Highlands that are present in the planning region are the Ozark Plateaus and Ouachita Mountains. The physiographic province of the Gulf Coastal Plain present in the planning region is the Mississippi Alluvial Plain. Because the Ouachita Mountain and Mississippi Alluvial Plain provinces comprise such small areas of the planning region, they will not be described in this document. Descriptions of the Ouachita Mountain and Mississippi Alluvial Plain provinces can be found in the background reports for other planning regions.

The Ozark Plateaus physiographic province is divided into three physiographic subdivisions that are defined by stratigraphic interval and geologic age. From north to south, these subdivisions are the Salem Plateau, Springfield Plateau, and the Boston Mountains (Adamski, Petersen, et al. 1995).

The Salem Plateau is mainly north and east of the White River in Arkansas (Figure 3.1). Elevations are generally 500 to 1,000 feet above sea level. Streams are gradually dissecting the broad uplands and the area is undulating to hilly, with relief seldom exceeding 200 feet.

The Springfield Plateau is found in northwestern Arkansas and in a narrow belt eastward (Figure 3.1). Elevations generally are from 1,000 to 1,500 feet. Extensive relatively level areas exist in Washington and Benton counties but relief of 200 to 300 feet occurs along major streams. Outliers of the Boston Mountains appear as isolated low mountains on the Plateau, the most notable being the Boat Mountain group near Harrison.

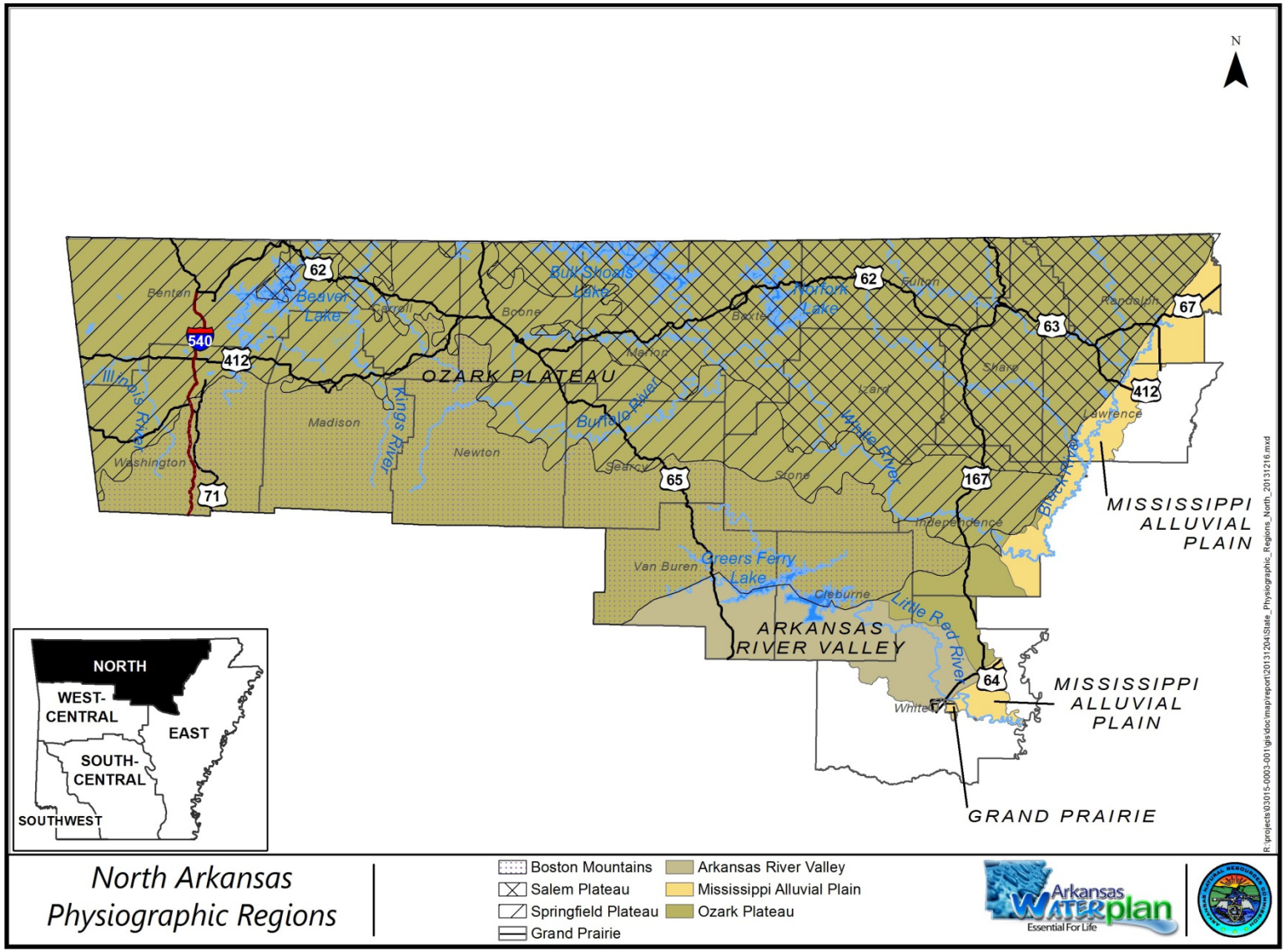

Figure 3.1. Physiographic regions of the NAWRPR.

The Boston Mountains physiographic subdivision consists of the higher southern edge of the Ozark Plateau province, and makes up most of the southern boundary of the planning region (Figure 3.1). These mountains are primarily flat-topped, with the summit ridges representing the original erosion surface of the plateau. Great stream dissection has occurred, creating steep sided mountains and deep narrow valleys. Elevations generally range between 1,500 and 2,200 feet but exceed 2,500 feet. Relief is mainly within the 500 to 1,000 feet range but exceeds 1,600 feet. The northern boundary is well marked by a retreating escarpment in most areas, being especially prominent in its central extent from Jasper to Mountain View.

3.2 Geologic Setting

Geologic formations underlying the NAWRPR range in stratigraphic order from the earliest deposited layers of the Ordovician Period in the Ozark Plateaus Province to Quaternary Alluvium in the Mississippi Alluvial Plain Province. Figure 3.2 displays the surface geology of the planning region. The geology of the Ozark Plateaus and Ouachita Mountain provinces are described below. The geology of the Mississippi Alluvial Plain province is described in the background report for the East Water Resources Planning Region.

Generally, the hydrogeology of the Interior Highlands can be described as an area of consolidated formations which yield relatively low volumes of water to wells. The low specific capacity in these wells is a direct result of the lithological nature of the strata itself. The consolidated formations typically are confined with most of the water yielded to wells coming through secondary porosity found in fractures and bedding plains. Typically, the most noted aquifer within NAWRPR is the deep Ozark aquifer. Groundwater resources of the NAWRPR are further described in Section 3.8

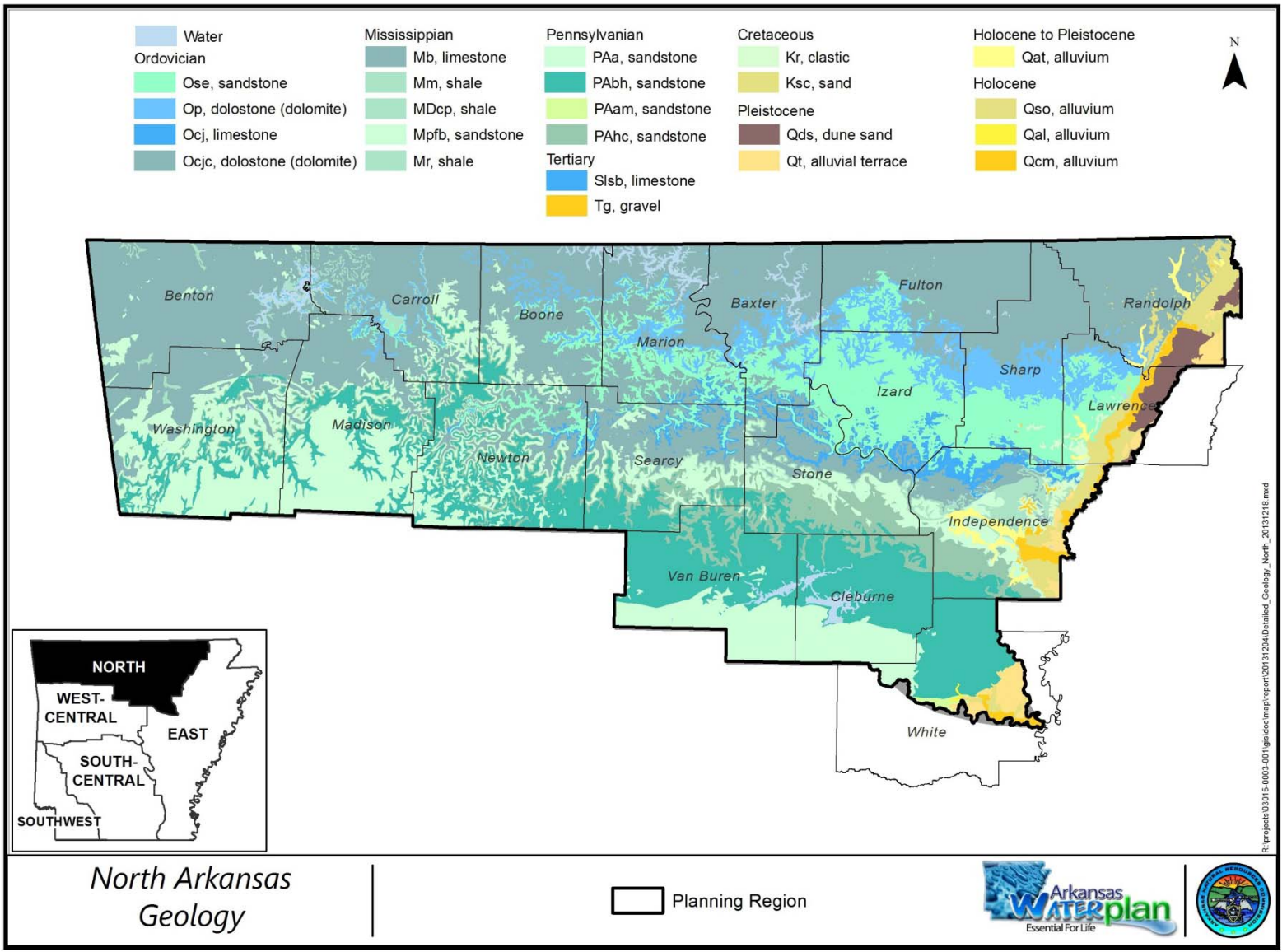

Figure 3.2. Detailed surface geology of the NAWRPR.

3.2.1 Geology of the Ozark Plateaus Province

The Ozark Plateaus are underlain by a structural dome formed by a series of uplifts that occurred between 1 billion and 280 million years ago (Precambrian through Permian). Most of the uplift is believed to have occurred between 325 and 280 million years ago (Carboniferous through Permian) when a continent-to-continent collision occurred along the southern border of North America, known as the Ouachita orogeny (Rogers 1987). The uplift of the Ozark Plateaus caused extensive faulting, joints, and fractures to occur. Major faults are oriented northwest and downthrown to the south. Gentle folding of very low amplitude is occasionally observed (McFarland 2004). The Ozark Plateaus represent a depositional environment of a relatively shallow continental shelf, sloping toward deeper water generally to the south.

The surface rocks of the Salem Plateau are the oldest of the Ozark Mountains, younger ones having been removed by erosion. They are predominantly dolomite and limestone of Ordovician age with some sandstone and shale (Figure 3.2). The Cotter dolomite of Lower Ordovician age, a massive formation 500 feet thick, covers most of the eastern and northern portions of this region. The Everton Limestone is the prominent formation in the western and southern areas. The Calico Rock Sandstone, a white colored sand, is at the base of the Everton. Dolomite and silica-rich sand are quarried. The former zinc-producing area of Arkansas is centered in the Ordovician rocks of Marion County but zinc was mined in numerous other areas where the same strata were exposed by stream cutting. Some lead is associated with the zinc deposits.

The Springfield Plateau is the surface feature of northwestern and north-central Arkansas and is generally underlain by limestones and cherty limestones of Mississippian age. It is commonly recognized at land surface as the Boone Formation, consisting of limestone and chert. Weathering more easily reduces the limestone, leaving large pieces of chert which are especially prominent on hillsides where the finer materials have been eroded away. The limestone is quarried in many localities. The St. Joe marble member is at the base of the Boone and is locally quarried for commercial purposes. The St. Joe Member is also the source rock for the majority of springs flowing in the Springfield Plateau. Outliers of the Boston Mountains are especially

common in the western part of the Springfield Plateau. They consist largely of sandstone and shale found in the Boston Mountains but lack the Atoka formation which caps the mountains.

The Boston Mountains are surfaced primarily in sandstone and shale of Pennsylvanian age. The massive Atoka Formation, over 1,500 feet thick, is the most prominent. The Atoka sandstone forms the bluffs at the top of the Boston Mountains.

The highly soluble nature of carbonate rocks (limestone and dolostone) along fractures and faults in the Springfield and Salem Plateaus has formed a unique karst terrain. Karst features include cave networks; dissolutionally enhanced fractures, faults, and bedding planes; sinkholes, losing stream segments, and cutters and pinnacles (Brahana 1997). Karst features do not exhibit a surface expression in many areas of the Springfield Plateau because cher t and clay tend to form a regolith cover which mantles the upper surface and masks the underlying karst features. Surface-karst features are generally only visible when carbonate rocks are within the zone of shallow groundwater circulation (less than 30 feet below land surface) (Fanning 1994). While a regolith still mantels underlying karstic bedrock in the Salem Plateau, karst features of the Salem Plateau are typically more abundant, are more concentrated, and are larger in size than karst features of the Springfield Plateau (Adamski, Petersen, et al. 1995).

3.2.2 Geology of the Arkansas River Valley

The subdivision of the Ouachita Mountain province that underlies the NAWRPR is southern Van Buren and Cleburne Counties, and White County, is the Arkansas River Valley, also known geologically as the Arkoma Basin. The central and eastern portions of the valley are dominated by the alternating sandstone and shale of the Hartshorne and Atoka Formation. There are numerous natural gas fields in this region, producing a dry gas.

The Arkoma Basin is a structural low trending east-west across central Arkansas that was created by compression from the Ouachita orogeny (Adamski, Petersen, et al. 1995). This province is dominated by Pennsylvanian age sandstone, siltstone, and shale that were originally sediments deposited on the margin of a continental shelf primarily by deltas and subsequently reworked by marginal marine processes (McFarland 2004). The sedimentary section in the Arkoma Basin is reported to range in thickness from 3,000 to 35,000 feet (Manger and Lloyd 2008). The structural geology of the area consists of relatively broad synclinal folds with

relatively narrow intervening anticlinal folds that trend east-west (McFarland 2004). In vicinity of the planning region, the structural geology is characterized by normal (growth) faulting and gentle folds (Hutto and Rains 2011).

3.3 Ecoregions

Ecoregions denote areas within which ecosystems, and the type, quality, and quantity of environmental resources, are generally similar (EPA 2010). The US Environmental Protection Agency (EPA) has defined 10 ecoregions within the NAWRPR (Figure 3.3). Seven of the ecoregions are in the Ozark Plateaus, and three are in the Mississippi Alluvial Plain. One of the ecoregions is associated with the Arkansas River Valley. Characteristics of all of the ecoregions in the NAWRPR are summarized in Table 3.1.

The ecoregion that developed on the Boston Mountains Plateau is considered distinct from the ecoregion that developed in the Springfield and Salem Plateaus. The Boston Mountains ecoregion is a mosaic of woodland, forest, and savanna. Oak-hickory-pine forest is the dominant natural vegetation. Higher moisture levels and cooler temperatures on north-facing slopes and in valleys support oak-hickory forest communities. Pines occur on drier west and south facing slopes over sandstone. Fish communities in Boston Mountain streams tend to be diverse and dominated by sensitive species (Woods, et al. 2004). The Boston Mountains contain habitat for a number of cave species (Anderson 2006).

The Ozark Highlands ecoregion of the Springfield and Salem Plateaus is characterized by being rich in karst features, including caves, sinkholes, and underground streams. Soils here are generally cherty. Habitat diversity and species richness are high in this ecoregion. Natural vegetation is primarily oak-hickory forest. Pines tend to grow here on steep, cherty escarpments, and on shallow soils derived from sandstone. Glades dominated by grass and cedar occur on shallow soils over dolomite. Streams in this ecoregion tend to have gravelly bottom material and are often spring-fed. Fish communities are characteristically dominated by sensitive species (Anderson 2006, Woods, et al. 2004).

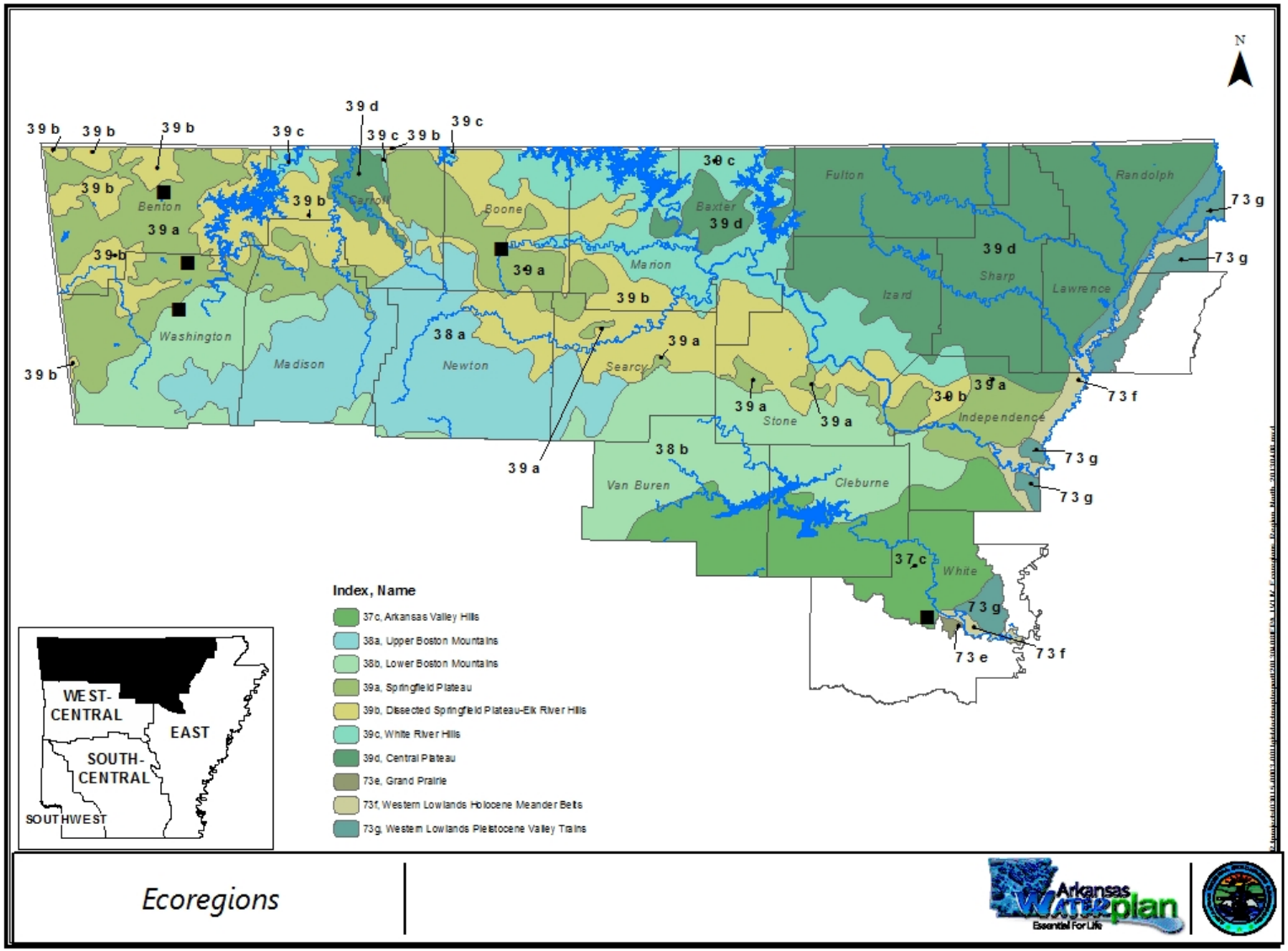

Figure 3.3. Level IV ecoregions of the NAWRPR (Woods, et al. 2004)

Table 3.1. Ecoregions in the NAWRPR (Woods, et al. 2004).

Level III Ecoregion	Level IV Ecoregion	Native Vegetation	Hydrology
Arkansas Valley	Arkansas Valley Hills	Oak-hickory forest and oak-hickory-pine	Low gradient streams
Boston Mountains	Upper Boston Mountains	Oak-hickory forest	Small streams intermittent in summer
Boston Mountains	Lower Boston Mountains	Oak-hickory-pine and oak-hickory forests	Small streams intermittent in summer
Ozark Highlands	Springfield Plateau	Oak-hickory-pine and oak-hickory forests	Perennial, spring-fed streams
Ozark Highlands	Dissected Springfield Plateau – Elk River Hills	Oak-hickory-pine and oak-hickory forests	Perennial, spring-fed streams
Ozark Highlands	White River Hills	Oak-hickory-pine and oak-hickory forests; cedar glades	Perennial, spring-fed streams and some dry valleys
Ozark Highlands	Central Plateau	Oak-hickory-pine and oak-hickory forests; barrens; cedar glades	Hilly; some karst features
Mississippi Alluvial Plain	Grand Prairie	Tall grass prairie, oak-hickory open woodland and savannah	Low gradient streams
Mississippi Alluvial Plain	Western Lowlands Holocene Meander Belts	Bottomland hardwood forest and woodland of primarily oaks	Runoff from Ozark Highlands and Boston Mountains feeds most streams, former and current river channels of White, Black, Cache Rivers, low gradient streams
Mississippi Alluvial Plain	Western Lowlands Pleistocene Valley Trains	Post oak, loblolly pine; sandpond forests primarily oak	Braided streams; little flooding in uplands

The Arkansas Valley ecoregion includes floodplains, terraces, and hills. Within the NAWRPR, oak-hickory forest and oak-hickory-pine forest are the most common forest communities in this ecoregion, within the Planning Region. Stream fish communities typically include a number of sensitive species (Woods, et al. 2004).

The ecoregion of the Mississippi Alluvial Plain, within the Planning Region, is characterized by floodplain features, including natural levees, terraces, swales, and abandoned stream channels; and poorly drained soils (Anderson 2006, Woods, et al. 2004). Soils here are sandy loam, silty loam, or clay (ASWCC 1987). Natural vegetation and habitats include southern bottomland forest and wetlands. Streams here have very low gradients and fine-grained bottom material, and they are frequently channelized or otherwise altered. Fish communities are dominated by tolerant species, with few, if any, sensitive species (Anderson 2006, Woods, et al. 2004).

3.4 Aquatic Biodiversity

The upper White River watershed in the NAWRPR includes streams with the best water quality and highest productivity in the state. Fish communities in these streams are often dominated by sensitive species. This planning region has the highest number of aquatic animal species of greatest conservation need in the state; 144 out of the 268 identified (Anderson 2006). Figure 3.4 provides a summary of the aquatic and semi-aquatic species of greatest conservation need found in the planning region. Of the over 180 aquatic and semi-aquatic plant species tracked by ANHC, over 70 occur in the NAWRPR (ANHC 2013). Of the 42 Arkansas endemic aquatic species (found nowhere else in the world), 15 occur in the planning region (Figure 3.5) (Anderson 2006). Approximately 443 miles of streams and over 20 springs and caves in the planning region have been designated by the Arkansas Department of Environmental Quality (ADEQ) as Ecologically Sensitive Waterbodies because they provide habitat for endemic, threatened, or endangered species (Figure 3.6) (APCEC 2011). Additional information on threatened and endangered species in the planning region is provided in Section 5.3.7.

3.5 Climate

The NAWRPR lies in a semi-humid region characterized by long summers, relatively short winters, and a wide range of temperatures. Temperature, precipitation, and evaporation data for the planning region were obtained from the National Weather Service, Oceanic and Atmospheric Administration National Climatic Data Center (NOAA NCDC) and the Prism Climate Group and reviewed. These data are available for each of the climate divisions in Arkansas (Figure 3.7). Data for climate divisions 1 and 2 were used to characterize climate in the NAWRPR. Summaries of these data are presented below, along with discussions of factors that influence climate in the NAWRPR and long-term climate trends in the region.

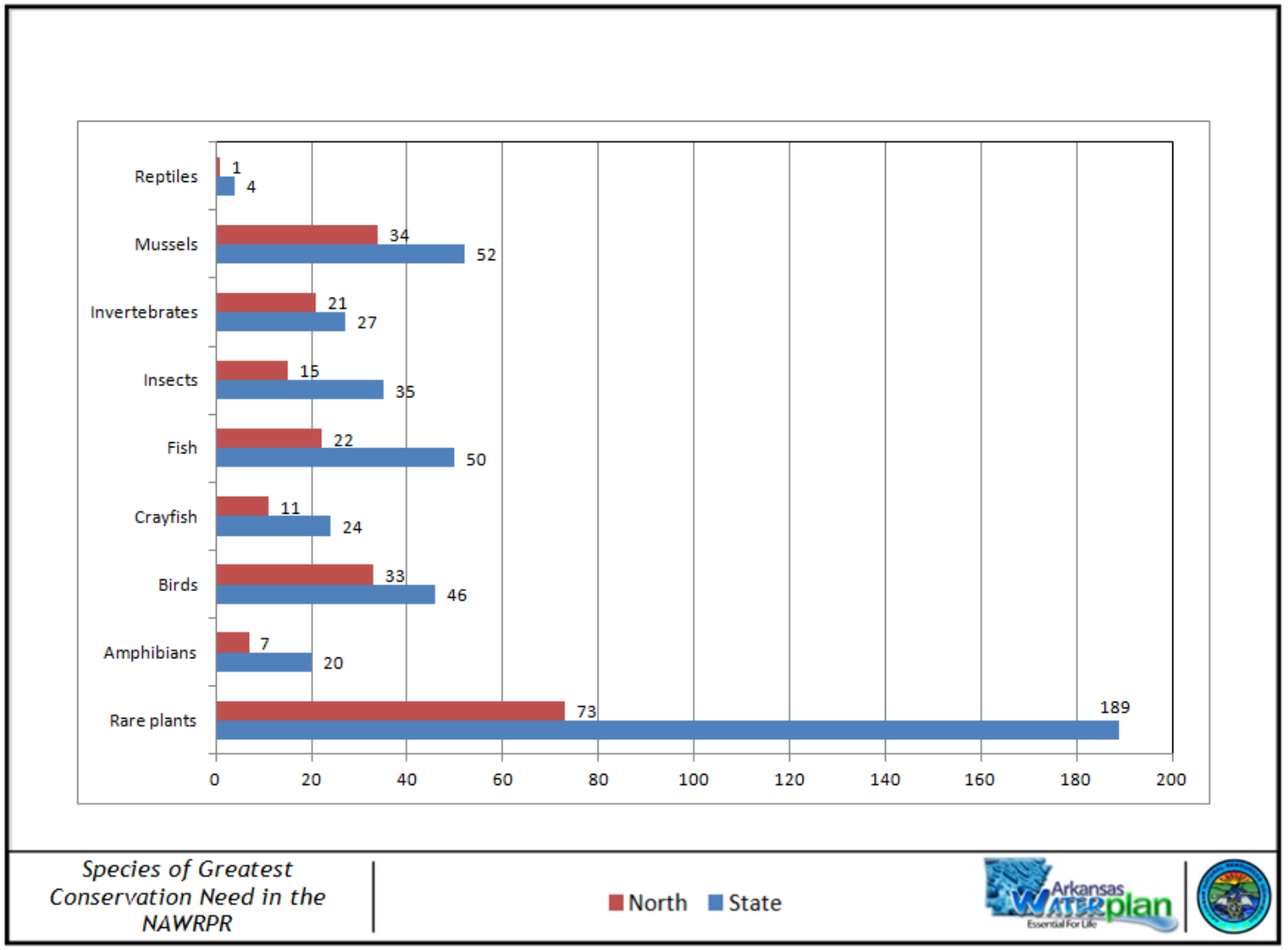

Figure 3.4. Species of greatest conservation need found in the NAWRPR (Anderson 2006, ANHC 2013).

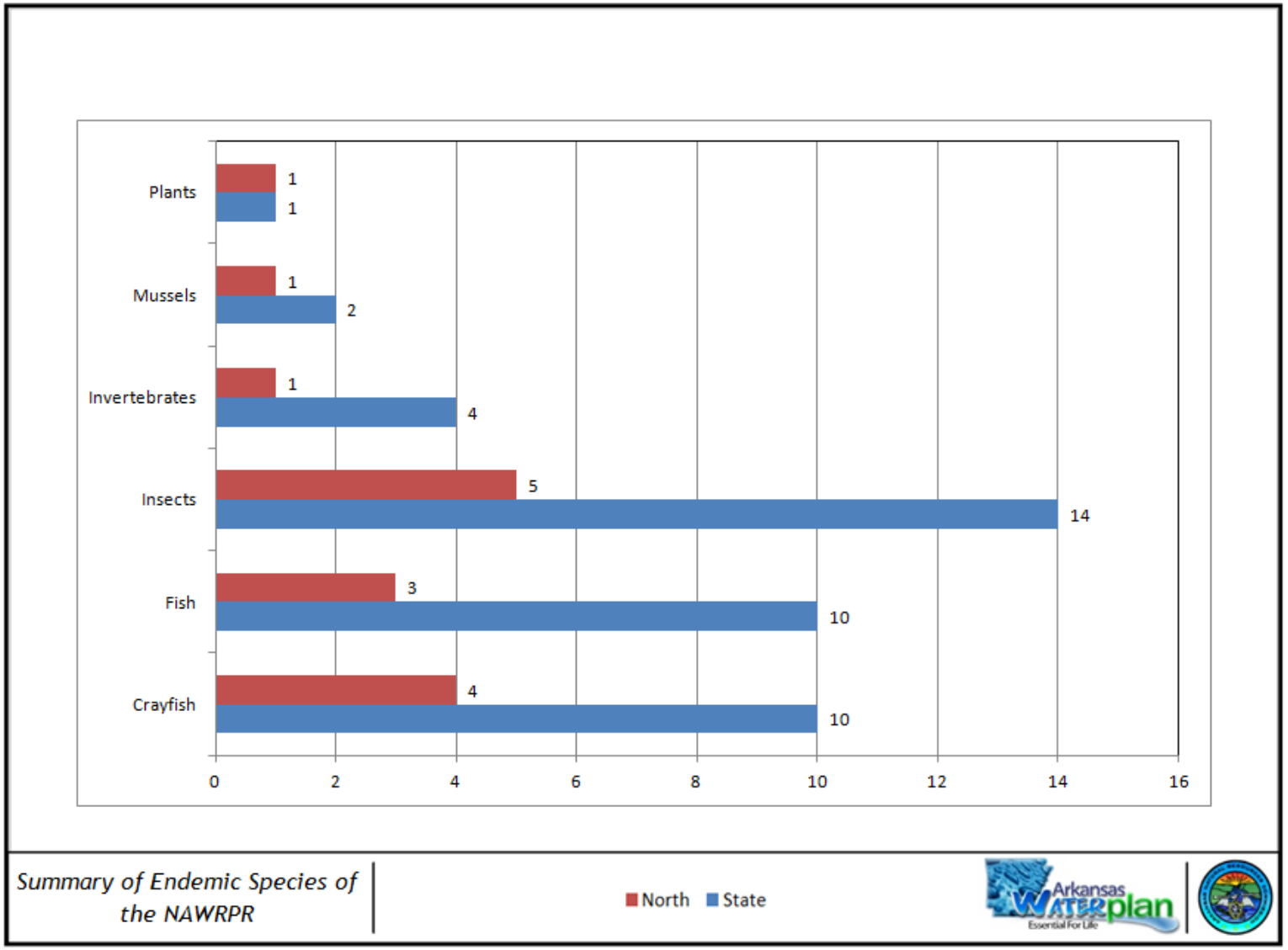

Figure 3.5. Summary of endemic species of the NAWRPR.

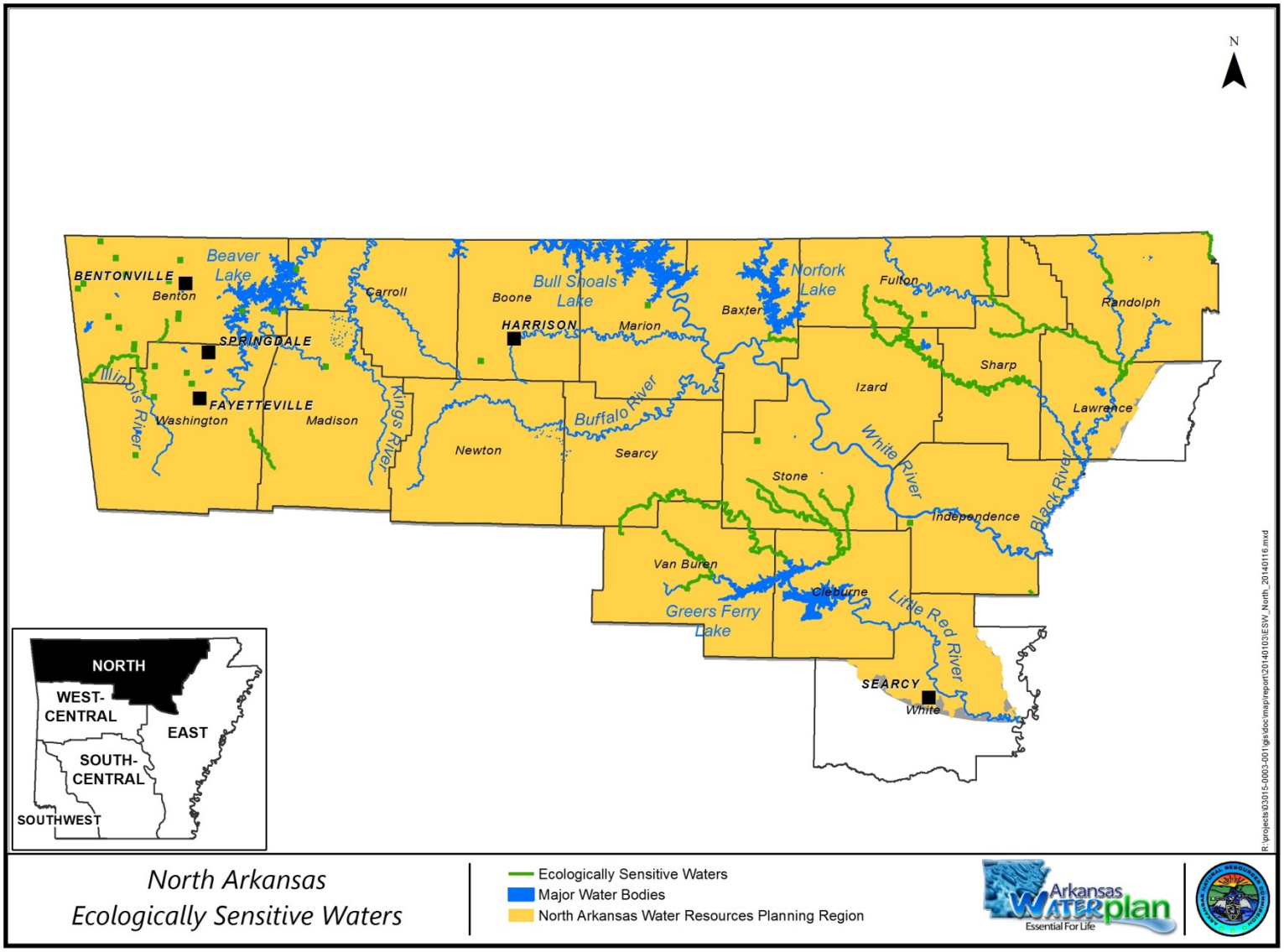

Figure 3.6. Ecologically sensitive waterbodies in the NAWRPR (APCEC 2011).

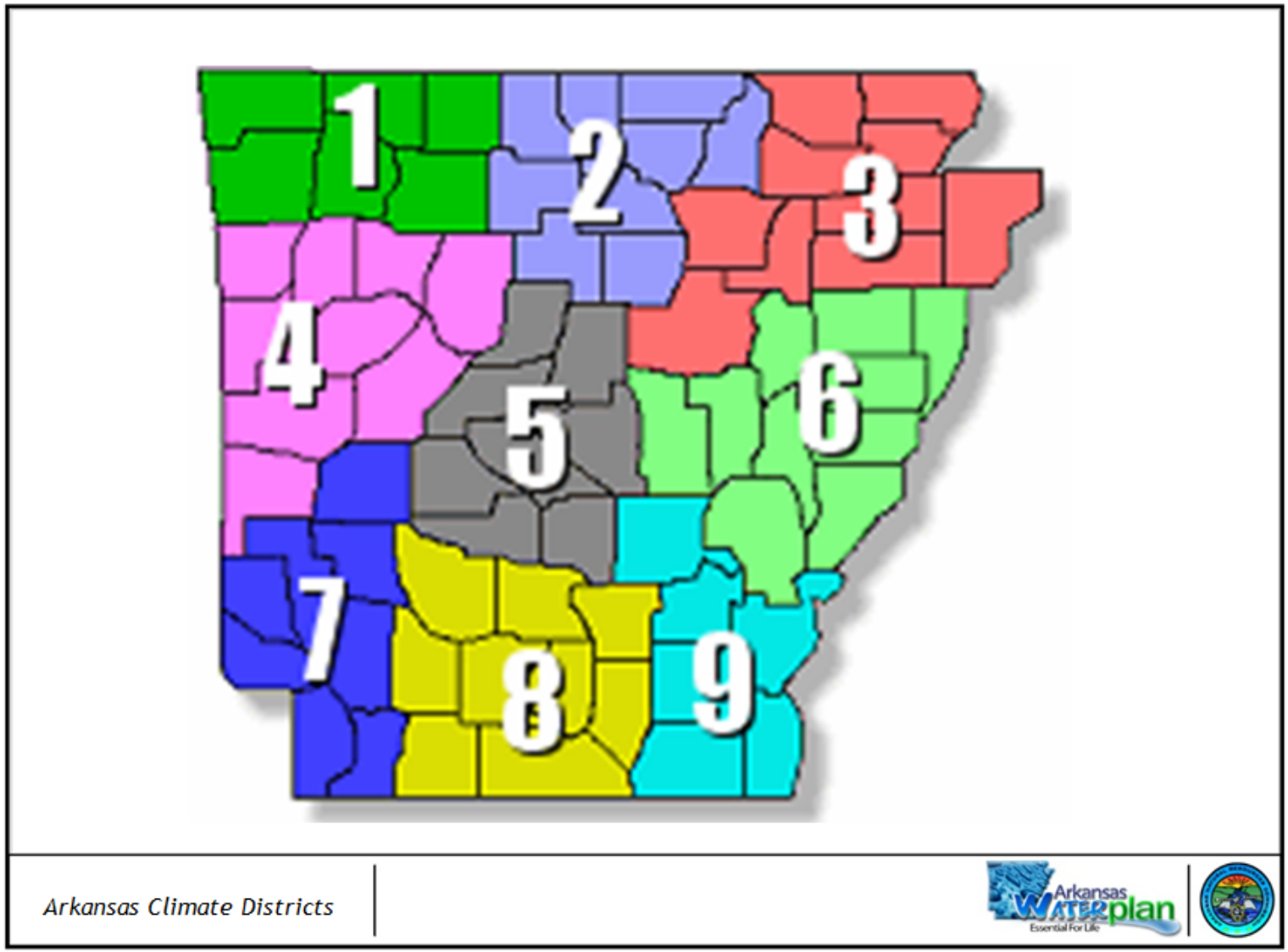

Figure 3.7. Arkansas climate divisions (NOAA NWS 2013).

3.5.1 Temperature

The average annual temperature in the NAWRPR is approximately 58°F (NOAA NCDC 2013a). Extremes in air temperatures may vary from winter lows around 0°F, usually caused by Canadian air masses, to summer highs above 100°F. Extreme temperatures may occur for short periods of time at any location within the study area (ASWCC 1987). The growing season averages around 200 days per year in the uplands, and around 220 days per year in the Mississippi River Alluvial Plain (Woods, et al. 2004). Average monthly temperatures over the period from 1981 through 2010 are shown in Figure 3.8. Variations in annual maximum daily temperatures across the planning region are shown in Figure 3.9.

3.5.2 Precipitation

According to the NOAA NCDC, the average annual precipitation for both Climate Divisions I and II was approximately 46 inches for the years 1985-2012 (NOAA NCDC 2013a).

The NAWRPR does experience snowfall as well as rainfall. Average snowfall amounts for the years 1981-2010 ranged from 1.6 inches per year in Black Rock, Arkansas, to 13.8 inches per year in Gravette, Arkansas (Golden Gate Weather Services 2011).

Average monthly precipitation over the period from 1981 through 2010 is shown in Figure 3.10. Variations in average annual precipitation across the region are displayed in Figure 3.11.

3.5.1 Evaporation

Evaporation is the process by which water changes from liquid to gaseous water vapor. When the conversion from liquid to water vapor occurs on leaves, the process is called transpiration. Evapotranspiration is the combination of these processes. The amount of evapotranspiration is controlled primarily by sunlight, but is influenced by humidity and wind (Scott, et al. 1998).

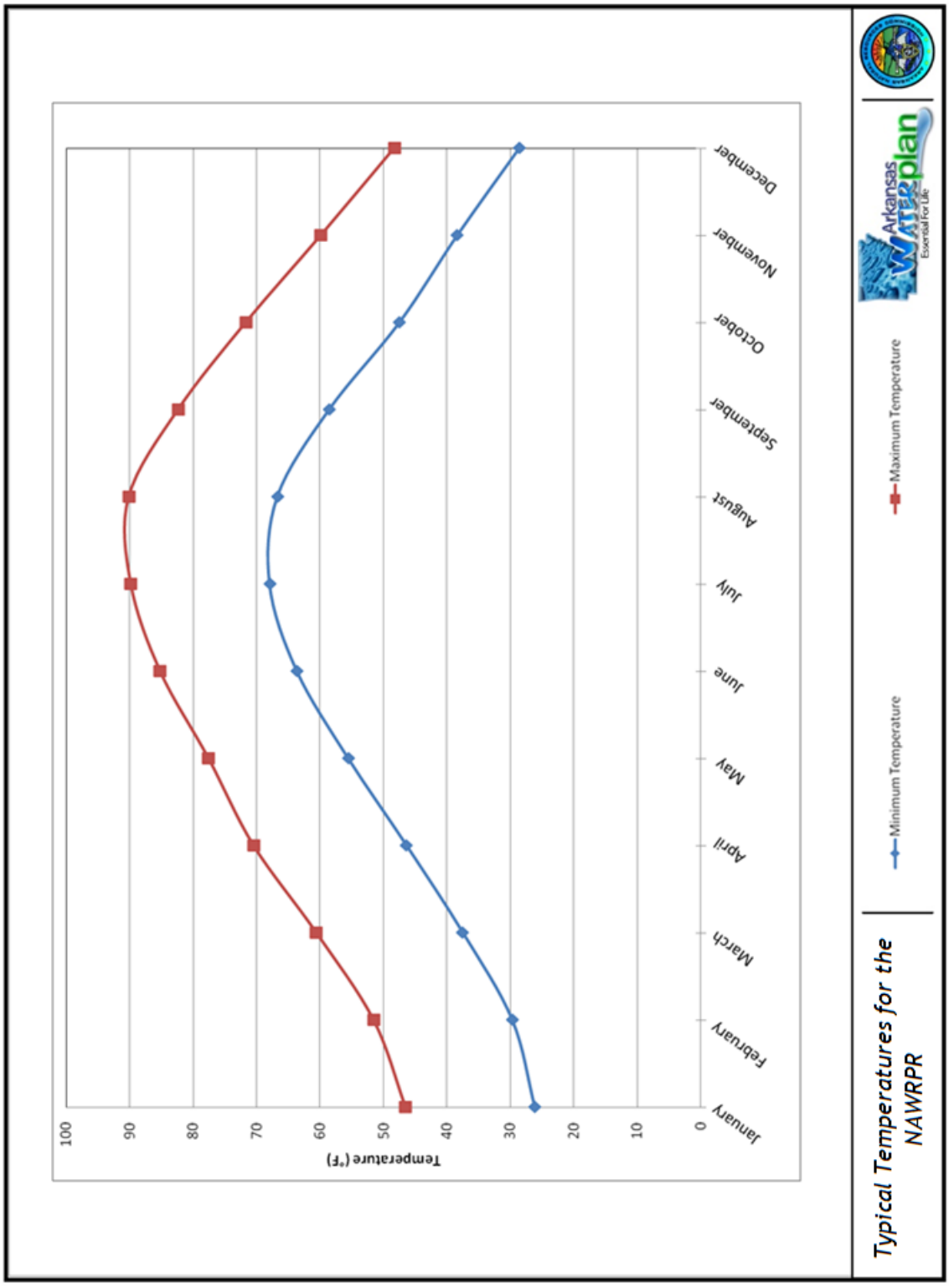

Figure 3.8. Typical temperatures for the NAWRPR (PRISM Climate Group 2012).

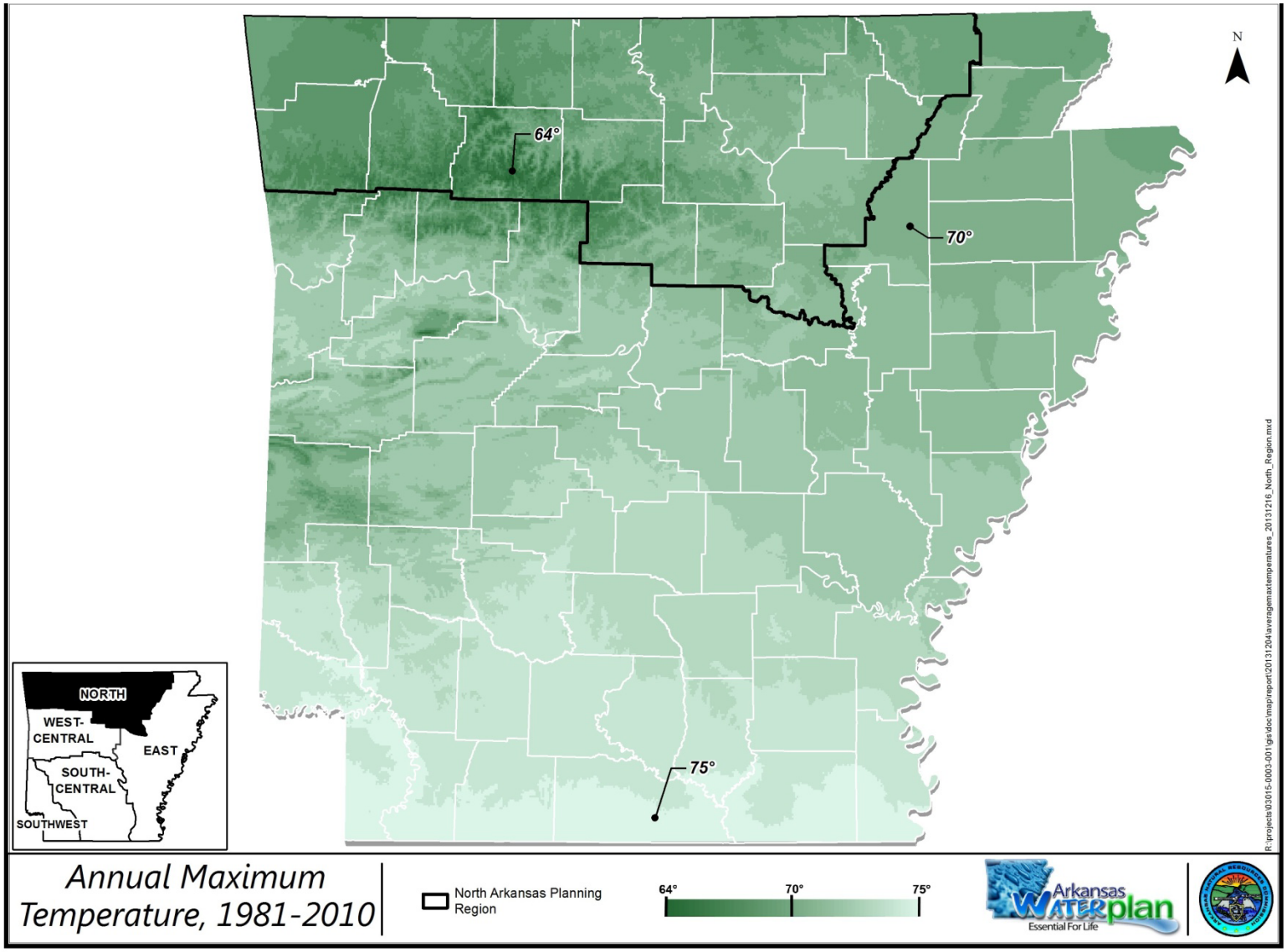

Figure 3.9. Annual maximum daily temperatures in the NAWRPR.

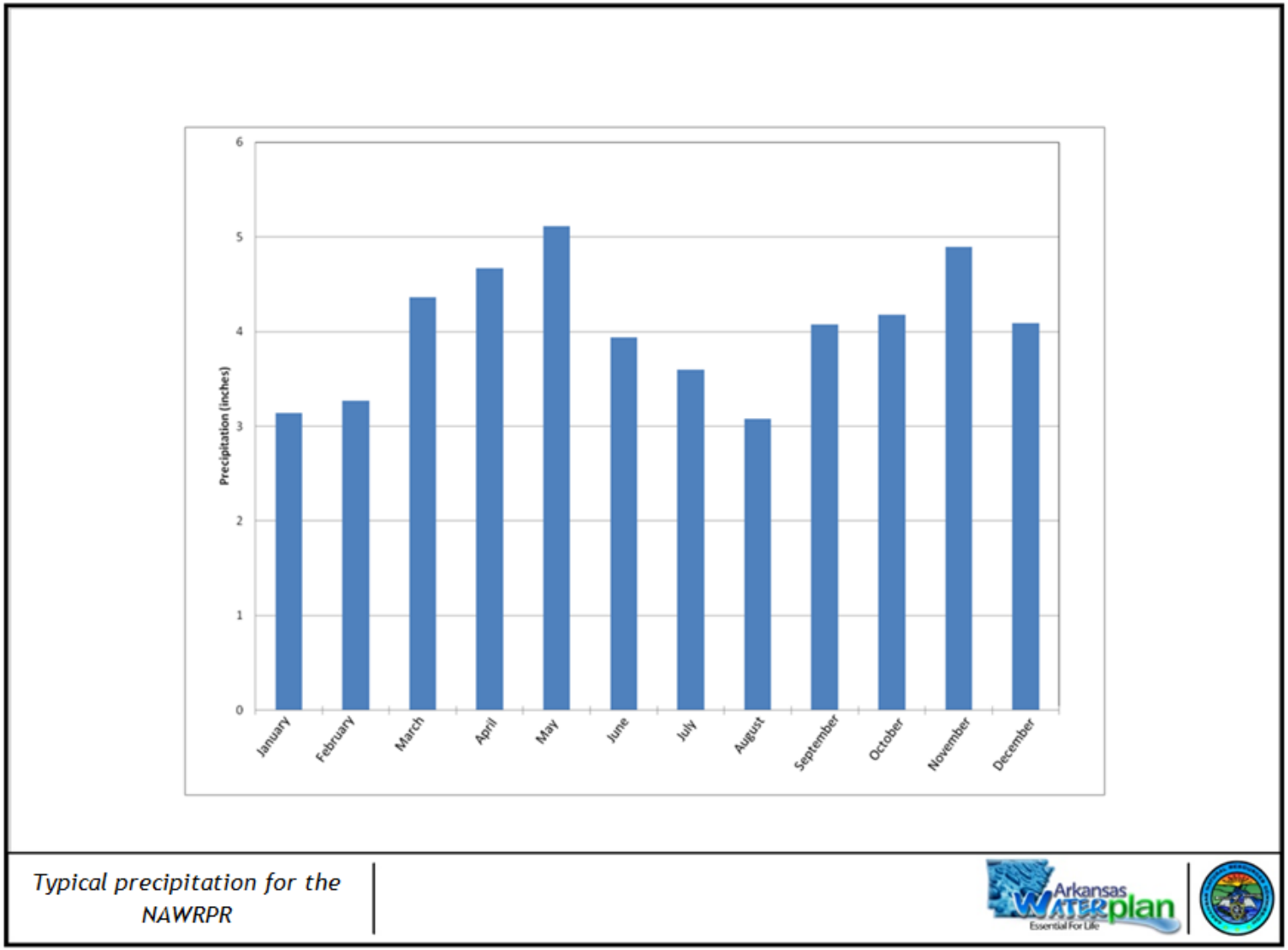

Figure 3.10. Typical precipitation for the NAWRPR (PRISM Climate Group 2012)

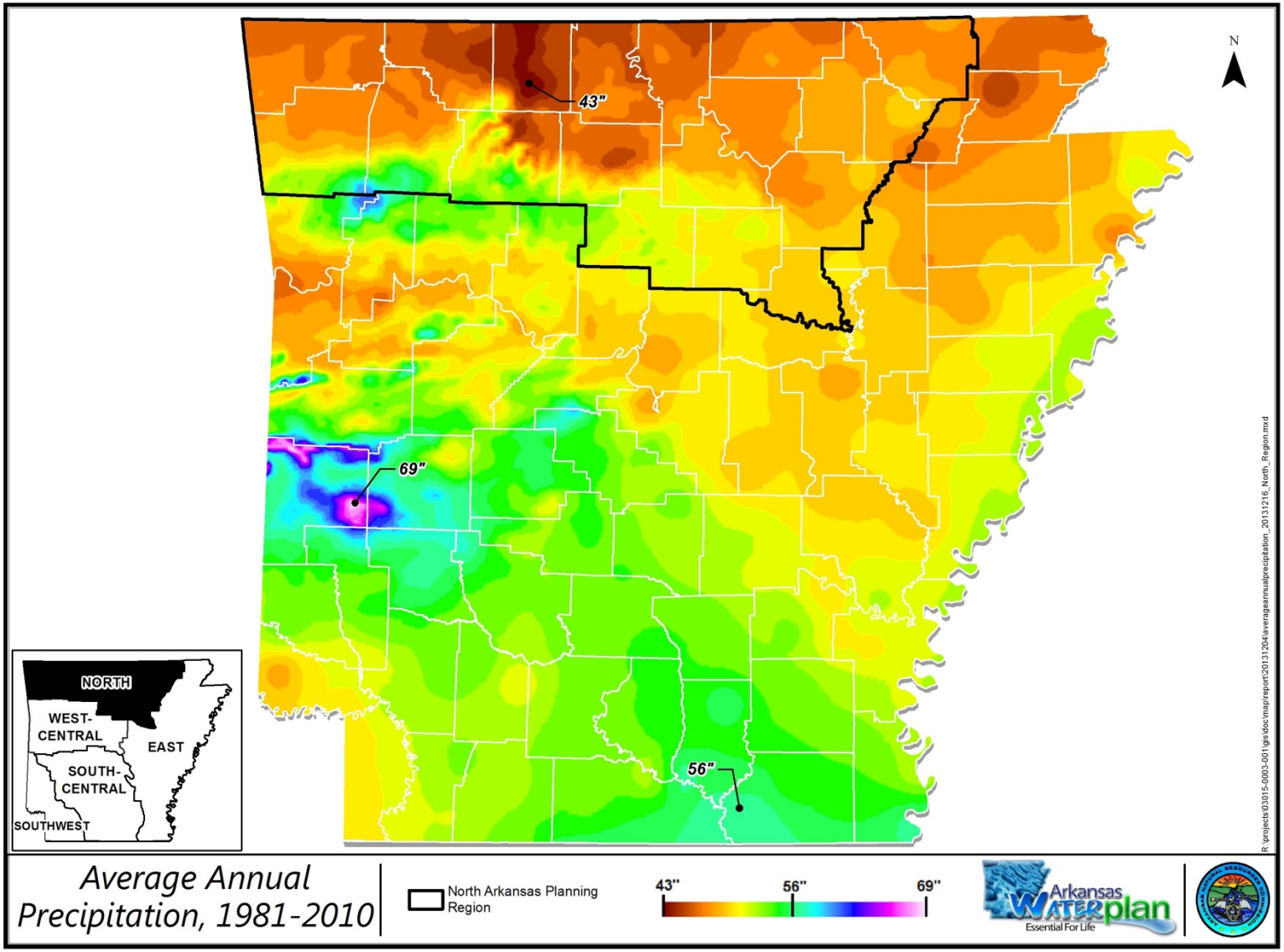

Figure 3.11. Average annual precipitation (inches) in the NAWRPR.

Potential evapotranspiration is the maximum rate at which water in soil and on plants would change to water vapor, assuming there is no shortage of water to be changed. Actual evapotranspiration is usually less than the potential. Potential evapotranspiration is difficult to measure, but can be estimated from the meteorological measurement, pan evaporation. Pan evaporation is the rate of evaporation of water from a specific style of open pan at a weather station.

Pan evaporation data taken from 1953 to 1979 in Mountain Home, Arkansas, was reported in a NOAA National Weather Service (NWS) report. It showed a sum of monthly averages of 35.85 inches evaporated in the May-October period. Annual average was not available (NOAA NWS 1982).

3.5.2 Drought

Although the NAWRPR receives precipitation throughout the year, drought conditions can occur in the region. One of the tools the NOAA uses to determine when drought conditions exist is the Palmer Drought Indices. These indices are based on the differences of precipitation and temperatures from normal. The Palmer Drought Severity Index (PDSI) also takes into account the length of time that drought conditions last. PDSI values less than zero indicate drought conditions. An index of -2 indicates moderate drought, -3 indicates severe drought, and -4 indicates extreme drought (NOAA 2012). Figures 3.12 and 3.13 show time series plots of PDSI values for Climate 1 and Climate 2 Divisions in Arkansas. Periods with multiple consecutive years of drought have occurred frequently in North Arkansas. This region is currently experiencing a period of drought that began in 2010 for Division 1 and 2011 for Division 2 (NOAA NCDC 2013b).

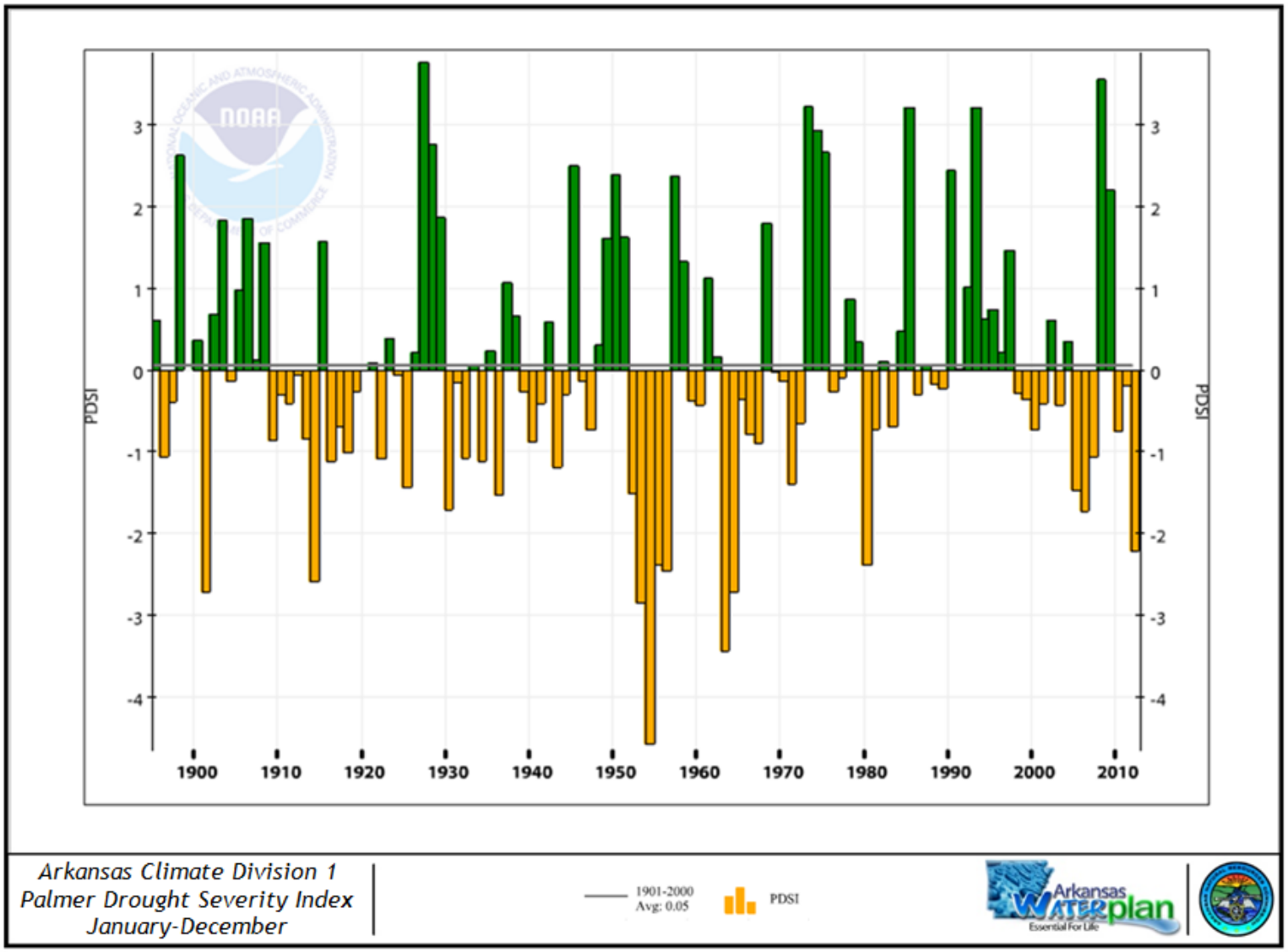

Figure 3.12. Historical values of the Palmer Drought Severity Index for the northwest climate division (1) (NOAA NCDC 2013b).

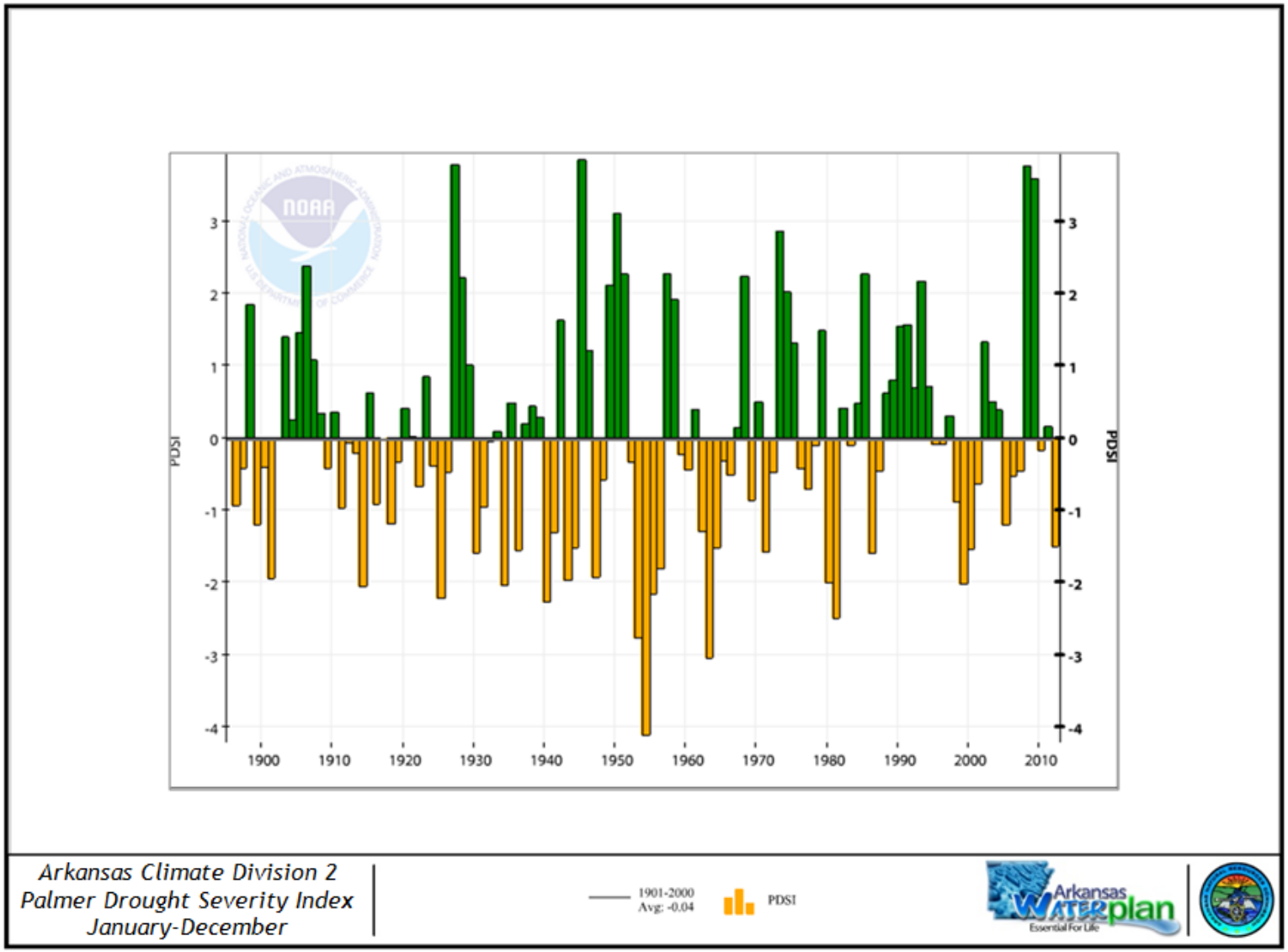

Figure 3.13. Historical values of the Palmer Drought Severity Index for the north-central climate division (2) (NOAA NCDC 2013b)

3.5.3 Climate Variability

In 2007, the Governor's Commission on Global Warming (GCGW) was established to, among other tasks, evaluate the potential impacts of global warming on the state citizens, natural resources, and economy. The GCGW's literature review conducted by the GCGW identified the following climate change effects anticipated for the state:

- Increased incidence of severe weather events,
- Increased incidence of flooding,
- Increased incidence of drought,
- Possible saltwater intrusion into aquifers resulting from sea level rise, and
- Changes in climatic zones (GCGW 2008).

Plots of annual average temperature and total annual precipitation from 1895 to 2013 for the north Arkansas climate divisions (1 and 2) are shown in Figures 3.14 and 3.15, respectively. The temperature data appear to exhibit a cycle of change, where temperatures in the first half of the 20th century were warmer than the second half, but appear to be warming again in the early 21st century (Figure 3.14). The US Department of Agriculture (USDA) modified their plant hardiness zone map in 2012. Changes in this map suggest that this Planning Region has experienced climatic changes. On the 1990 plant hardiness zone map, the Planning Region was classified as primarily zone 6b, with some areas of 7a along the southern border. On the 2012 plant hardiness zone map, the majority of the Planning Region is classifies as zone 7a, with some areas of 6b. These changes suggest that the Planning Region has become warmer, which follows the trend shown on Figure 3.14 (Clark and Karklis 2012). Precipitation totals for both climate divisions appear to exhibit a slight long-term increasing trend. A detailed analysis of long-term precipitation trends across the state is being prepared as part of the 2014 water plan update.

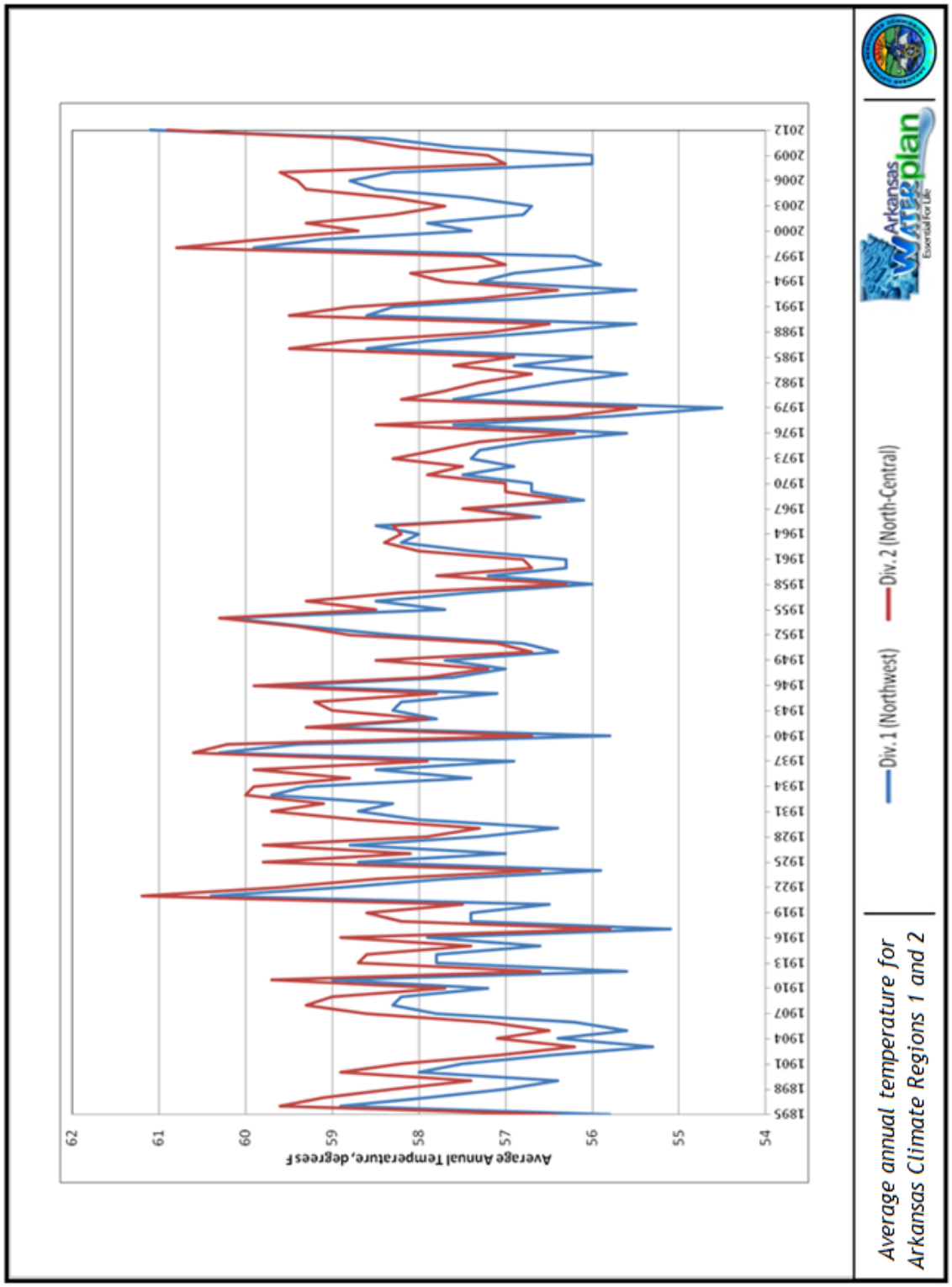

Figure 3.14. Average Annual Temperature for Arkansas Climate Regions 1 and 2.

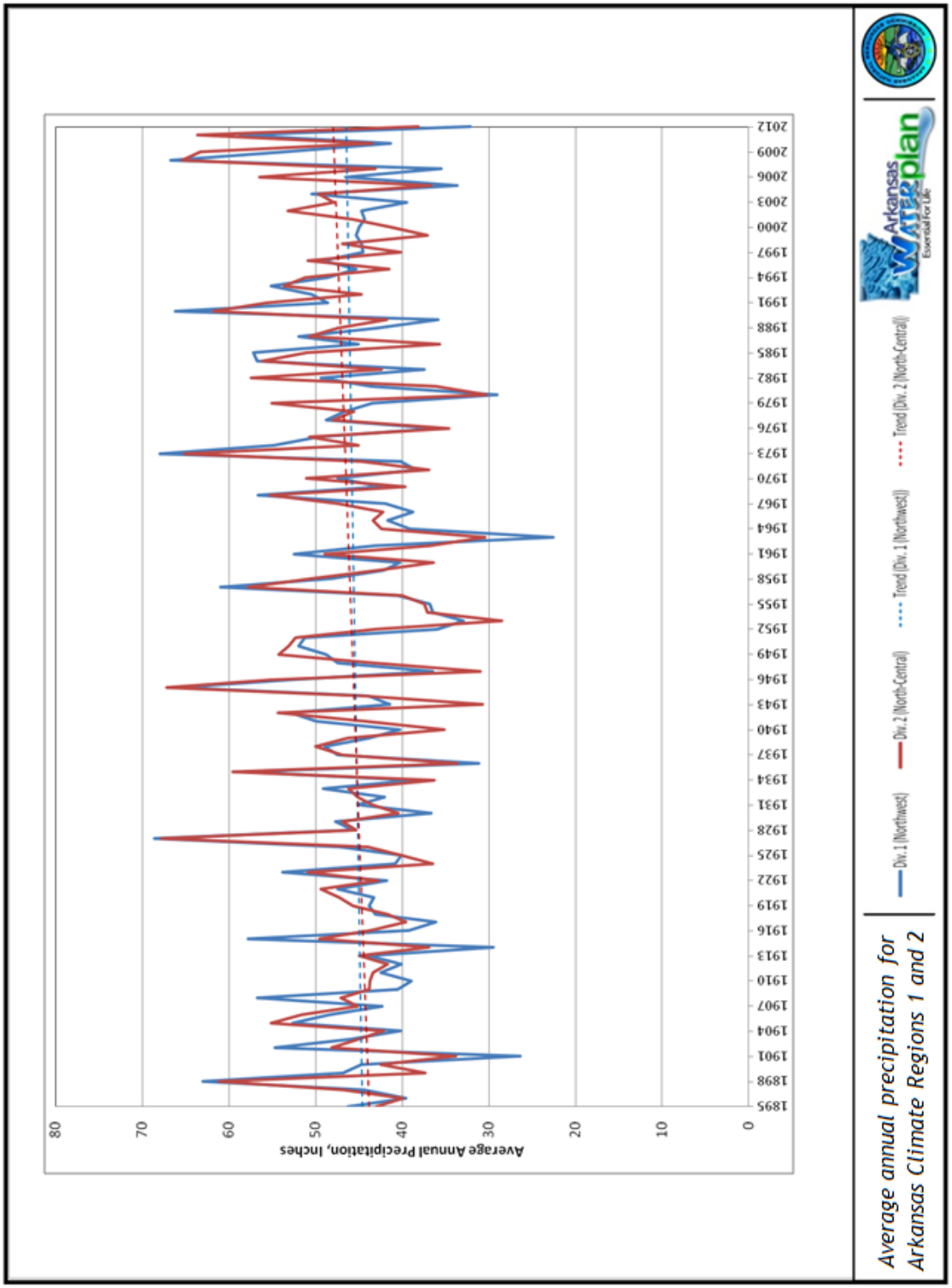

Figure 3.15. Average Annual Precipitation for Arkansas Climate Regions 1 and 2

3.6 Land Use

The types and percentages of land use for the NAWRPR as taken from data from the 2006 US land cover database (Fry, et al. 2011) are displayed in Figure 3.16. A map of land use is displayed in Figure 3.17. The majority of the land in the NAWRPR is forested, primarily with deciduous forest. Total forested area in the NAWRPR is approximately 61.2%. Pasture is the next most common land use with approximately 21.8% of land, followed by developed land with a total of approximately 6.4%.

3.6.1 Forest

There are over 4.9 million acres of forest in the NAWRPR. Table 3.2 lists the acreage of forest land per county as reported by the USDA Forest Service (USFS). Newton County has the most acreage of forest. Forested areas in the region include the Ozark National Forest, which is located in Benton, Washington, Madison, Newton, Searcy, Marion, Van Buren, Baxter, Izard, and Stone Counties. The majority of the forest land in the planning region counties (over 95%) is classified by the USFS as timberland or commercial forest land (USFS 2013). Table 3.2 also includes the forest land areas from the Resource Inventory Data System in 1977 reported by county in the 1990 AWP reports. Because these data are from different sources, their comparability is uncertain. However, the values suggest that there has been no significant change in the amount of forest land in the planning region counties during the period since the 1990 AWP update.

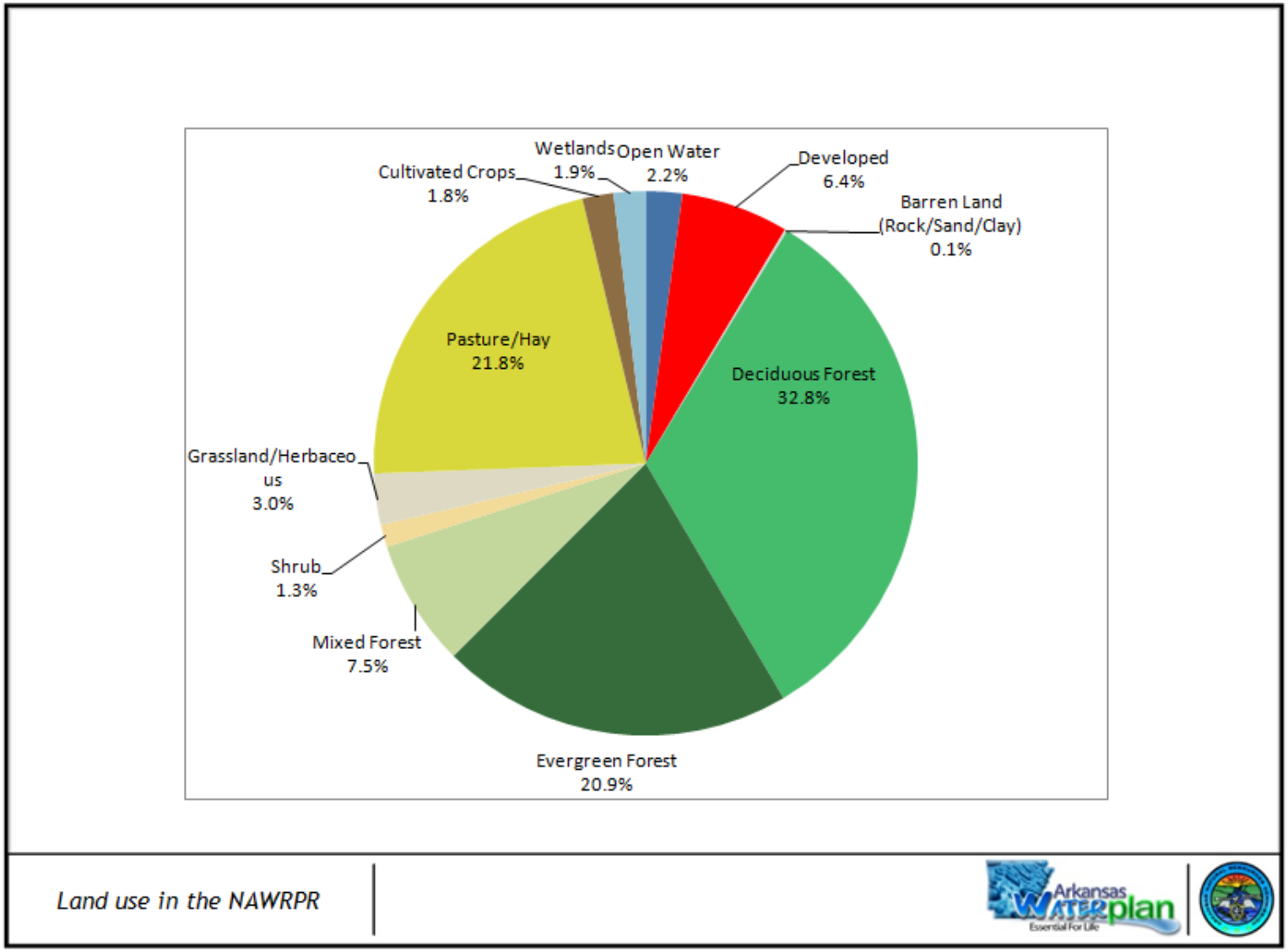

Figure 3.16. NAWRPR land use (Fry, et al. 2011).

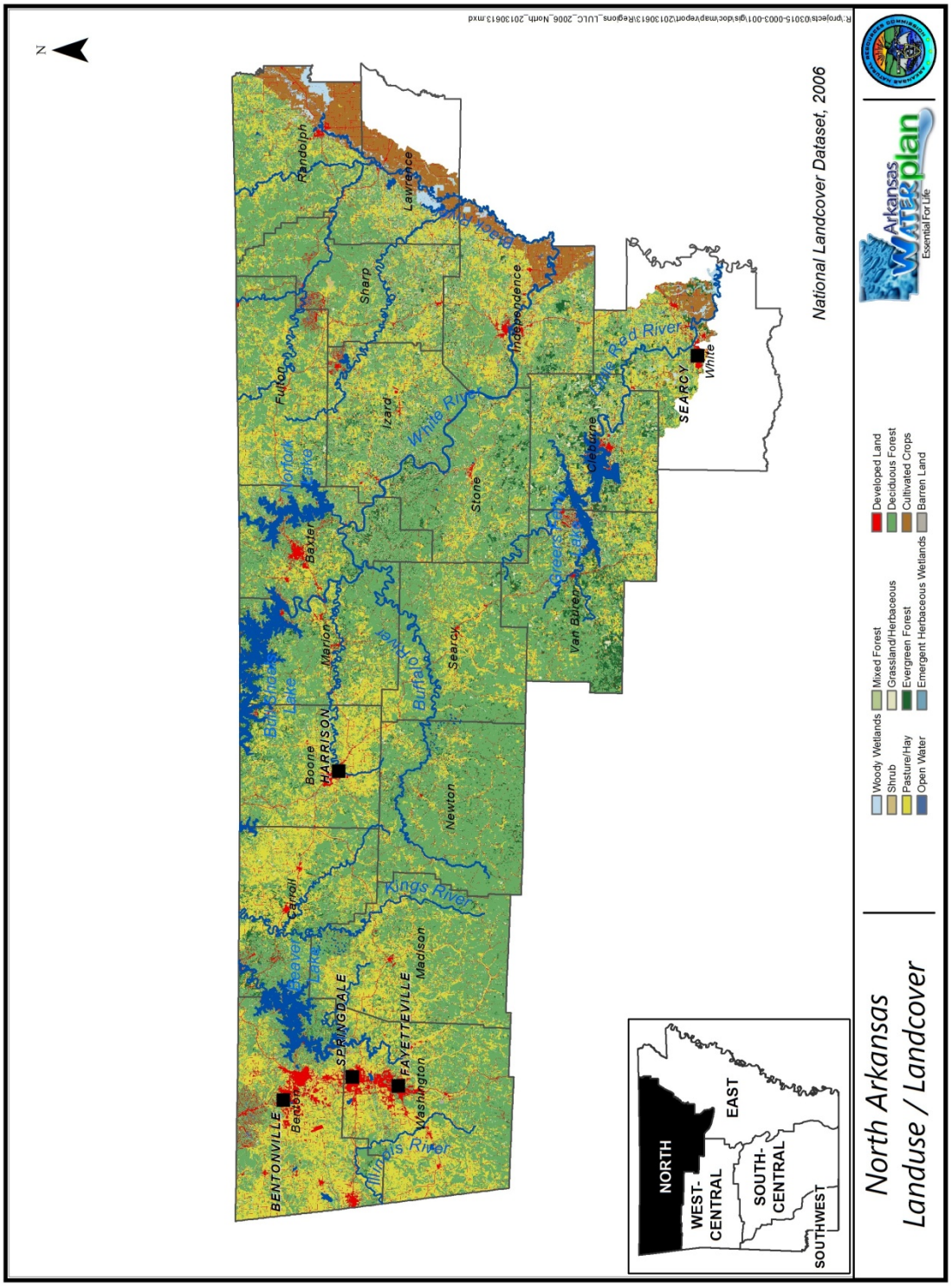

Figure 3.17. NAWRPR land use map (Fry, et al. 2011).

Table 3.2. Forest land acreage per county in the NAWRPR (USFS 2013, ASWCC 1987, USACE Little Rock District 1988)

County	1990 AWP Forest Land (acres)	2012Forest Land (acres)	Change
Baxter	251,317	231,750	-
Benton	225,310	224,350	-
Boone	183,074	167,034	-
Carroll	189,460	214,415	+
Cleburne	249,183	274,063	+
Fulton	205,464	248,883	+
Independence	241,651	228,953	-
Izard	203,427	252,589	+
Lawrence*	110,589	86,918	-
Madison	374,185	337,071	-
Marion	271,513	255,126	-
Newton	470,821	433,023	-
Randolph	196,729	188,648	-
Sharp	259,232	261,468	+
Stone	327,873	346,659	+
Searcy	289,360	293,974	+
Van Buren	318,502	359,242	+
Washington	306,674	330,528	+
White*	144,001	241,113	+
Total	**4,818,365**	**4,975,807**	+

* Note: the acreage reported is for the entire county, but part of this county is in a different planning region.

3.6.2 Agriculture

Agricultural land accounts for the next largest proportion of the planning region at approximately 23% (Figure 3.16). Pasture and haylands account for the majority of this land use category (90%). The acreage reported in the 2007 Census of Agriculture for pasture in the counties of the NAWRPR was 2.5 million with 1.0 million acres of cropland. In the 1990 AWP, the acreage reported for pasture was 2.6 million, with 0.4 million acres of cropland. Because these data are from different sources, their comparability are uncertain (see Table 3.3) Comparing pasture and cropland areas from the 1987 and 2007 Census of Agriculture indicates there has been a slight decline in pasture area, but no significant change in the amount of cropland in the counties of the NAWRPR since 1990 (Table 3.3) (US Census Bureau1989, USDA National Agricultural Statistics Service 2009).

Table 3.3. Agricultural land uses with acreage (USDA National Agricultural Statistics Service 2009, US Census Bureau 1989, ASWCC 1987).

	Cropland (acres)			Pasture (acres)		
County	1990 AWP	1987 Census of Agriculture[a]	2007 Census of Agriculture[a]	1990 AWP	1987 Census of Agriculture[b]	2007 Census of Agriculture[b]
Baxter	0	8,547	12,146	93,037	105,317	73,175
Benton	17,655	74,438	76,869	286,794	270,207	165,779
Boone	0	24,217	33,732	181,022	260,707	188,440
Carroll	0	32,179	41,452	181,908	247,918	184,497
Cleburne	7,463	18,143	28,204	93,618	108,082	80,654
Fulton	0	16,489	17,274	185,576	202,292	142,614
Independence	65,044	97,089	86,270	165,119	180,134	129,679
Izard	0	14,604	23,403	155,451	188,042	125,122
Lawrence*	157,031	209,581	190,038	50,903	81,931	62,782
Madison	0	36,069	48,711	158,295	226,942	170,768
Marion	0	11,288	12,875	105,880	145,707	107,119
Newton	0	8,958	13,514	55,259	88,707	80,418
Randolph	71,088	113,985	113,581	140,670	136,531	126,541
Searcy	0	17,775	22,818	132,936	188,358	137,847
Sharp	0	14,076	22,630	106,621	152,523	126,844
Stone	0	13,577	21,519	59,290	115,155	101,579
Van Buren	0	19,861	22,763	128,510	111,217	63,868
Washington	12,527	77,296	83,080	250,401	315,351	201,373
White*	89,039	200,237	159,002	114,688	203,280	197,977
Total	**419,847**	**1,008,409**	**1,029,881**	**2,645,978**	**3,328,401**	**2,467,076**

*Note: the acreage reported is for the entire county, but part of this county is not in the NAWRPR
a Note: sum of "harvested cropland" and "other cropland" reported in census
b Note: sum of "pastureland, all types" and "cropland used only for pasture" reported in census

The majority of cropland occurs east of the Fall Line and along the White River (Figure 3.17). Approximately 20% of the cropland in the counties of the planning region was irrigated in 2007. This is 4 times what it was in 1987 (US Census Bureau1989, USDA National Agricultural Statistics Service 2009). The crop items with the largest acreage within the planning region counties in 2007 were forage, soybeans, and rice (USDA National Agricultural Statistics Service 2009). Soybeans and rice were identified as the two crops with the most acreage in the upper White River basin 1990 AWP (ASWCC 1987). There are several counties in the planning region that grow select crops a little more unique to their area, which include field and grass seed (Benton, Boone, Fulton, Izard, Madison, and Stone Counties), and English walnuts (Searcy County) (2007 Census of Agriculture, County Profiles).

3.6.2 Developed Land

Developed land accounts for over 6% of the land area in the planning region. The Fayetteville – Springdale – Bentonville metropolitan area is located within the NAWRPR. This area, and other urban areas, has expanded since the 1990s. Table 3.4 compares areas for urban and built-up lands in the counties of the NAWRPR reported in the 1990 AWP, and from the most recent land use data set. These data indicate that developed land has increased in all of the counties of the planning region. Some of the differences in these numbers are likely the result of differences in the methodologies for classifying land use, however, population changes in these counties suggest that not all of the increase is due to differences in methodology (See Section 4.1)

Table 3.4. Comparison of urban/built-up area reported for counties in the NAWRPR (Fry, et al. 2011, USACE Little Rock District 1988, ASWCC 1987).

County	Urban/Built-up 1977 (acres)	Urban/Built-up 2006 (acres)
Baxter	0	24,774
Benton	10,101	68,465
Boone	11 ,965	20,762
Carroll	17 ,584	20,992
Cleburne	2,349	16,128
Fulton	0	18,978
Independence	5,502	25,106
Izard	10,402	17,620
Lawrence*	4,990	20,136
Madison	0	21,005
Marion	5,578	17,148
Newton	0	16,539
Randolph	234	17,744
Searcy	0	14,927
Sharp	16,867	20,038
Stone	0	14,259
Van Buren	9,948	20,148
Washington	28,292	55,215
White*	7,353	35,240
Total	**101,382**	**465,224**

3.6.3 Public Land

There are approximately 877,600 acres of public land in the NAWRPR, around 12% of the planning region total area. Table 3.5 reports the number of each type of public land as reported by the Arkansas State Highway and Transport Department (AHTD), along with the total acreage for each. The Ozark National Forest accounts for the majority of public land in the NAWRPR. There are also several wildlife management areas (WMAs), national wildlife refuges (NWRs), and two national parks. In addition, there are several city and state parks. Many of the public land types overlap in some areas of the region. For example, there are several wilderness and wildlife management areas within the Ozark National Forest.

Table 3.5. Public lands in the NAWRPR (AHTD 2006, AGFC 2009)

Public Land Type	Count	Total Acreage	Percent of Total Area in NAWRPR
City Park	159	6,361	0.08%
County Park	29	3,267	0.04%
Local Park	18	2,262	0.03%
National Forest	1	638,527	7.93%
National Park	2	97,199	1.21%
National Wildlife Refuge	2	15,127	0.19%
Natural Area	13	4,300	0.05%
Natural Area (no public access)	1	1.6	0.00%
Park & Campsite	1	0.2	0.00%
Park / Public Use Area	8	958	0.01%
Public Use Area	20	2,410	0.03%
Recreation Area	5	2.5	0.00%
State Park	9	16,398	0.20%
Wayside Park	2	4.1	0.00%
Wilderness Area	6	91,270	1.13%
Wildlife Demonstration Area	1	1,050	0.01%
Wildlife Management Area	14	272,217	3.38%

3.7 Surface Water

There are approximately 19,620 miles of rivers and streams in the NAWRPR and 25,170 acres of impounded water (USGS 2009, ASWCC 1981). The major river in the region is the White River. The largest impoundments in this region are Beaver Lake, Bull Shoals Lake, Norfork Lake, and Greers Ferry Lake. Surface water availability issues, both water quantity and water quality, are discussed in detail in Section 5.

3.7.1 Rivers and Streams

There are approximately 19,620 miles of rivers and streams in the NAWRPR. One of the state's major rivers, the White River, flows through the planning region. Additional principal streams in the planning region include the Illinois River, Kings River, Buffalo River, Black River, and Little Red River.

The White River originates in Northwest Arkansas, in the Boston Mountains. Flow is regulated by four mainstem reservoirs and two tributary reservoirs. The river flows north past Fayetteville in Washington County, into Beaver Lake, located in Benton and Carroll Counties. Downstream of Beaver Lake dam, the river continues flowing northeast and crosses the Arkansas-Missouri state line just north of Eureka Springs, Arkansas. The river then flows generally east through southern Missouri, forming Table Rock Lake and Lake Taneycomo. Downstream of the Lake Taneycomo dam, the river flows past Branson, Missouri, and then south, where it reenters Arkansas. The river meanders back and forth over the state line several times before feeding into Bull Shoals Lake. Downstream of Bull Shoals Lake, the White River continues south-southeast and joins up with the North Fork tributary near Norfork, Arkansas. The White River leaves the planning region in Jackson County, near Newport. The river eventually empties into the Mississippi River in Desha County. Tributaries of the White River in the planning region are the Kings River, Buffalo River, Black River, and Little Red River.

The Kings River originates in the Boston Mountains in Madison County. It flows north through Carroll County, Arkansas, into Missouri where it flows into Table Rock Lake. Tributaries of the Kings River are Osage Creek, Piney Creek, Keels Creek, Dry Fork Creek,

Warmfork Creek, Pine Creek, Felkins Creek, and Sweden Creek (Miller 2006). All of these tributaries originate in the planning region.

The Buffalo River originates in the Boston Mountains in Newton County. It flows east from Newton County through Searcy, Marion, and Baxter County, where it empties into the White River. The headwaters of the river are formed by two of its tributaries, Big Buffalo Creek and Reeves Fork. Other tributaries include Richland Creek, Calf Creek, Bear Creek, Brush Creek, Mill Creek, Tomahawk Creek, Water Creek, and Spring Creek (National Park Service 2013). All of the tributaries originate in the planning region except Richland Creek, which originates just outside of the planning region in Pope County (USGS 2009).

The Black River is formed in southeast Missouri by three streams, and enters Arkansas flowing south near the town of Corning in Clay County (Cavaneau 2012). It enters the planning region in Randolph County near Pocohontas. The Black River flows generally south and eventually empties into the White River at Jacksonport in Jackson County, at the boundary between the North and East planning regions. Tributaries of the Black River in the NAWRPR include the Little Black River, Spring River, and Strawberry River. Of these tributaries, the Strawberry River is the only one originating in the planning region. The Little Black and Spring Rivers both originate in southeast Missouri (USGS 2009).

The Little Red River is formed by three forks, the South, Middle, and Devils Fork, all of which originate in the Ozark Mountains. These three forks feed into Greers Ferry Lake, an impoundment of the river in Cleburne County. Downstream of Greers Ferry Dam, the river flows southeast through Cleburne and White Counties, emptying into the White River north of Georgetown, at the edge of the planning region. Tributaries of the Little Red River downstream of Greers Ferry Lake are Sulphur Creek, Canoe Creek, and Big Creek (Arkansas Department of Parks and Tourism 2013b). All of these tributaries originate within the planning region.

The Illinois River is the only major river in the planning region that is not a tributary to the White River. The Illinois River is located in western Northwest Arkansas. Its headwaters begin near Hogeye in Washington County. The river then flows northwest through Washington County before turning southwest in Benton County. It flows out of Arkansas into Oklahoma about 5 miles south of Siloam Springs (IRWP 2013a). The Illinois River eventually empties into

the Arkansas River near Gore, Oklahoma, upstream of where the Arkansas River enters Arkansas at Fort Smith. Tributaries of the Illinois River that originate in the planning region are Osage Creek, Flint Creek, and Baron Fork Creek. Of these tributaries, Osage Creek is the only one whose confluence with the Illinois River is in the planning region. Flint Creek and Baron Fork Creek both meet up with the river in Oklahoma.

The historical average annual surface runoff in the NAWRPR ranges from approximately 7 inches in the northeastern area of the planning region to approximately 13 inches in the south-central area of the planning region (Figure 3.18). Seasonal variation in surface runoff mirrors seasonal variation in precipitation (Pugh and Westerman 2014).

The mean monthly flows for four USGS stream gages in the NAWRPR are compared in Figure 3.19. Figure 3.20 shows the locations of these gages. Streamflow in the NAWRPR is generally highest from December through May because of the large amount of precipitation during this period (Figure 3.16). Similarly, streamflow is generally lowest during June through November due to lower precipitation and increased water use and evapotranspiration that occur during the growing season.

Long term flow records in the NAWRPR have recently been analyzed for trends. A 1992 USGS report found that no trend existed for 7-day annual low flow series at gage stations on the Buffalo River with a 50-year period of record. An analysis of stations in undisturbed watersheds showed that there were no climatic trends for the period of record and therefore it could be inferred that any increasing or decreasing flow trends could be attributed to human influences (USGS 1992). An updated state-wide analysis of long term trends in flow runoff is being conducted by the USGS and USACE as part of the 2014 AWP update.

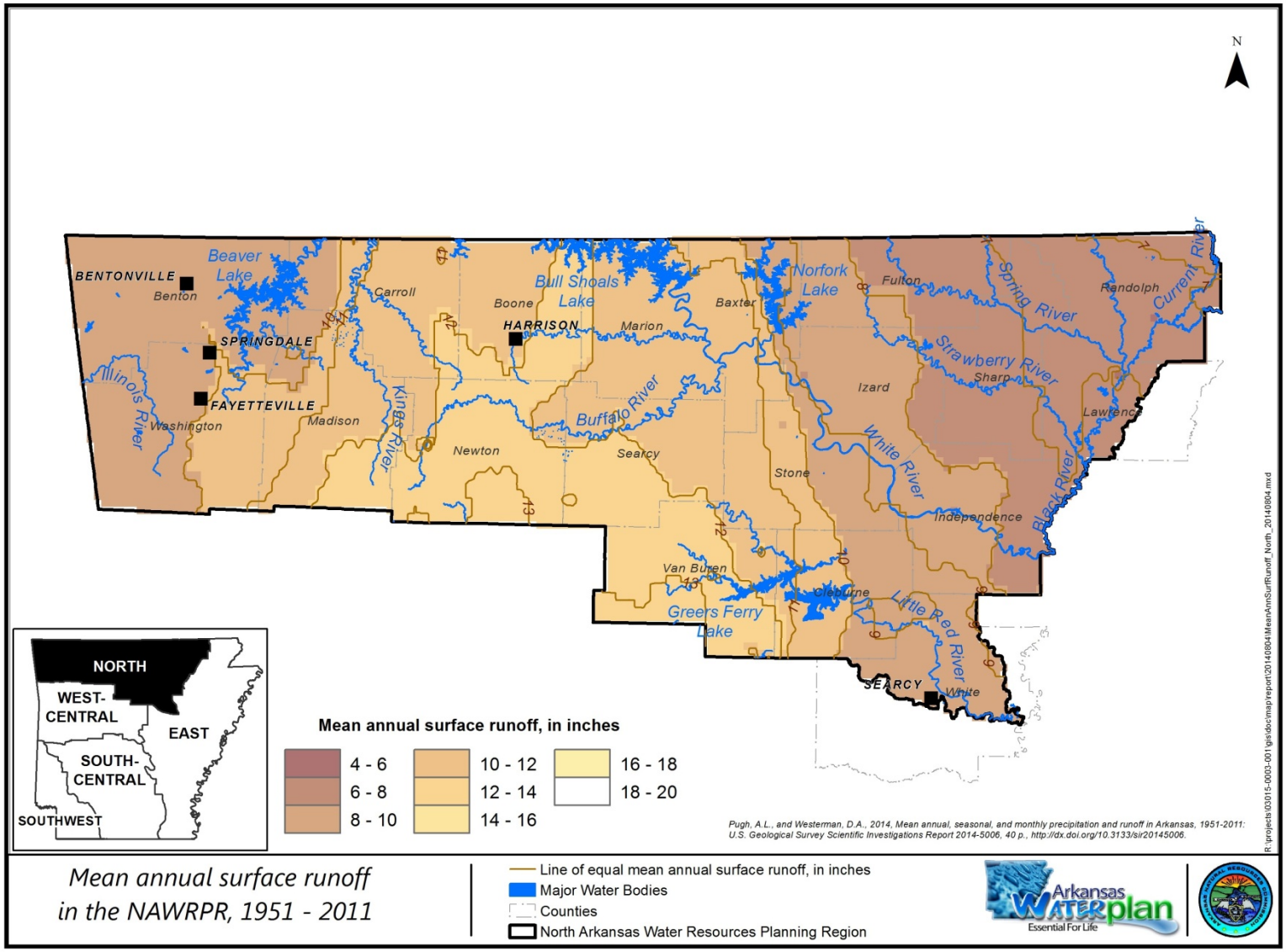

Figure 3.18. Average annual surface runoff in the NAWRPR, 1951 to 2011 (Pugh and Westerman 2014).

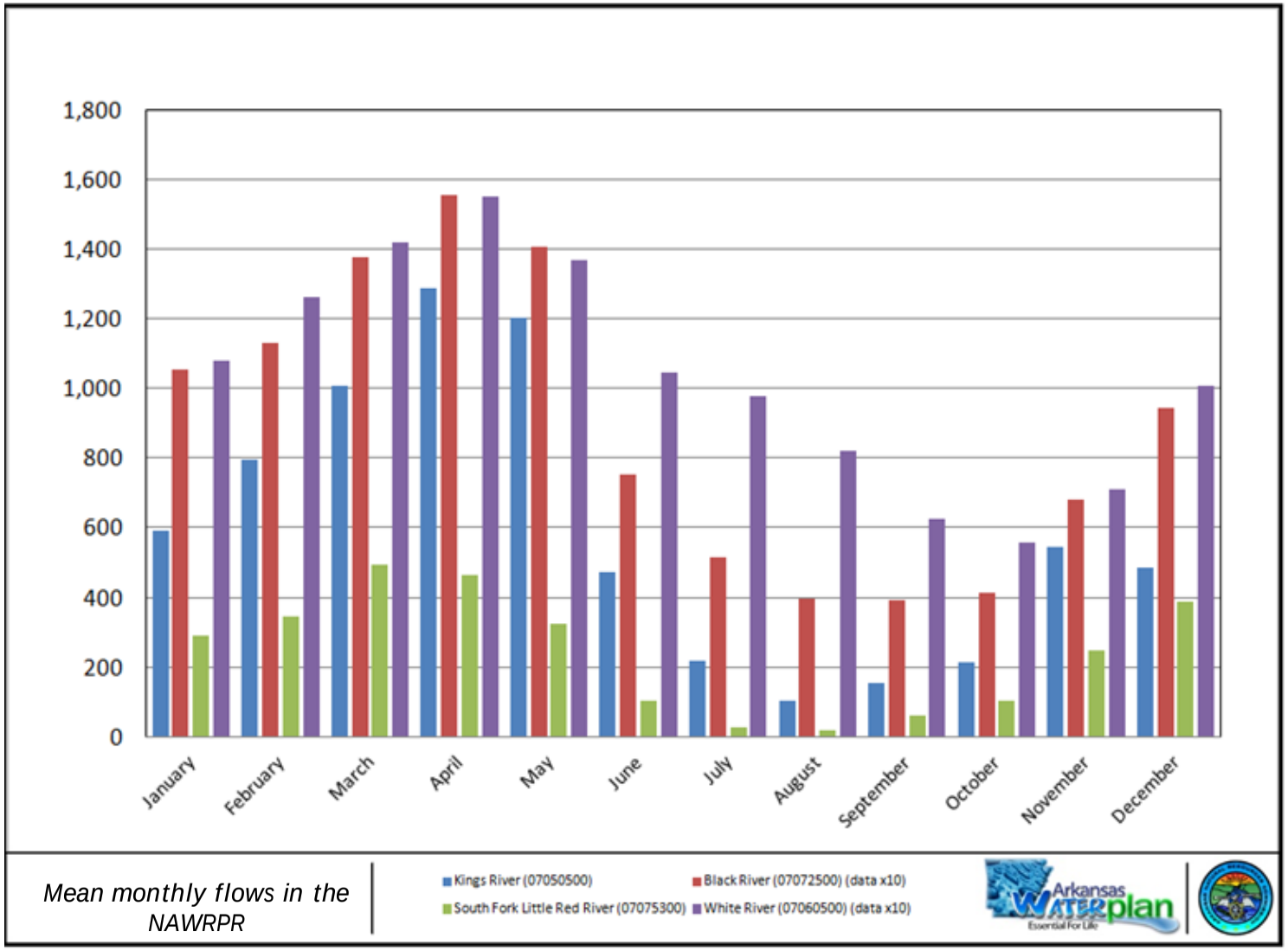

Figure 3.19. Mean monthly flows reported for USGS gaging stations on selected streams in the NAWRPR (USGS 2013c) (Data for the Black River and White River gages have been divided by 10 for easier compairison).

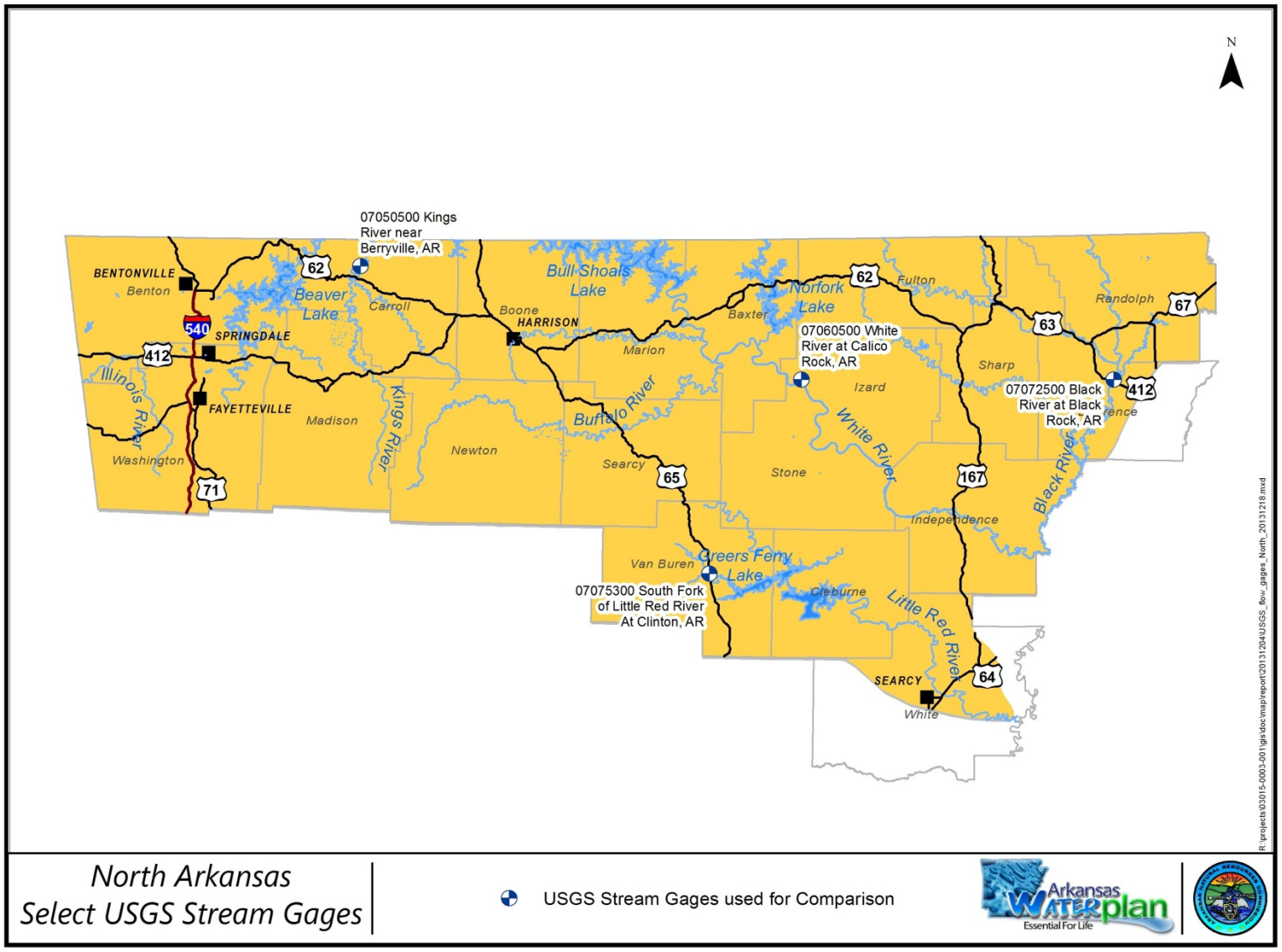

Figure 3.20. Select USGS gage stations in the NAWRPR.

3.7.2 Impoundments

In 1981 there were over 25,170 acres of impoundments in the planning region (Table 3.6). An updated state-wide inventory of impoundments is being prepared for the 2014 AWP update. ADEQ has identified 12 significant publicly owned lakes in the planning region. The Arkansas Department of Pollution Control and Ecology (ADPCE), now ADEQ, defined these as lakes that are at least 100 acres and have access designed to enhance public use (ADPCE 1990). A list of these significant publicly owned lakes is given in Table 3.7.

Table 3.6. Lakes in the NAWRPR (ASWCC 1981).

County	Number of Lakes	Area (acres)	Capacity (acres-feet)
Baxter	1,624	731	2,105
Benton	3,599	2,055	36,585
Boone	3,036	784	2,166
Carroll	2,107	979	4,938
Cleburne	2,242	1,036	3,170
Fulton	3,329	1,376	10,048
Independence	2,283	1,134	5,119
Izard	2,388	2,118	25,605
Lawrence*	910	1,015	5,838
Madison	3,202	1,020	2,623
Marion	1,400	463	832
Newton	1,362	368	1,130
Randolph	1,692	2,547	7,406
Searcy	3,034	1,091	1,975
Sharp	1,770	1,723	13,552
Stone	3,162	1,207	3,968
Van Buren	2,683	1,967	30,573
Washington	5,014	2,225	18,275
White*	2,515	1,338	7,847
USACE	5	226,370	15,649,500
USFS	1	102	1,600
Arkansas Department of Parks & Recreation	2	18	121
AGFC	16	1,652	34,424

*Part of this county is not in the NAWRPR. The number of lakes, area, and capacity of lakes were adjusted so that any lake over 5 acres that was outside of the planning region was not included. An inventory of exact locations of smaller lakes was not available.

Table 3.7. Information for significant publicly owned lakes in the NAWRPR (ADEQ 2008, 2012c; ADPCE 1990)

Name	County	Lake type	Surface area (acres)	Average Depth (feet)	Capacity (acre-feet)	Purpose
Norfork Lake	Baxter	Reservoir	22,000	57	1,983,000	Hydropower
Beaver Lake	Benton	Reservoir	28,200	58	1,952,000	Hydropower
Greers Ferry Lake	Cleburne	Reservoir	31,500	60	2,844,500	Hydropower
Bull Shoals Lake*	Marion	Reservoir	45,440	67	5,408,000	Hydropower
Crystal Lake	Benton	Reservoir	60	12	1,020	Fishing
Lake Wedington	Washington	Reservoir	102	16	1,600	Recreation
Lake Elmdale	Washington	Reservoir	180	8	180	Fishing
Lake Fayetteville	Washington	Reservoir	196	15	2,940**	Recreation
Bobb Kidd Lake	Washington	Reservoir	200	13	4,018	Fishing
Lake Sequoyah	Washington	Reservoir	500	8	4,000**	Recreation
Swepco Lake	Benton	Reservoir	531	17	9,027**	Water Supply
Lake Charles	Lawrence	Reservoir	562	8	7,740	Fishing

* Portion of lake outside planning region
** Capacity not reported; calculated as surface area (acres) x average depth (feet)

Several of the impoundments in the NAWRPR were built for the purpose of generating hydroelectric power at the dams. The federal Flood Control Acts of 1938, 1941, and 1954 led to the creation of several dams and reservoirs along the White River for flood control, water supply, and hydroelectric power generation. The dams on Beaver Lake, Table Rock Lake, Bull Shoals Lake, Norfork Lake, and Greers Ferry Lake all provide hydroelectric power (Reynolds 2012).

3.7.3 Wetlands

Several types of wetlands exist in the NAWRPR, including mountaintop depressions, which can be found along the mountaintop areas in the Ozark National Forest. Sinkholes are also present in the planning region, mainly in the terraces and uplands north of the Buffalo River (Arkansas Multi-Agency Wetland Planning Team 2001a). Some designated wetland natural areas exist in the planning region, such as the wet tallgrass prairie areas of Chesney Prairie, Searles Prairie, and Baker Prairie Natural Areas (ANHC 2010). A unique type of riverine

wetland, known as a Spring Run, exists in the planning region in the Ozark Mountains (Arkansas Multi-Agency Wetland Planning Team 2001b).

3.7.4 Surface Water Quality

Surface water in the Boston Mountains region of the NAWRPR is exceptional overall, with concentrations of most biochemical and nutrient characteristics being very low. Water quality in the Ozark Highlands region differs from this in that alkalinity, total dissolved solids, and total hardness concentrations are higher due to limestone and dolomite. Developed and pasture land use also have an effect on the water quality of the area (Woods, et al. 2004). Surface water quality issues within the NAWRPR are discussed in detail in Section 5.

3.8 Groundwater

Compared to the Gulf Coastal Plain, the Interior Highlands have less reported groundwater use, which has contributed to the prevalent use of surface water, less agriculture, lower population and industry densities, lower yield from geologic formations, and lack of detailed reporting in the Interior Highlands. The aquifers of the Interior Highlands generally occur in shallow, fractured, and discontinuous bedrock that results in lower porosity, storage, and yields than the laterally extensive, coarse-grained, and unconsolidated sediments of the Gulf Coastal Plain. The dominant use of groundwater in the Interior Highlands is domestic supply, with minor industrial, small-municipal, and commercial-supply use (Kresse, et al. 2013).

3.8.1 Aquifers

There are four recognized aquifers in the NAWRPR, listed in Table 3.8 and mapped on Figure 3.21. These aquifers are designated as regional aquifers and encompass parts of several states. For a more detailed description of these formations refer to McFarland (2004). Kresse and others (2013) provide a comprehensive review of the aquifers of Arkansas to include the geologic setting, hydrologic characteristics, water levels, water use, and water quality. Much of the information presented in this section was summarized from the Kresse and others (2013) report.

Table 3.8. Nomenclature, geologic age, and use for aquifers in the NAWRPR.

Province	Section	Formation or Group of Formations	Geologic Age	Hydrogeologic Unit Name	Aquifer Use[1]
Gulf Coastal Plain	Mississippi Alluvial Plain	Coastal Plain Alluvium	Quaternary	Mississippi River Valley,	IR, PS, IN
		Nacatoch Sand	Cretaceous	Nacatoch aquifer	PS
Ozark Plateaus	Boston Mountains	Atoka Formation Bloyd Formation Hale Formation Imo Shale Pitkin Limestone Fayetteville Shale Batesville Sandstone Ruddell Formation Moorefield Formation	Mississippian and Pennsylvanian	Western Interior Confining System	D
	Springfield-Salem Plateaus	Boone Formation	Mississippian	Springfield Plateau Aquifer	D, PS
		Clifty Limestone Penters Chert Lafferty Limestone St. Clair Limestone Brassfield Limestone Cason Shale Fernvale Limestone Kimmswick Limestone Plattin Limestone Joachim Dolomite St. Peter Sandstone Everton Formation Smithville Formation Powell Dolomite Cotter Dolomite Jefferson City Dolomite Rubidoux Formation Gasconade Formation Van Buren Formation Eminence Dolomite Potosi Dolomite	Ordovician through Devonian	Ozark aquifer	PS, D

[1]IR= irrigation, PS = public supply, IN = industrial, D = domestic. Listed in order of highest use by volume. Primary use in capital letters; secondary use in small caps.

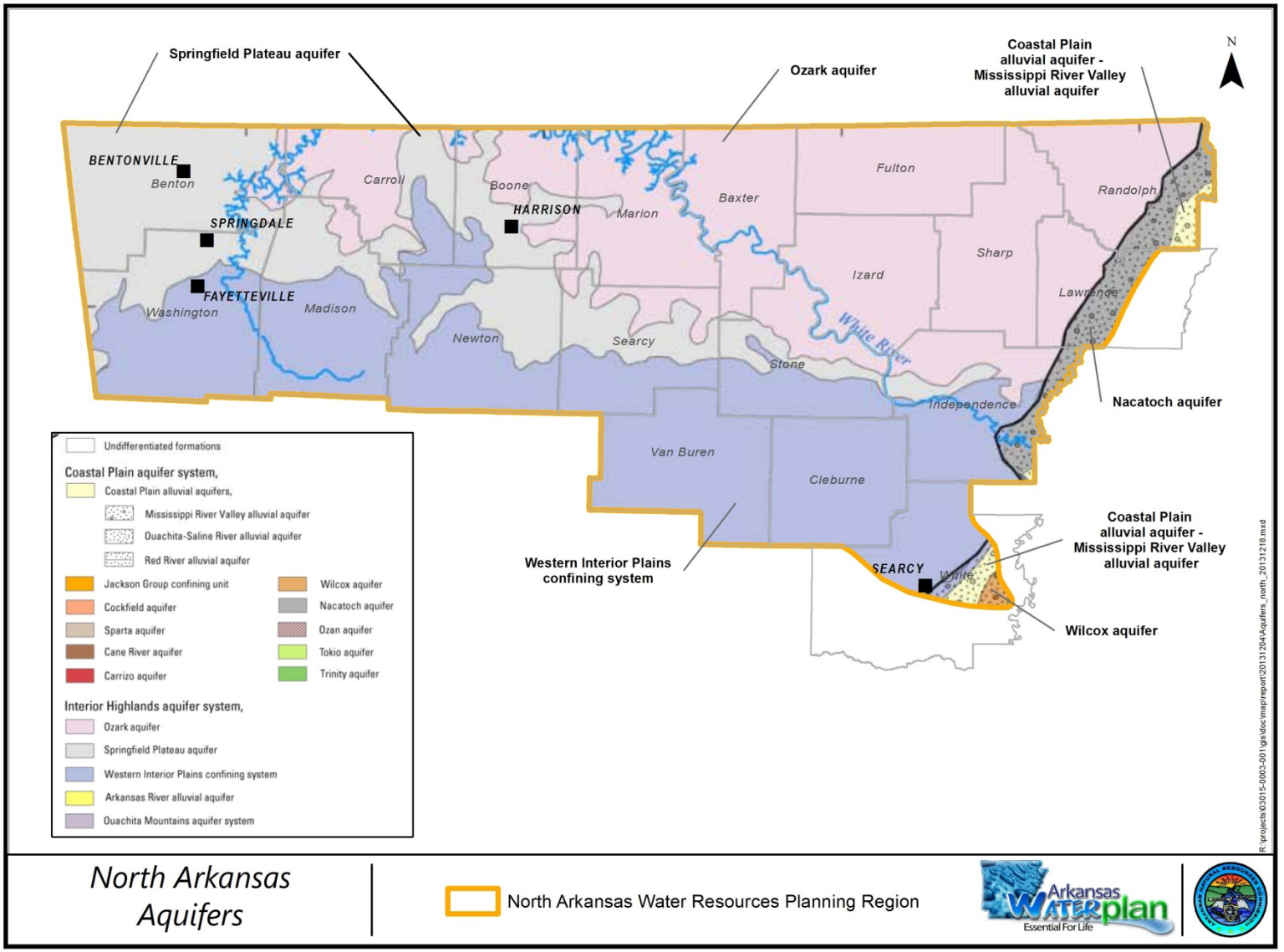

Figure 3.21. Aquifers of the NAWRPR (Kresse, et al. 2013).

Only a small area of the NAWRPR is underlain by the regional aquifers of the Mississippi Alluvial Plain, where they overlap the Ozark Plateaus. Therefore, these aquifers will not be described here. Aquifers of the Mississippi Alluvial Plain are described in detail in the background report for the Eastern Arkansas Water Resources Planning Region.

Recognized aquifers in the Ozark Plateaus include the Springfield Plateau and Ozark aquifers. The Boston Mountains Plateau and the portion of the Arkansas River Valley included in the NAWRPR belong to the Western Interior Plains (WIP) confining unit and there are no formally recognized aquifers. However, there are several shallow, undifferentiated, and saturated rocks of limited extent that serve as groundwater supply for domestic and small community purposes (Adamski, et al. 1995).

3.8.1.1 Springfield Plateau aquifer

The Springfield Plateau aquifer encompasses the Springfield Plateau and portions of the Salem Plateau in the Ozark Plateaus physiographic province. The Boone Formation comprises the Springfield Plateau aquifer and is the uppermost stratigraphic unit throughout most of the province (Imes and Emmett 1994). The Boone Formation is a limestone with abundant chert and clay, except for the base of the unit which is a relatively pure limestone known as the St. Joe Limestone Member. The porosity and permeability of the Boone Formation is very low except along fractures and bedding planes. Portions of this limestone have been dissolved to form an open network of caves, enlarged fractures, dissolutionally enhanced bedding planes, conduits, sinkholes, sinking streams, and springs creating a distinct karst topography and complex hydrological system (Brahana, et al. 1999).

The Springfield Plateau aquifer is generally unconfined across the Springfield Plateau and confined in the Boston Mountains Plateau by an interval of formations known as the Western Interior Plains Confining System. Most recharge to the aquifer occurs by infiltration of precipitation across outcrop areas of the Boone Formation. Where confined, recharge occurs as leakage through the overlying units (Adamski, et al. 1995). The nature of the primary and secondary porosity of this aquifer creates a dual flow system (diffuse and focused), which is further discussed by Kresse, and others (2013). The result is an aquifer with well yields that

range from 0.01 to 1,000 gallons per minute (gpm). However, most wells throughout the extent of the aquifer yield less than 20 gpm (Adamski, et al. 1995). Water levels generally reflect the topography and exhibit a strong relation to elevation.

Groundwater movement at local scales is strongly controlled by lithology (rock type and bedding planes), structure (fractures, faults, and dip), and karst features (sinkholes and conduits). Structural features (faults and fractures) have been shown to either facilitate or impede groundwater flow (Kresse, et al. 2013; Brahana and Davis 1998). Discharge from the Springfield Plateau aquifer primarily occurs through springs, with withdrawals from wells and leakage to the underlying Ozark aquifer system playing a minor role. When present, the Chattanooga Shale serves as a lower confining unit, known as the Ozark Confining Unit, and exchange between the Springfield Plateau and Ozark aquifers is limited.

3.8.1.1 Ozark aquifer

The Ozark aquifer encompasses the Salem, Springfield and Boston Mountain Plateaus. The Ozark aquifer is separated into an upper and lower section based on differences in dominant lithologies, groundwater levels, confined or unconfined conditions, yields, and geochemistry. The upper Ozark aquifer is exposed and generally unconfined in the Salem Plateau and is confined in the Springfield and Boston Mountain Plateaus by the Springfield Plateau aquifer system. For a detailed discussion of the hydraulic properties of this aquifer refer to Imes and Emmitt (1994) and Kresse and others (2013).

The upper Ozark aquifer is primarily composed of limestones and dolostones, which consist of nine geologic formations (Table 3.8). These formations range in thickness from very thin to intervals of a 1,000 feet or more throughout Arkansas. In the unconfined upper Ozark aquifer, recharge occurs as precipitation across outcrop areas, but where the upper Ozark aquifer is overlain by the Springfield Plateau aquifer system, most recharge occurs as downgradient flow from the outcrop areas. The primary porosity and permeability of the upper Ozark aquifer is low, with well yields ranging from 5 to 10 gpm (Kresse, et al. 2013); however, in the upland areas of the Salem Plateau, where karst topography is well developed and focused flow paths exists, spring discharges commonly exceed 100 cubic feet per second (cfs) (Imes and Smith 1990).

The lower Ozark aquifer is confined throughout Arkansas and consists of the Rubidoux Formation and the Gunter Member of the Gasconade Dolomite. These units are predominately sandstones with abundant dolomite and shaly intervals (Kresse, et al. 2013). While there are additional formations comprising the lower Ozark aquifer, these units are not used in Arkansas and were precluded from this report. The Ozark aquifer is confined below by the St. Francois Confining Unit. Recharge occurs as downgradient flow from outcrop areas in southern Missouri, with some leakage from the upper Ozark aquifer. Although the formations of the lower Ozark aquifer form a complex karst hydrological system of high yield in Missouri, production from the lower Ozark aquifer in Arkansas is attributed to porous sandstone layers rather than karst features. Wells in the lower Ozark aquifer are among the most productive in the region, with well yields ranging from less than 10 to near 600 gpm (Lamonds 1972).

Water-level data for the upper and lower Ozark aquifers are limited in Arkansas. For both aquifers, groundwater flow is generally south along the regional dip. For the upper Ozark aquifer, water levels average between 700 and 1000 feet in elevation. Water levels are generally a subdued reflection of topography, where the upper Ozark aquifer is unconfined, and groundwater flow directions are outward from areas of high elevation to discharge areas (streams) occurring at lower elevations (Kresse, et al. 2013). For the lower Ozark aquifer, water levels average between 400 and 1,000 feet elevation. Water-level variations are attributed to topographic relief, changes in pumping, and regional dip (Kresse, et al. 2013).

3.8.1.2 Western Interior Plains Confining Unit

The Boston Mountains Plateau and the portion of the Arkansas River Valley included in the NAWRPR are represented by a group of formations referred to as the Western Interior Plains (WIP) Confining Unit. These formations are comprised primarily of fractured shale, sandstone, and siltstone rocks of Mississippian and Pennsylvanian age that are characterized by low porosity, permeability, and yields. While there are no formally recognized aquifers, there are numerous shallow, undifferentiated, and saturated rocks of limited extent that are used for domestic and small community supply (Kresse, et al. 2013).

For this system, recharge occurs as precipitation that infiltrates the ground in upland areas and percolates to the water table. Groundwater flow paths are defined by small-scale topographic features where flow occurs from elevated areas to valley floors terminating in small stream systems. Groundwater storage in these aquifers is limited primarily to fractures and faults. Typical well yields range from 1 to 5 gpm, and thicker sandstone units in the eastern part of the WIP system commonly yield 5 to 10 gpm. It is not uncommon for wells in the WIP system to go dry during pumping, especially during dry periods. Water levels in the WIP confining system range from near land surface to approximately 50 feet below ground surface. Seasonal fluctuations are about 10 feet, with drawdowns from pumping increasing fluctuations to as much as 45 feet (Kresse, et al. 2013).

3.8.2 Groundwater Quality

In general, the water quality of groundwater in the NAWRPR is of good quality. Some problems with groundwater quality include sedimentation and some nutrient issues. Groundwater quality is discussed in more detail in Section 5.

3.9 Groundwater-Surface Water Connections

In the Springfield Plateau and Ozark aquifers, the karst network creates a hydrologic system of great complexity with a close connection between surface watersheds and groundwater basins. Direct hydraulic connections of karst features (sinkholes and conduits) to the land surface lead to rapid recharge from surface derived runoff associated with precipitation events. Flow in these areas is typically rapid, flow directions are difficult to predict, and inter-basin transfer (groundwater diversion to adjacent basins owing to karst piracy) is common. Locally, interaction between surface and groundwater can be extensive through losing and gaining stream segments and through cave streams, springs, and seeps that serve as tributaries or directly discharge to streams. Regionally, streams serve as flow boundaries and as primary drains to groundwater basins (Brahana 1997; Kresse, et al. 2013; Brahana, et al. 1999) Owing to the more pure carbonate lithologies of the Ozark aquifer, karst features tend to be more abundant, are more concentrated, and are larger in size than the karst features of the Springfield plateau aquifer

(Adamski, et al. 1995) which allows for a greater quantity of water to be transported through the system.

In general, there is less surface water-groundwater interaction in the Boston Mountains and the northern portions of the Arkansas River Valley than in the Springfield and Salem Plateaus. In the Boston Mountains, stream flow is primarily derived from surface runoff and typically none of the streams are considered perennial (Adamski, et al. 1995).

4.0 SOCIO-ECONOMIC CHARACTERISTICS

The socio-economic characteristics of the NAWRPR include current demographics, income, employment, and industries. This section describes these characteristics and presents changes in these regional characteristics since the 1990 AWP update. In addition, the wastes generated by the communities and industries in the NAWRPR are characterized. These wastes must be properly managed to protect water quality in the NAWRPR.

4.1 Demographics

Demographic information from the 2010 US Census for the counties within the NAWRPR are presented below. Demographic data presented include population totals, the percentages of people living in urban and rural areas, above or below selected ages, and of different races. Information from the 2010 Census is compared to information from the 1990 Census to identify population changes that have occurred since the last AWP update. Although the 1990 AWP updated reported population data from the 1980 Census, the 1990 Census data better represents conditions at the time of the previous update. Population changes affect the need and demand for water resources, not just for drinking water, but also for recreation, food supply, irrigation, and aesthetics. Population demographics also affect the potential tax base to pay for water infrastructure updates, expansion, and repairs.

4.1.1 2010 Population

The population of the NAWRPR was over 800,000 in 2010, an increase of over 50% since 1990. Population data for the region is summarized in Table 4.1, and mapped in Figure 4.1. Benton County and Washington County are the second and third most populated counties in the state, respectively. These two counties are part of the Fayetteville-Springdale-Rogers Large Metropolitan Statistical Area and contain the Fayetteville-Springdale-Rogers Urbanized Area (Figure 4.2) (US Census Bureau 2012). Large Metropolitan Statistical Areas are geographic regions, defined by the US Office of Management and Budget, where an area of high population density has close economic ties. Urbanized areas have a population of at least 50,000 people at a

density of 1,000 to 500 people per square mile (US Census Bureau 2011). In addition, 13 areas within the planning region were identified as Urban Clusters in the 2010 census (Figure 4.2). Urban Clusters are areas with population densities of 500 to 1,000 people per square mile, which contain a total of 25,000 to 50,000 people (US Census Bureau 2011, 2012). However, there are also two counties in the planning region with population under 10,000 inhabitants. About half of the total 2010 population in the planning region counties (51%) lived in urban areas. The percentage of people living in rural areas in 2010 varied from 100% in seven of the counties, to around 25% in Benton and Washington counties (US Census Bureau 2012).

Table 4.1 County populations in the NAWRPR (U of A at Little Rock Institute for Economic Advancement 2002, US Census Bureau 2012).

	Total population			**Percent Urban Population**		
County	**1990**	**2010**	**Change 1990 to 2010**	**1990+**	**2010**	**Change in percent urban population 1990 to 2010**
Baxter	31,186	41,513	33%	28.9%	34.2%	5.3
Benton	97,499	221,339	127%	55.6%	74.8%	19.2
Boone	28,297	36,903	30%	35.1%	37.8%	2.7
Carroll	18,654	27,446	47%	17.3%	27.2%	9.9
Cleburne	19,411	25,970	34%	28.8%	24.5%	-4.3
Fulton	10,037	12,245	22%	5.7%	7.1%	1.4
Independence	31,192	36,647	17%	29.5%	31.4%	1.9
Izard	11,364	13,696	21%	0%	0%	0.0
Lawrence*	17,457	17,415	0%	40.4%	36.4%	-4.0
Madison	11,618	15,717	35%	0.0%	0%	0.0
Marion	12,001	16,653	39%	0.0%	0%	0.0
Newton	7,666	8,330	9%	0.0%	0%	0.0
Randolph	16,558	17,969	9%	37.1%	32.6%	-4.5
Searcy	7,841	8,195	5%	0%	0%	0.0
Sharp	14,109	17,264	22%	27.0%	19.9%	-7.1
Stone	9,775	12,394	27%	0%	0%	0.0
Van Buren	14,008	17,295	23%	0%	0%	0.0
Washington	113,409	203,065	79%	65.2%	74.5%	9.3
White*	54,676	77,076	41%	40.8%	45.7%	4.9
Total	**526,758**	**827,132**	**57%**	**38.9%**	**51.0%**	**12.1**

*Part of this county is in another planning region

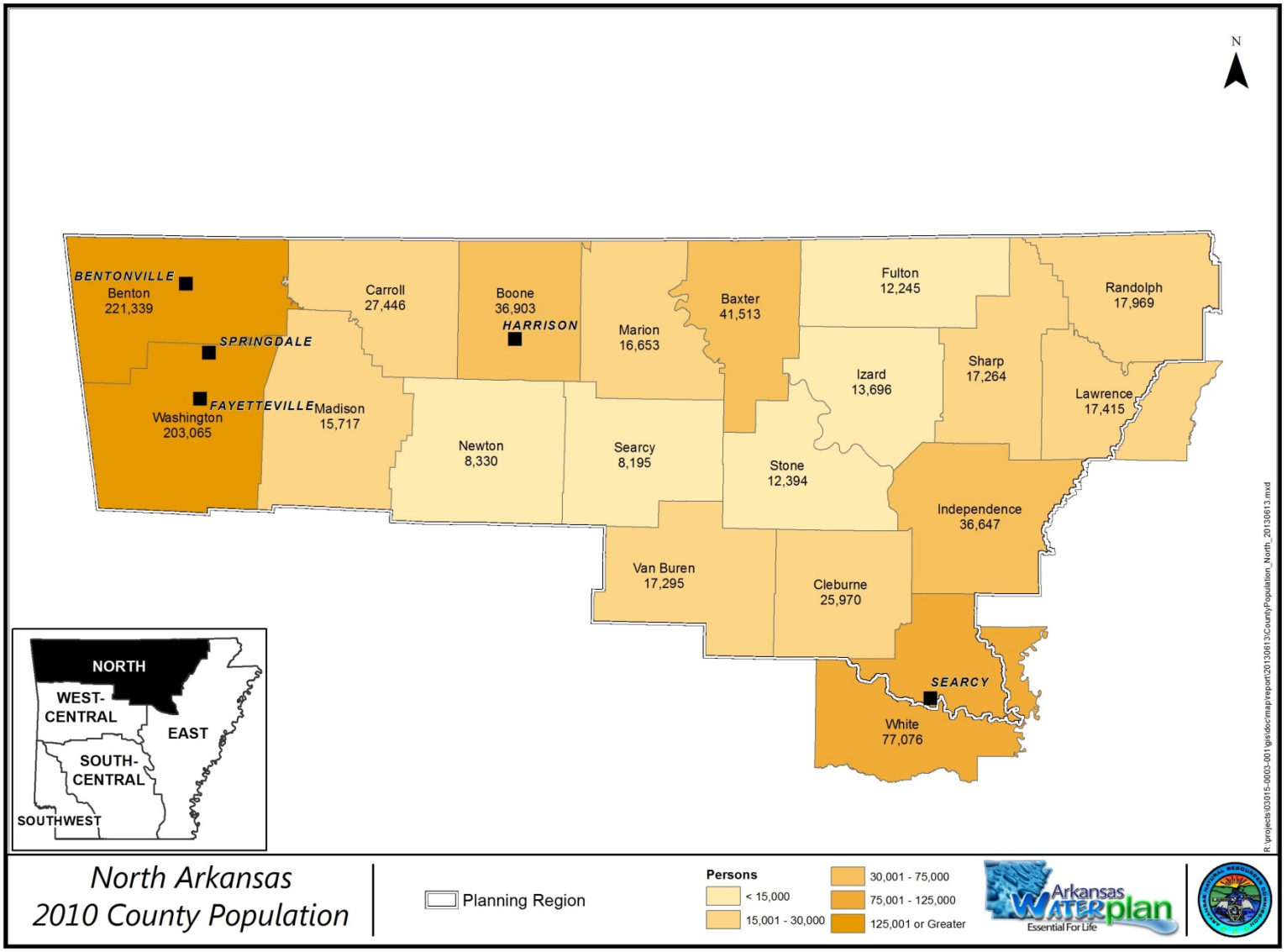

Figure 4.1. Population totals from the 2010 census for counties in the NAWRPR (US Census Bureau 2012b).

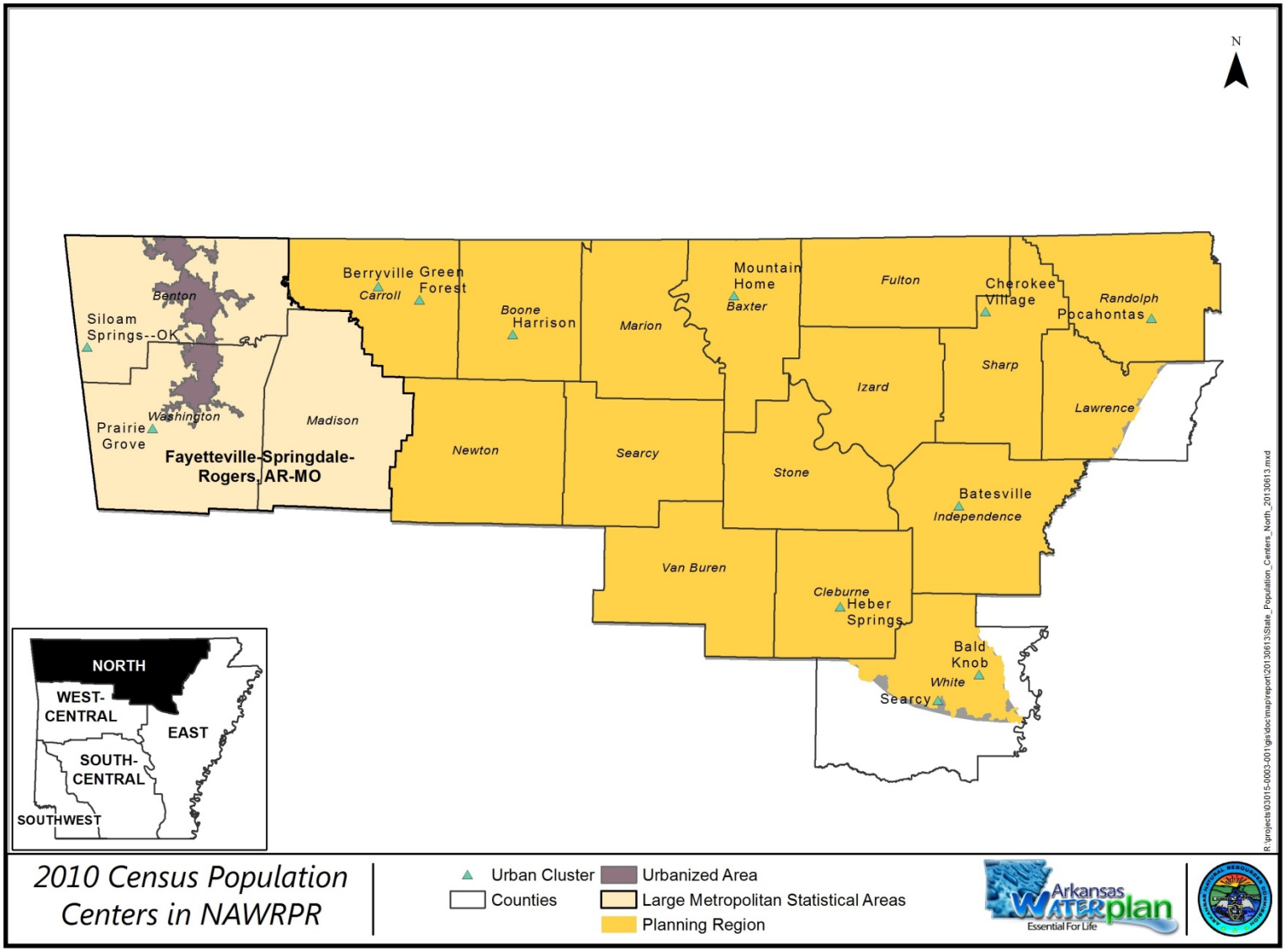

Figure 4.2. 2010 population centers located in the NAWRPR (US Census Bureau 2012a).

Demographic data on race for the counties within the NAWRPR are summarized in Table 4.2. There is a relatively large Hispanic population in a number of the counties in the region. Washington County is home to the largest population of Pacific Islanders in the state.

Table 4.2. Demographic summary for counties in the NAWRPR (US Census Bureau n.d.).

County	White Non-Hispanic	Black	Hispanic	Asian	American Indian	Pacific Islander	Other Single Race	Multiple Race
Baxter	39,837	59	688	163	217	16	14	519
Benton	169,605	2,647	34,283	6,245	3,440	634	224	4,261
Boone	35,139	64	674	153	247	21	17	588
Carroll	23,062	74	3,489	160	224	16	18	403
Cleburne	24,894	67	517	51	126	7	4	304
Fulton	11,805	39	97	28	79	1	5	191
Independence	32,914	709	2,139	276	142	19	16	432
Izard	13,006	175	208	39	102	2	3	161
Lawrence*	16,848	134	158	22	61	4	1	187
Madison	14,451	27	759	81	171	11	6	211
Marion	15,963	28	287	37	99	4	4	231
Newton	7,894	5	141	22	84	1	4	179
Randolph	17,226	128	283	28	89	4	1	210
Searcy	7,800	3	121	11	91	1	1	167
Sharp	16,399	91	290	49	164	2	4	265
Stone	11,912	11	157	45	82	3	3	181
Van Buren	16,282	65	475	56	113	2	7	295
Washington	150,546	5,828	31,458	4,372	2,154	4,100	227	4,380
White*	69,026	3,033	2,879	411	425	30	43	1,229
Total	**313,048**	**13,187**	**79,103**	**12,249**	**8,110**	**4,878**	**602**	**14,394**
Percentage	**38%**	**2%**	**10%**	**1%**	**1%**	**<1%**	**<1%**	**2%**

*Part of this county is in another planning region
+ Percentage based

Demographic data on age, sex, and education level for the counties within the NAWRPR are summarized in Table 4.3. The majority of the population in these counties (60%) is between the ages of 18 and 65. Of the total population over the age of 18, 30% are high school graduates. The highest percentage of high school graduates occurs in Sharp County, with 40% of inhabitants. An overall average of 18% of the population in the NAWRPR over the age of 18 are college graduates, with the highest percentages occurring in Benton and Washington Counties.

Table 4.3. Additional Demographic Characteristics of Counties in the NAWRPR (US Census Bureau n.d.).

County	Total female population	Total population under 18 Years	Total population over 65 Years	High School Graduates	College Graduates
Baxter	21,490	7,506	11,659	11,699	4,677
Benton	112,215	61,848	26,986	41,582	38,017
Boone	18,837	8,585	6,673	10,231	3,609
Carroll	13,915	6,183	5,131	7,000	3,271
Cleburne	13,193	5,162	6,118	6,975	3,067
Fulton	6,246	2,598	2,742	3,949	1,025
Independence	18,687	8,792	5,730	9,839	3,235
Izard	6,642	2,625	3,229	3,966	1,282
Lawrence*	8,947	3,992	3,160	4,957	1,098
Madison	7,836	3,801	2,452	4,362	1,288
Marion	8,366	2,983	3,964	4,924	1,834
Newton	4,124	1,736	1,701	2,463	754
Randolph	9,159	4,171	3,361	4,999	1,419
Searcy	4,110	1,675	1,745	2,338	504
Sharp	8,732	3,717	4,134	5,449	1,610
Stone	6,266	2,555	2,826	3,366	1,047
Van Buren	8,673	3,537	3,923	4,893	1,570
Washington	101,579	51,484	19,641	34,553	33,267
White*	39,274	18,433	10,848	18,146	8,892
Total	**418,291**	**201,383**	**126,023**	**185,691**	**111,466**
Percentage	**51%**	**24%**	**15%**	**30%+**	**18%+**

*Part of this county is in another planning region
+Percentage based on population 18 years or older

4.1.2 Changes from 1990

Table 4.3 shows population data for 1990. In 1990, Washington County had the largest population, followed closely by Benton County. At that time, Washington County was ranked as having the second largest county population the state, and Benton County was ranked fourth (U of A Little Rock Institute for Economic Advancement 2002).

Table 4.3 and Figure 4.3 show the population change for each county between 1990 and 2010. Most counties in the NAWRPR experienced population growth during this period. Overall, the population of the counties in the NAWRPR increased 57%. The greatest growth occurred in Northwest Arkansas in Benton and Washington Counties. Benton County had the greatest growth with a 127% increase in population. Population in Washington County increased 79%. Northwest Arkansas was named the 15th fastest growing region in the US by a 2010 U.S. Census Bureau Report (The City Wire 2012).Other counties in the region also experienced significant growth. Baxter, Boone, Carroll, Cleburne, Madison, Marion, Stone, and White Counties all had a population increase greater than 25%. Only Lawrence County experienced a decrease in population between 1990 and 2010, with a -0.2% change.

Most counties in the NAWRPR also experienced a growth in urban population percentage between 1990 and 2010. Benton County had the greatest growth from 55.6% to 74.8%. Some counties experienced no change in urban population, as their urban population remained 0. These counties are Izard, Madison, Marion, Newton, Searcy, Stone, and Van Buren Counties. Others had a decrease in urban population percentage. Cleburne, Lawrence, Randolph, and Sharp Counties all had a decline in the percent of population in urban areas.

4.2 Income and Employment

Income and employment data are available by county from the US Census Bureau. Recent data are presented below to characterize the current quality of life within the NAWRPR. Data from 1990 are also presented for comparison, to provide insight into changes that have occurred in the region since the 1990 AWP update.

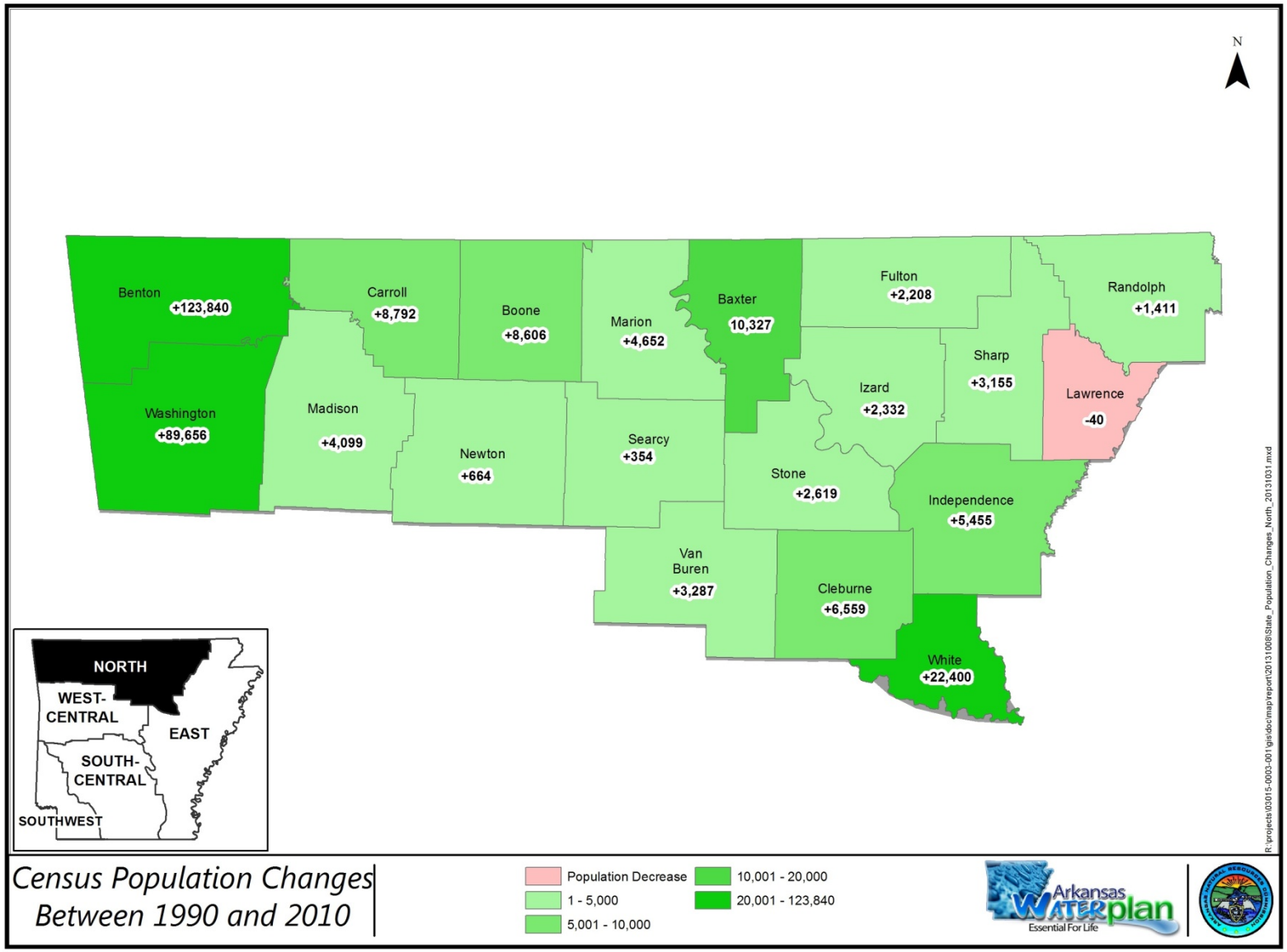

Figure 4.3. Population changes in the NAWRPR between 1990 and 2010.

4.2.1 Current Income and Employment Levels

Median household incomes reported by the US Census Bureau in the 2007-2011 Community Survey for counties in the NAWRPR are shown in Table 4.4. The average median household income in the planning region was just over $35,000. Searcy County had the lowest median household income in the planning region, $29,384. Two other counties in the planning region had median household incomes below $30,000. Benton County had the highest median household income in the region, $52,159, and the second highest in the state. Three counties - Benton, Washington, and White - had median household incomes greater than the state average of $40,149.

4.2.2 Changes in Income and Employment from 1990

Information on income and employment from the 1990 Census (1989 data) for the counties in the NAWRPR is included in Table 4.4. The average median income in the NAWRPR in 1989 was less than the state-wide median income of $21,147. The average median income in the 2010 census remained less than the state-wide median of $40,149 (US Census Bureau 2013).

Overall, the percentage of families and the percentage of population below poverty decreased from 1990 to 2010. However, the overall unemployment rate increased from 7.3% to 7.9%. All counties experienced an increase in unemployment except for Cleburne, Newton, Searcy, Sharp, Stone, and White Counties.

Table 4.4. Income and employment characteristics for counties in the NAWRPR (US Census Bureau n.d., U of A at Little Rock Institute for Economic Advancement 2002).

	Median household income		Families with income below poverty level		Population below poverty level		Unemployment	
County	1989	2007 - 2011	1990	2007 – 2011	1990	2007 – 2011	1990	2007 – 2011
Baxter	$ 18,826	$ 35,589	12.2%	10.8%	16.3%	16.0%	7.3%	8.9%
Benton	$ 26,021	$ 52,159	6.8%	8.5%	9.6%	11.8%	3.5%	5.5%
Boone	$ 20,656	$ 37,703	10.7%	10.9%	13.9%	15.8%	4.8%	6.3%
Carroll	$ 20,623	$ 36,031	12.1%	13.0%	15.2%	17.0%	5.9%	8.1%
Cleburne	$ 19,438	$ 38,510	14.0%	12.0%	17.3%	16.6%	8.8%	8.2%

Table 4.4. Income and employment characteristics for counties in the NAWRPR (continued).

County	Median household income		Families with income below poverty level		Population below poverty level		Unemployment	
	1989	2007 - 2011	1990	2007 – 2011	1990	2007 – 2011	1990	2007 – 2011
Fulton	$ 14,950	$ 33,281	22.1%	13.6%	26.3%	19.6%	8.3%	11.8%
Independence	$ 20,208	$ 34,878	13.2%	16.2%	17.1%	21.4%	6.6%	7.1%
Izard	$ 16,910	$ 31,865	16.4%	14.5%	21.1%	17.8%	7.2%	10.7%
Lawrence*	$ 15,337	$ 32,337	20.6%	19.0%	25.0%	23.3%	7.9%	9.2%
Madison	$ 18,392	$ 35,579	17.1%	16.9%	20.1%	20.8%	4.0%	6.5%
Marion	$ 17,220	$ 34,063	14.7%	13.1%	18.9%	17.0%	7.3%	8.0%
Newton	$ 18,000	$ 29,702	22.9%	18.1%	29.6%	21.6%	9.3%	3.8%
Randolph	$ 16,719	$ 33,072	15.8%	16.5%	20.4%	19.9%	7.6%	8.1%
Searcy	$ 13,221	$ 29,384	24.5%	13.7%	29.9%	22.1%	9.1%	5.8%
Sharp	$ 17,362	$ 29,590	16.9%	15.6%	21.8%	24.0%	11.4%	10.2%
Stone	$ 15,655	$ 31,364	21.0%	16.4%	26.0%	22.4%	9.3%	7.3%
Van Buren	$ 17,103	$ 32,906	17.2%	16.9%	22.2%	24.9%	8.7%	9.6%
Washington	$ 23,124	$ 41,474	9.8%	12.8%	14.6%	18.9%	3.9%	6.9%
White*	$ 19,722	$ 41,618	14.7%	12.5%	18.7%	16.4%	8.0%	7.4%
Average	**$ 18,394**	**$ 35,321**	**15.9%**	**14.3%**	**20.2%**	**19.3%**	**7.3%**	**7.9%**

*Part of this county is in another planning region

4.3 Economic Drivers

Agriculture, tourism, manufacturing, education, and retirement communities are important economic drivers in the NAWRPR (Association of Arkansas Counties 2013). The US Census Bureau conducts an economic census every 5 years. This includes information on the value of sales, and the number of people employed by the industrial sector by county. Information from the 1992 and 2007 economic census, as well as the 1990 and 2010 census, are presented below. It should be noted that US Census data withholds some information in order to avoid disclosing information for individuals and individual companies. Also, all totals include county-wide data for Lawrence and White Counties, both of which are not entirely in the NAWRPR. Therefore the reported US Census data for all years should be considered estimations.

4.3.1 Current Regional Economic Drivers

The value of sales and receipts reported for the counties within the NAWRPR in the 2007 economic census is summarized on Figure 4.4. Agriculture is not an economic sector reported in the economic census. However, agriculture contributes value to manufacturing, real estate, wholesale trade, and transportation and warehousing economic sectors (U of A Divison of Agriculture 2012). Retail trade accounts for the largest proportion of the value of sales and receipts, followed by manufacturing and services. Note that approximately 57% of the value of sales and receipts reported in 2007 were from Northwest Arkansas, with 39.2% of the total in Washington County. White County also had a significant portion, with approximately 10% of the total.

The number of people employed in the NAWRPR by economic sectors, as reported in the 2007-2011 American Community Survey (ACS) and the 2007 Economic Census, are summarized on Figure 4.5. The economic sectors for which employment is reported in these two sources are slightly different. However, both sources indicate that health care and education, retail trade, and manufacturing provide the majority of employment in the NAWRPR. Agriculture generates jobs in every economic sector, particularly manufacturing, health care, retail trade, and transportation and warehousing (included in administration on Figure 4.5) (U of A Divison of Agriculture 2012).

The majority of people employed in the NAWRPR reside in Northwest Arkansas, in Benton and Washington Counties. These two counties account for approximately 55% of employment in the region, according to the 2007-2011 ACS data. White County accounts for approximately 9% of jobs. The least number of jobs are located in Newton County (US Census Bureau n.d.).

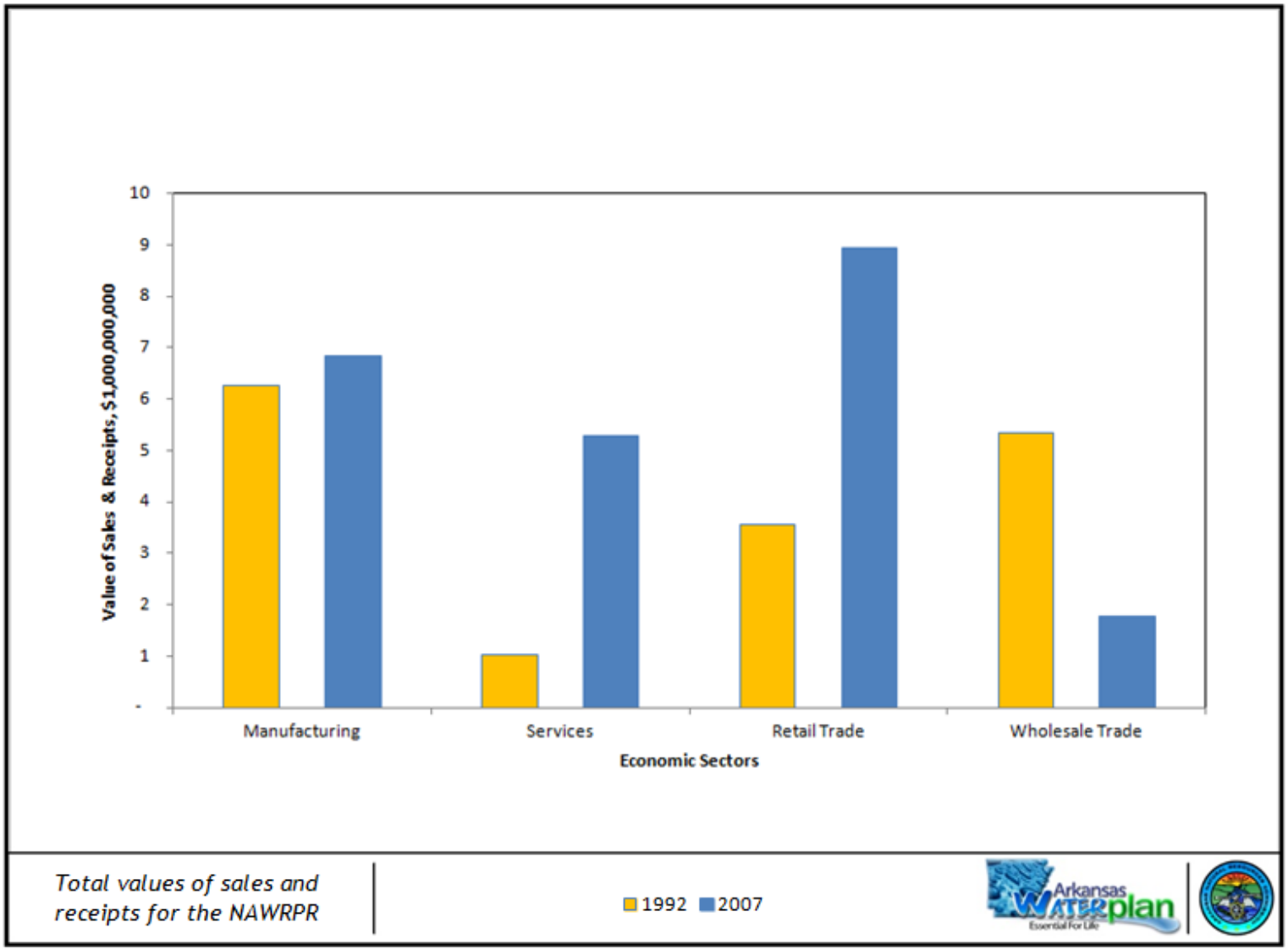

Figure 4.4. Total values of sales and receipts by economic sector for the NAWRPR (US Census Bureau 1992,2007).

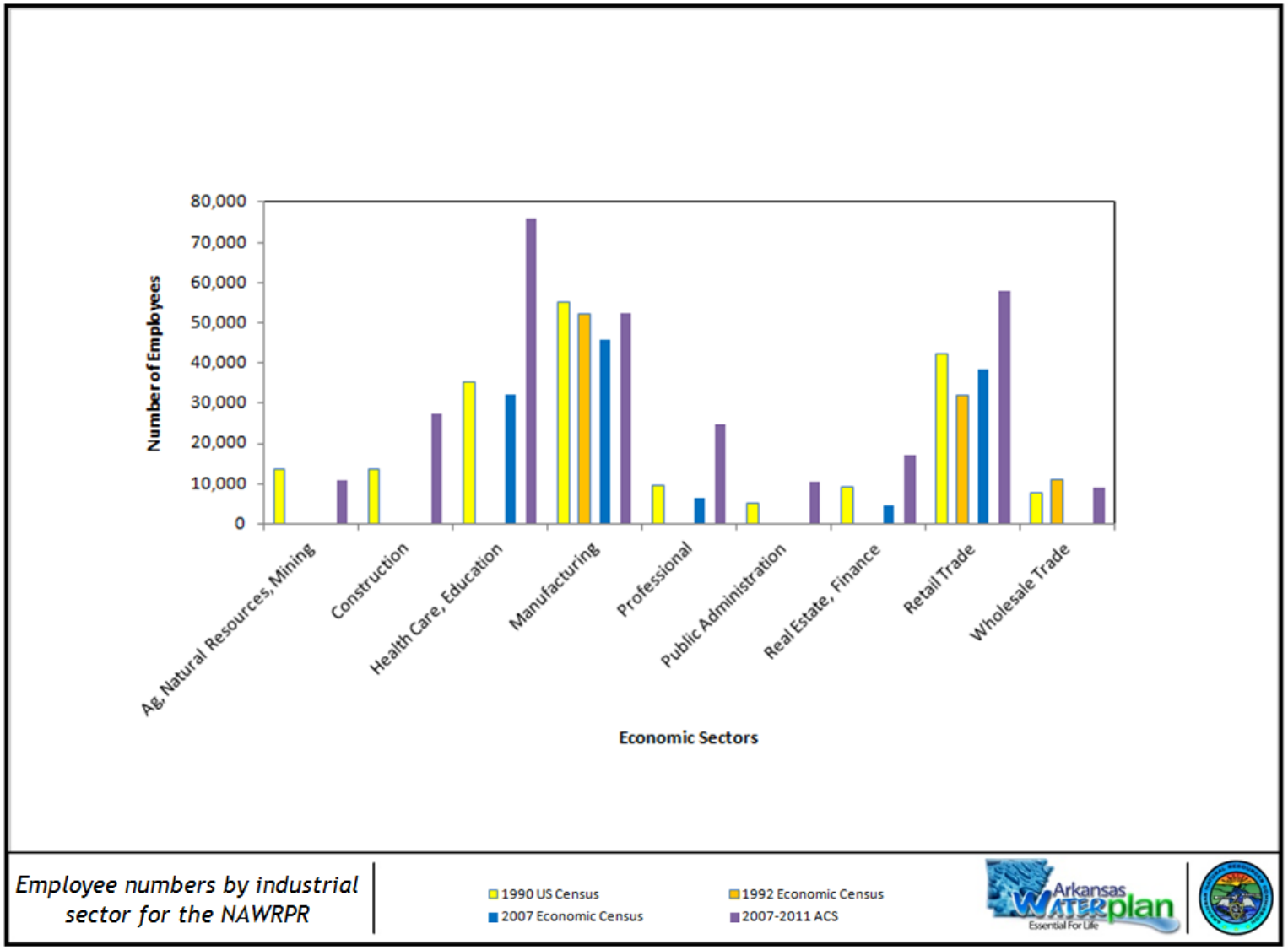

Figure 4.5. Total number of employees by economic sector for the NAWRPR (US Census Bureau n.d. 1992, 2007, 2011; U of A at Little Rock Institute for Economic Advancement 2002).

4.3.1.1 Agriculture

Agriculture is the largest industry in Arkansas. Arkansas is the second-largest broiler producer in the country (USDA 2012). Northwest Arkansas, particularly Benton and Washington Counties, produces most of the state's poultry (Riffel 2013a). Livestock sales, which includes poultry and eggs, accounted for the majority (95%) of the 2007 revenues from sale of agricultural products in the counties in the planning region. The total value for sale of livestock produced in these counties during 2007 was close to $2 billion, and poultry sales accounted for the majority of this value (Table 4.5). In most counties, the value of poultry sales was greater than the value of cattle and swine sales (USDA National Agricultural Statistics Service 2009).

Crop production also contributes to the economy of the planning region. The total value for sale of crops produced in the counties of the NAWRPR during 2007 was over $184 thousand (Table 4.5).

Table 4.5. Value of selected agricultural product sales in the counties of the NAWRPR (US Census Bureau 1989, USDA National Agricultural Statistics Service 2009).

	Poultry and eggs value ($1,000)		Cattle value ($1,000)		Swine value ($1,000)		Livestock value ($1,000)		Crop value ($1,000)	
County	**1987**	**2007**	**1987**	**2007**	**1987**	**2007**	**1987**	**2007**	**1987**	**2007**
Baxter	$8,170	$4,955	$6,203	$10,249	$150	$22	$14,661	$16,781	$186	$741
Benton	$199,986	$378,588	$20,708	$28,435	$26,726	D	$259,452	$427,015	$4,032	$6,942
Boone	$10,240	$92,109	$11,673	$24,398	$506	$21	$24,990	$117,725	$528	$2,081
Carroll	$55,312	$227,899	$16,643	$27,147	D	$47	$79,649	$258,836	$840	$2,273
Cleburne	$27,637	$42,987	$4,060	$9,901	$533	$9	$34,040	$54,505	$269	$1,618
Fulton	$1	D	$7,205	$21,393	$1,524	$36	$12,352	$25,121	$209	$649
Independence	$28,815	$73,215	$7,805	$28,312	$608	$19	$37,662	$101,877	$9,233	$21,754
Izard	$10,795	$23,563	$4,284	$10,170	$1,245	D	$17,253	$39,138	$200	$1,165
Lawrence*	D	$19,139	$2,807	$5,067	$602	$42	$3,986	$15,589	$36,815	$53,548
Madison	$57,339	$137,964	$10,226	$16,554	D	$34	$75,656	$157,340	$604	$2,787
Marion	$2,295	$25,186	$7,629	$8,143	$240	$31	$11,240	$34,048	$156	$755
Newton	D	$11,147	$2,904	$5,130	$1,034	$1,456	$4,735	$18,093	$122	$927
Randolph	D	$10,191	$4,615	$10,407	$1,243	$97	$6,316	$20,984	$14,369	$43,265
Searcy	D	D	$6,199	$8,528	$392	D	$9,468	$11,548	$273	$719
Sharp	$4,626	$43,117	$4,555	$11,903	$593	$22	$10,376	$55,860	$275	$805
Stone	$25,124	$26,243	$3,887	$16,266	$108	$4	$29,218	$42,673	$309	$1,012
Van Buren	$8,053	$4,854	$3,236	$5,980	$272	D	$16,391	$14,226	$407	$1,276
Washington	$245,398	$365,621	$19,861	$32,084	$19,501	D	$295,579	$410,061	$3,120	$7,904
White*	$22,604	$59,068	$8,577	$22,375	$328	$58	$35,025	$34,000	$18,066	$34,241
Total	**$706,395**	**$1,545,846**	**$153,077**	**$302,442**	**$55,605**	**$1,898**	**$978,049**	**$1,855,420**	**$90,013**	**$184,462**

* Part of this county is in another planning region.; D=data withheld to protect privacy

4.3.1.2 Tourism

Tourism is the second largest industry in Arkansas. Tourism, including water-based recreation, is a large contributor to the economy of the NAWRPR. According to the 2012 Annual Report Summary from the Arkansas Department of Parks and Tourism, Northwest Arkansas (Benton, Carroll, Madison, and Washington Counties) has the highest revenue from tourism in the state, as well as the greatest number of visitors (Arkansas Department of Parks and Tourism 2012).

The five large reservoirs in the NAWRPR (Beaver Lake, Bull Shoals Lake, Norfork Lake, Greers Ferry Lake, and Table Rock Lake) contribute to the economy of the region in many ways. The reservoirs are popular tourist attractions, with several state parks, marinas, campgrounds, and activities to draw tourists to the area. USACE has estimated economic impacts of recreation at the reservoirs located in the NAWRPR. Overall, the five USACE reservoirs in the planning region generate over 1,000 jobs, and over $625 million in revenue, wages, and taxes (Table 4.6). Also, Beaver Dam, Bull Shoals Dam, Norfork Dam, and Greers Ferry Dam all house hydroelectric power plants. In 1990, approximately 9% of electricity in Arkansas was produced by hydroelectric plants, but this usage dropped to 3% by 2006 (Reynolds 2012).

Table 4.6. Economic benefits from USACE reservoirs in the NAWRPR in 2012 (USACE 2013).

Reservoir	Total Sales ($1,000)	Jobs	Payroll ($1,000)	Value Added ($1,000)
Beaver Lake	$65,637	955	$25,342	$40,558
Bull Shoals Lake	$58,680	919	$21,415	$36,005
Greers Ferry Lake	$164,296	2,706	$58,986	$98,499
Norfork Lake	$29,549	520	$9,961	$17,363
Table Rock Lake+	$98,883	1,446	$35,879	$59,887
Total	**$417,045**	**6,546**	**$151,583**	**$252,312**

*Includes wages, salaries, payroll benefits, profits, rents, and indirect business taxes.
+ The majority of this reservoir and its benefits are in Missouri.

Hunting, fishing, and wildlife watching account for a significant portion of the tourism economy of the NAWRPR. In 2011, Arkansas ranked seventh in the nation in hunting-related sales. There are several WMAs in the region. Along with the large reservoirs in the region, there

are also several smaller lakes, ponds, and rivers that attract anglers. The AGFC maintains 36 fishing locations in the NAWRPR (AGFC 2011a). Four of these locations are on WMAs that are maintained by the state. Three of the AGFC –listed fishing areas are also USACE-maintained lakes. Economic contributions from wildlife recreation in Arkansas are summarized in Table 4.7. Regional data are not available.

Table 4.7. Economic contributions from wildlife recreation in Arkansas (AGFC 2013a, USFWS, US Census Bureau 1993, 2013).

Activity	Total expenditures (million $)		2011 Retail sales (million $)	2011 State/local tax revenue (million $)	2011 Federal tax revenue (million $)
	1991	2011			
All hunting	$85.0	$1,018.8	$877.4	$99.2	$99.5
Waterfowl hunting	NR	$288.0	$236.7	$29.1	$23.9
Sport fishing	$216.9	$495.6	$508.0	$49.4	$49.8
Wildlife watching	NR	$216.1	NR	NR	NR

NR=Not reported

Streams in the NAWRPR are also important to the tourism and recreation economy of the planning region. ADEQ has designated Bull Shoals Lake and 1,165 miles of streams in the planning region as Extraordinary Resource Waterbodies for “scenic beauty, aesthetics, broad scope recreation potential, and intangible social values” (Figure 4.6) (APCEC 2011). Over 325 miles of streams in the planning region are designated as Natural and Scenic Waterways (Figure 4.6). The Buffalo River is the first designated National River. Forty-three miles of the Strawberry River are designated as Arkansas Natural and Scenic River, and portions of North Sylamore Creek and Richland Creek are designated as National Wild and Scenic Rivers (ANHC 2012).

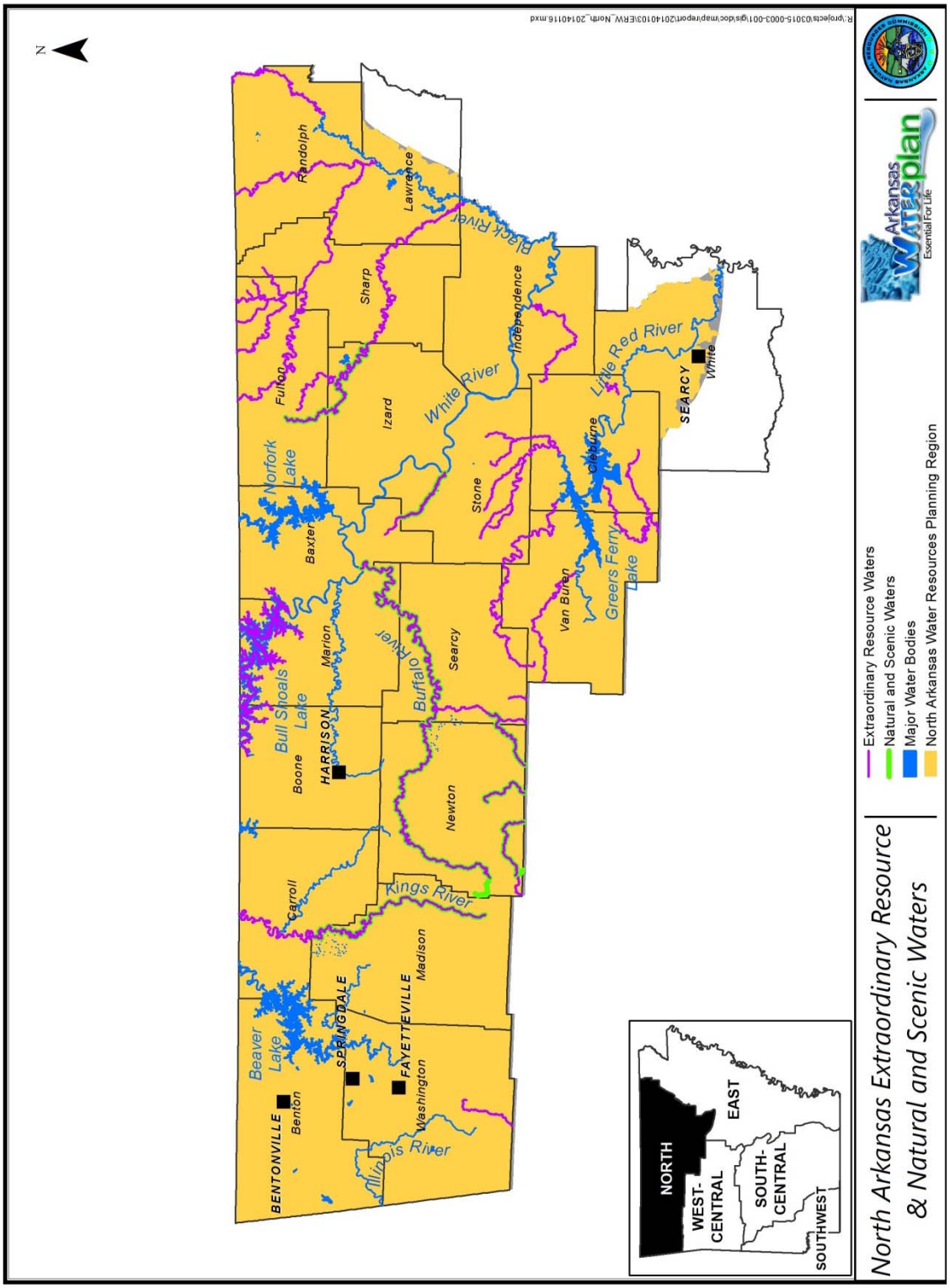

Figure 4.6 Designated extraordinary resource waters and natural and scenic waterways in the NAWRPR.

4.3.1.3 Fayetteville Shale Natural Gas Production

A new horizontal fracturing technique established in the late 1990s in the natural gas industry has made it possible to extract natural gas from shale formations. Beginning in the mid-2000s, gas production began in the Fayetteville Shale formation in Central Arkansas, including Van Buren, Independence, Cleburne, and White Counties (Figure 4.7). The introduction of this new industry in the region had a very positive impact on the economy, providing new employment opportunities and also boosting other industries in the region, including transportation, hospitality, education, and finance (Center for Business and Economic Research, U of A 2012).

4.3.1.4 Fish Hatcheries

Several fish hatcheries are located in North Arkansas. Trout hatcheries maintained by the USFWS are located downstream of Greers Ferry Dam, Bull Shoals Dam, Beaver Dam, and Norfork Dam. According to the USFWS, for every $1 spent on fish hatchery operations, more than $100 was generated for the economy (Shoults 2012).

A warm water fish hatchery is located in Centerton, in Benton County. The C.B. "Charlie" Craig State Hatchery is managed by the Arkansas Game and Fish Commission. Another warm water hatchery is located at Mammoth Spring, in Fulton County. It was established in 1903 and is maintained by the USFWS. The Mammoth Spring National Fish Hatchery works to restore various species of fish to areas in the White River basin and also is working to help recover endangered and threatened species such as freshwater mussels. The USFWS states that for every tax dollar used for the hatchery, there is a $12 net economic value, totaling over $1.5 million per year (USFWS 2010b).

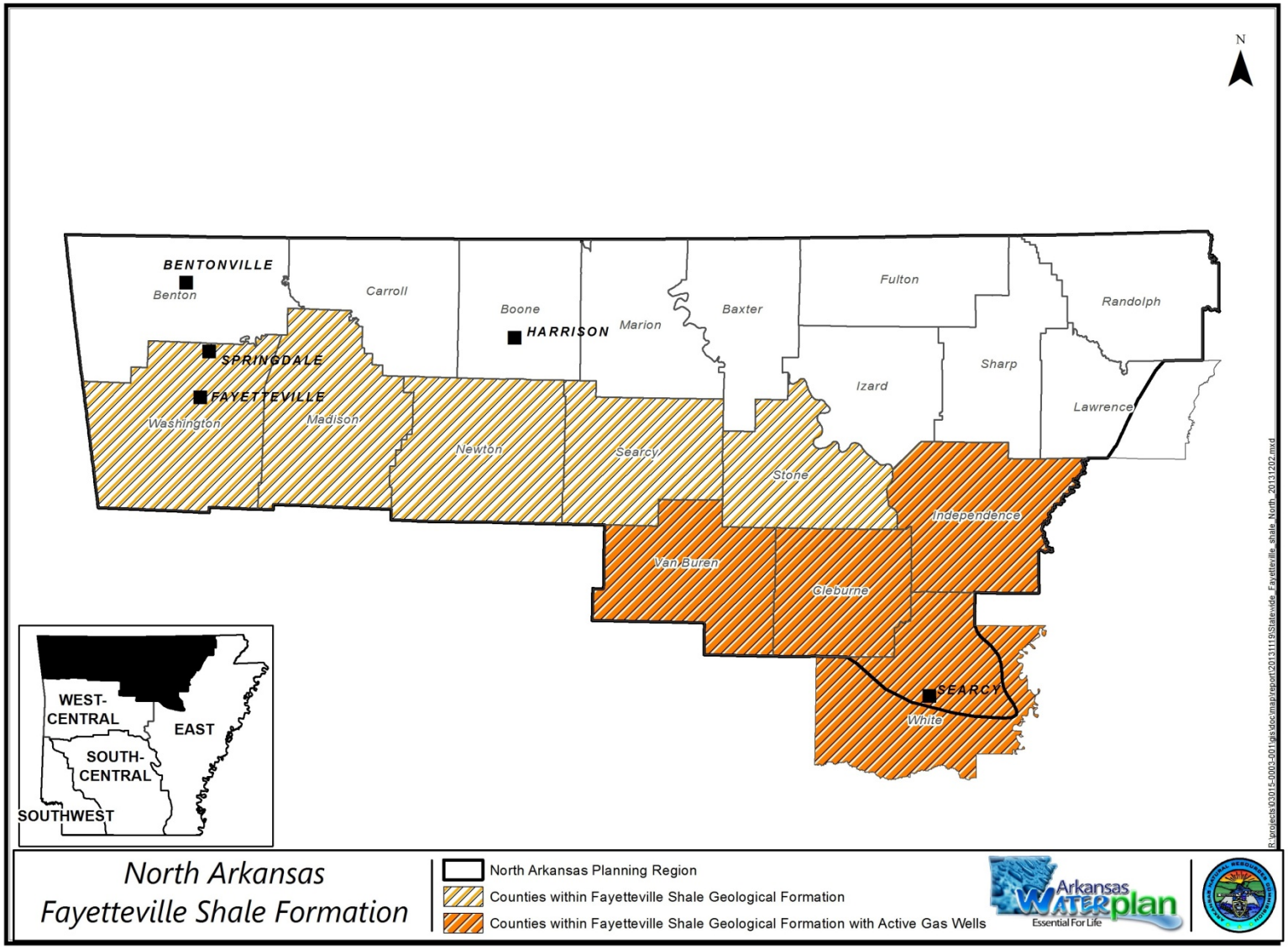

Figure 4.7. North Arkansas Fayetteville Shale formation and counties with active gas well sites.

4.3.1.5 Corporations

There are a number of large corporations based in the NAWRPR, including Tyson Foods, Wal-Mart Stores, Inc., and J.B. Hunt. The largest of these is Wal-Mart Stores, Inc. Wal-Mart is the most profitable retail outlet in the world (Riffel 2013b). It is based in Bentonville and is one of the largest employers in the United States (Wal-Mart 2014a). Wal-Mart annual revenues in 2013 were over $460 billion (Walmart 2014b).Tyson Foods, which is based in Springdale, is one of the largest producers of food in the world. In 2013, Tyson Foods annual revenue was over $34 billion (Tyson Foods, Inc. 2014). J.B. Hunt Transport Services, Inc., is based in Lowell. It is the largest trucking company in Arkansas and one of the largest transportation logistics companies in the United States (Cothren 2011). J.B. Hunt annual revenues in 2013 were greater than $5 billion (J.B. Hunt Transportation Services Inc. 2014).

4.3.2 Comparison to 1990 Regional Economy

1992 US Economic Census totals for values of sales and receipts for the NAWRPR are given in Figure 4.3 along with the 2007 data. The 1992 data does not report several economic sectors for county level, and several sectors are grouped together. From the data provided, however, it can be seen that manufacturing and retail have continued to be the dominant sales industries in the region. Wholesale trade sales have declined.

1992 US Economic Census totals and 1990 Census totals for number of employees per industrial sector are given in Figure 4.5 alongside the 2007 Economic Census and 2007-2011 ACS data. Again, some sector divisions are slightly different among the different census reports. However, it can be inferred from the given data that manufacturing, retail, and health care have continued to be the main sectors of employment since 1990. The finance and real estate, professional and administrative services, and construction sectors have shown a general increase in employment numbers from 1990 to present. The overall number of employees was significantly greater in the 2007-2011 data as compared to all other data sets.

4.3.2.1 Agriculture

Agriculture was the largest industry in the state in 1990. In 1987 and 1992, Arkansas was first in the nation in terms of broiler production (US Census Bureau 1990, US Department of Commerce 1994). As in 2012, Washington and Benton Counties were ranked highest in the state in value of poultry product sales in 1987 and 1992 (US Department of Commerce 1994). The value of both livestock sales and crop sales in 1987 was less than in 2007 (Table 4.5). Swine production appears to have declined since 1987 in most of the counties of the planning region (Table 4.5).

4.3.2.2 Tourism

Tourism trends have not changed significantly since 1990. Northwest Arkansas was the most profitable area of the NAWRPR for tourism in 1990, as it was in 2012 (Arkansas Department of Parks and Tourism 1991, 2012).

4.3.2.3 Other Changes

The development of the Fayetteville Shale natural gas is the largest change in the regional economy since 1990. Other changes include the growth of companies in the region. J.B. Hunt Transport Services, Inc. increased annual revenue from $1 billion in 1993 to over $5 billion in 2013. Wal-Mart grew as well. In 1990 Wal-Mart was the top retailer in the nation, but expanded globally throughout the world in the 1990's and 2000's (Walmart 2014c).

4.4 Waste Generation and Disposal

Industries and communities in the NAWRPR produce wastes that must be properly managed to protect water quality, which contributes to water availability for the water users of the NAWRPR. The ADEQ is the state agency responsible for regulating solid waste, hazardous waste, and wastewater. These three waste sources are managed through separate permitting programs overseen by the US Environmental Protection Agency (EPA). Waste management in the NAWRPR is quantified below, along with changes in waste management that have occurred since the 1990 AWP update.

4.4.1 Solid Waste

There are three regional solid waste management districts (RSWMDs), and portions of two RSWMDs, within the NAWRPR (Figure 4.8). Information on solid waste generation and disposal for each of these districts is summarized in Table 4.8. All but the Ozark Mountain RSWMD, report that their solid waste disposal facilities and collection services are sufficient to meet demand. However, illegal dumping that occurs in the districts could pose local threats to water quality.

Table 4.8. Solid waste generation and disposal information for RSWMDs in the NAWRPR (Benton County RSWMD 2011, Boston Mountain RSWMD 2011, Northeast Arkansas RSWMD 2011, Ozark Mountain RSWMD 2011, White River RSWMD 2011).

RSWMD Name	Number of counties in RSWMD	Number of Counties in planning region	Number of landfills in planning region	2010 Solid Waste Generated In-district (tons)	2010 Solid Waste Disposed In-district (tons)	Number Illegal Dump Sites Identified 2010
Benton	1	1	1	351,929	238,995	Not available
Boston Mountain	2	2	1	450,000	Not available	31
Ozark Mountain	6	6	0	Not available	71,628	Not available
White River	10	7 + 1 partial	2	127,845	101,794	12
Northeast	4	1 + 1 partial	0	70,558	70,064	Not available

There have been significant changes in the solid waste arena since 1990, driven by the need to protect water quality. In 1991, federal regulations changed, requiring improvements in the way landfills were constructed in order to protect groundwater quality. In addition, the new regulations required monitoring of groundwater quality around landfills (EPA 2012a, ADEQ 2011a). At the same time, state regulations set up programs to fund cleanup of groundwater contamination from landfills, and for collection and recycling of batteries and waste oil, both of which pose risks to surface and groundwater quality when disposed of improperly. Around 1995, the Arkansas General Assembly established a policy to eliminate illegal dumping, another threat to surface and groundwater quality. State legislation to implement this policy was passed in 1997. In 2005, state legislation was passed that resulted in the development and implementation

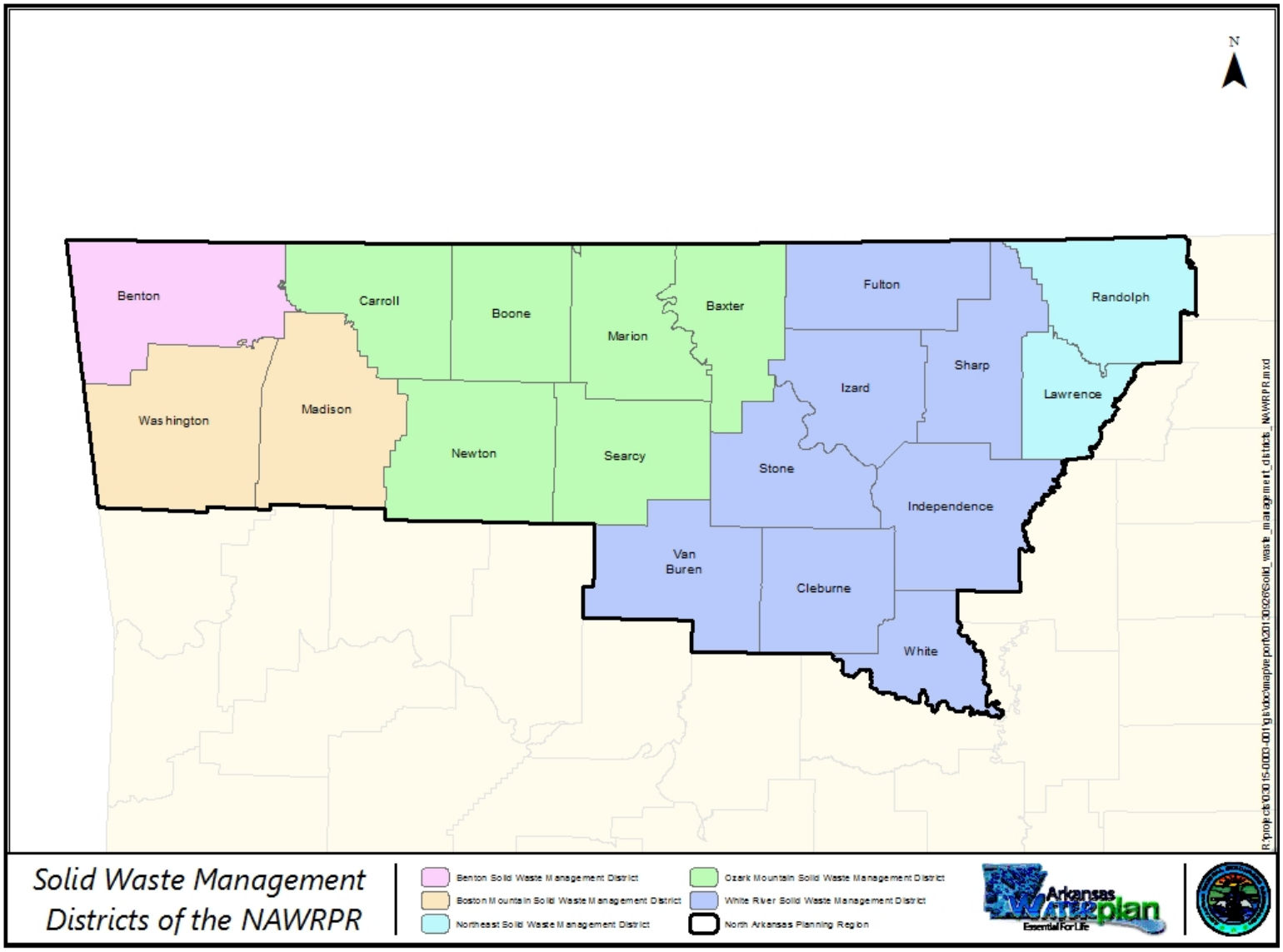

Figure 4.8. Solid waste management districts of the NAWRPR (ADEQ 2011b).

of a comprehensive mercury minimization program for the state. Mercury is a surface water quality issue throughout the state (ADEQ 2011a).State programs initiated since 1990 for the collection and recycling of electronics and collection of household hazardous wastes also protect water quality.

4.4.2 Hazardous Waste

There are 145 permitted hazardous waste generators in the counties within the NAWRPR (Table 4.9). The majority of the permitted hazardous waste generation facilities in the planning region are located in Washington County. There are 38 facilities in the counties within the NAWRPR that are classified as large quantity generators, meaning they generate at least 1,000 kilograms of hazardous waste per month (EPA 2012b). There are 107 facilities classified as small quantity generators, meaning they generate between 100 and 1,000 kilograms of hazardous waste per month (EPA 2012c).There are also two active hazardous waste treatment/storage/disposal facilities in the region; one in Independence County, and one in Izard County (ADEQ 2012a).

Hazardous waste generation data is compiled annually, but this program was not implemented in Arkansas until after 1990. Information from 1990 on the number of hazardous waste generators is also not readily available. Therefore, a comparison with 1990 conditions has not been made in this document.

Table 4.9. Hazardous Waste Generators in the NAWRPR (ADEQ 2012a).

County	Large Quantity Generator	Small Quantity Generator
Baxter	1	8
Benton	6	27
Boone	1	5
Carroll	0	1
Cleburne	1	3
Fulton	0	0
Independence	3	3
Izard	1	0
Lawrence*	0	0
Madison	0	2
Marion	1	0
Newton	0	0
Randolph	1	3
Searcy	0	0
Sharp	0	0
Stone	0	1
Van Buren	0	1
Washington	18	44
White**	5 (5)	9 (6)
Total	**38**	**107**

*Part of this county is in another planning region; values reported are for the permits located within the planning region only
** Part of White County is in another planning region; some permits were located in the City of Searcy, which is divided by the region boundary; all permits for this city were included and are shown in parentheses

4.4.3 Wastewater and Stormwater

There are around 960 point sources with active permits to discharge wastewater and stormwater in the NAWRPR (Table 4.10). These discharges are permitted by ADEQ through the federal National Pollutant Discharge Elimination System (NPDES). Industrial, municipal, and domestic wastewater discharges are permitted through NPDES as well as discharges of stormwater and runoff associated with industrial sites, municipalities (MS4s), and temporary construction sites. See Section 6 for more details on wastewater regulations and permitting in Arkansas.

Table 4.10. Active NPDES Permits in the NAWRPR (ADEQ 2013d).

County	NPDES Industrial	NPDES Municipal	NPDES Domestic	NPDES Stormwater	Construction of WWTP	NPDES Other[1]	Total
Baxter	14	3	7	21	4	2	51
Benton	25	10	5	159	6	18	223
Boone	15	3	1	25	2	1	47
Carroll	8	4	5	10	5	3	35
Cleburne	9	3	5	29	2	4	52
Fulton	6	2	0	4	0	0	12
Independence	27	4	1	34	3	6	75
Izard	8	5	1	15	5	1	35
Lawrence*	6	5	1	3	0	0	15
Madison	6	1	0	14	0	2	23
Marion	3	2	3	4	0	2	14
Newton	2	2	0	7	2	4	17
Randolph	8	5	0	6	2	2	23
Searcy	1	2	0	3	1	3	10
Sharp	1	4	1	8	0	0	14
Stone	2	1	2	7	1	2	15
Van Buren	10	2	6	13	2	2	35
Washington	36	6	3	139	3	2	189
White**	19 (14)	6 (1)	2 (1)	43 (33)	1	7 (3)	78
Total	**206**	**70**	**43**	**544**	**39**	**61**	**963**

*Part of this county is in another planning region; values reported are for the permits located within the planning region only

** Part of White County is in another planning region; some permits were located in the City of Searcy, which is divided by the region boundary. The given value for permits is for the whole region in the NAWRPR including Searcy, with the number of permits in Searcy in parentheses

[1]Includes filter backwash, process water, agricultural, cooling water, toxics, and saltwater discharges.

Approximately 95 surface water bodies in the planning region receive discharges from permitted entities. Several of these water bodies receive discharges from more than one point source (ADEQ 2008).

Table 4.11 compares the number of NPDES permits for municipal, domestic, and industrial wastewater reported for the NAWRPR in the 1990 state-wide water quality assessment, with the current numbers for the same categories of NPDES permits. The number of permitted wastewater discharges in these categories in the NAWRPR has increased approximately 165% since the 1990 AWP update. Note that the state-wide water quality assessment reports do not include permits for municipal, industrial, or construction stormwater runoff. The first industrial and construction stormwater runoff NPDES permits were issued by

ADEQ in 1992 (ADEQ 2013a, ADEQ 2013b). ADEQ did not issue permits for small municipalities' stormwater runoff until 2004 (ADEQ 2013c).

Table 4.11. Comparison of active NPDES Permits in the NAWRPR in 1990 and 2013 (ADEQ 2013d, ADPCE 1990)

Permit type	1990	2013	Change
Industrial	10	206	196
Municipal	66	70	4
Domestic	48	43	-5
Cooling water	3	2	-1
Filter backwash	3	23	20
Process water	1	23	22
Agricultural	1	2	1
Other	14	19	5
Total	**146**	**388**	**242**

5.0 WATER RESOURCES ISSUES

Water resources issues in the NAWRPR include concerns about the amount of water that is available, how the water is used, and the chemical and biological quality of water resources. In addition, there are concerns in the region about how water is managed in terms of flood control, water supply infrastructure, and wastewater treatment infrastructure. These issues are discussed and, to some extent, quantified below. Changes in regional water resources issues since the 1990 AWP update are also discussed.

5.1 Flooding

Flood control has long been an issue for the White River, the main waterway in the NAWRPR. As a result of the Flood Control Act of 1944, several dams were constructed along the river in order to control flooding, including USACE projects – Beaver Dam, Table Rock Dam (in Missouri), Greers Ferry Dam, Norfork Dam, and Bull Shoals Dam. Flooding occurs routinely throughout the planning region, but many of the floods are isolated events that affect only small areas or are limited to a few watersheds. Large, widespread disasters also occur. Since 1957, there have been 34 major disaster declarations involving flooding in Arkansas. From 2003 to 2010, some or all of the counties included in the NAWRPR were included in 15 flooding disaster declarations (Arkansas Department of Emergency Management 2010).

The most recent significant flood event in Arkansas occurred largely in the NAWRPR. Major flooding occurred during April and May of 2011 that included the White River, Kings River, and Illinois River, as well as the tributaries to these major rivers. Heavy rains during the week of April 21-27, 2011 resulted in record water levels at gages along the Illinois River and Baron Fork (NWS Weather Forcast Office 2011). A USGS report on the flood events of late April and early May of 2011 calculated the recurrence intervals for several gages in the NAWRPR. The recurrence interval of the storm events ranged from a 5-year event at the White River near Fayetteville, to a 100-year event at Osage Creek at Elm Spring. Several of the gages in the NAWRPR experienced a 50-year flood event (Westerman, et al. 2013).

Another more recent flood disaster occurred during the week of August 8-14, 2013, and led to six counties in the NAWRPR being declared as a federal disaster area (FEMA 2013a).

5.2 Water Supply

Population growth, as well as expansion of water-intensive industries in this region, such as irrigated agriculture, aquaculture, and hydrofracking, has resulted in increased demands in the NAWRPR.

5.2.1 Groundwater

Historically, the Springfield Plateau aquifer was extensively used for domestic, municipal, commercial, and industrial uses. Numerous towns were founded near large springs, which were used to power grain and lumber mills and to serve as a water supply. Today, the primary use of the aquifer is for domestic and livestock supply. Low yields limit use of the Springfield Plateau aquifer, and most commercial, municipal, and industrial water users rely on surface water supply systems (Kresse, et al. 2013).

In the WIP confining unit, water use is limited to domestic, small community, and non-irrigation agricultural supply, owing to poor well yields and limited groundwater resources. Since domestic and water supply systems producing less than 50,000 gallons per day are not required to report groundwater use, there is no way to accurately quantify the number of domestic and livestock wells in use in the WIP. As of 2010, water use from 13 wells completed in the Atoka Formation of the WIP confining unit was reported. These wells were primarily used for public supply at parks, schools, stores, and some commercial business.

As of 2010, there were 108 wells reported in the Ozark aquifer, with 79 wells completed in the lower Ozark aquifer and the remainder completed in the upper Ozark aquifer. Higher costs associated with drilling prevent many small community suppliers from using the more productive lower Ozark aquifer. As a result, there are communities in the planning regions that struggle to provide adequate water to meet their needs (ADH 2009, Grant 2013). The primary use of the Ozark aquifer is public water supply, with 76.45 million gallons per day (mgd)

withdrawn in 2010. Primary users of the Ozark aquifer in Arkansas include Cherokee Village, Decatur, Holiday Island, Corning, and Mammoth Spring.

5.2.1.1 Groundwater Water Level Monitoring

Most groundwater monitoring in the NAWRPR is performed for the purpose of determining water quality, but water levels are also monitored. The USGS monitors water levels at several sites in the planning region. They maintain one real-time water level monitoring site in the planning region, in Stone County. There are also four USGS master wells located in the planning region, three in Fulton County, and one in Benton County (T. Fugitt, ANRC, personal communication 9/4/2013). The ANRC collects data on groundwater in areas where water-level problems are a known issue (Kresse, et al. 2013). ANRC is not currently collecting data on groundwater levels in the NAWRPR (ANRC 2013).

5.2.1.2 Ozark Aquifer

Ground-water withdrawals do not appear to have caused distinguishable differences in shallow groundwater levels over time in northern Arkansas (Gillip 2007). Although wells completed in the Ozark aquifer are limited, declines in water levels were noted in northwest Arkansas in the counties of Benton, Carroll and Washington. However, water level monitoring has observed recent decreases in the rates of water-level declines and water level increases in some wells. These water level changes were attributed to the expansion of rural communities and conversion to surface-water resources (Gillip, Czarnecki and Mugel 2008, Schrader 2005).

5.2.2 Surface Water

Current water supply in Northwest Arkansas is meeting needs, and projections have showed that the potable water supplied by Beaver Water District (from Beaver Lake) will be ample through at least 2055 (Wiest 2011).

Water supply in Central Arkansas is of growing concern, and recent proposals have been made to reallocate water storage from Greers Ferry Lake in order to meet water supply needs in several areas in central Arkansas (Waldon 2012). In 2010, the Little Rock District USACE

issued a Finding of No Significant Impact, supporting the proposal for this water reallocation (USACE Little Rock District 2010).

Drilling in the Arkhoma Basin Fayetteville Shale, a geologic formation being heavily developed for natural gas resources in the state, extends into Van Buren, Independence, Stone, Cleburne, and White Counties. The gas is being extracted from this formation using the hydrofracking process. This process uses large volumes of surface water. Development of the Fayetteville Shale in this region has increased surface water demand and use.

Minimum streamflow criteria have been promulgated for the White River from Bull Shoals dam to the Mississippi River. These criteria protect the ability of the White River to support multiple uses. Concern about the White River trout fisheries located downstream of USACE dams resulted in the modification of operations at Bull Shoals dam on the White River and Norfork dam on the North Fork of the White River to provide minimum releases. The purpose of these minimum releases is to provide enough downstream flow to maintain dissolved oxygen (DO) and temperature levels appropriate for trout during periods of reduced power generation demand.

5.3 Water Quality Issues

Federal law requires states to assess the water quality of the waters of the state (both surface water and groundwater) and prepare a comprehensive report documenting the water quality, which is to be submitted to EPA every 2 years. ADEQ is the agency in Arkansas responsible for enforcing the water quality standards and preparing the comprehensive report for submittal to EPA. This section discusses surface water and groundwater quality issues that have been identified in the NAWRPR. These issues include non-attainment of surface water quality standards, non-attainment of drinking water standards and water quality guidelines in groundwater, fish consumption advisories, nonpoint source pollution of surface water and groundwater, and contaminants of emerging concern.

5.3.1 Water Quality Monitoring

To assess water quality, it is necessary to collect water quality data through monitoring programs. Monitoring of water quality in the NAWRPR occurs under a range of programs, including routine ambient, special project, and research-oriented monitoring. Multiple agencies are responsible for the various water quality monitoring programs, and numerous entities assist with monitoring activities. Surface water and groundwater monitoring programs in the planning region are outlined below.

5.3.1.1 Surface Water

ADEQ monitors water quality of surface waters through several programs. There are 274 ADEQ water quality monitoring station locations in the NAWRPR (ADEQ 2013e). The ambient water quality monitoring network includes 45 sites on rivers and streams in the NAWRPR that are sampled monthly for chemical analysis. The roving water quality monitoring network includes 42 stream sites in the planning region. These sites are divided into four regional groups. Each group of sites is sampled for chemical and bacterial analysis on a rotating basis, bimonthly over a 2-year period, every 6 years. Bacterial analysis is also performed on samples from the ambient water quality monitoring network within the active region of the roving water quality monitoring network. ADEQ also routinely monitors water quality in 12 significant publicly owned lakes within the planning region (ADEQ 2004, ADEQ 2012c).

In addition, ADEQ conducts water quality monitoring during “intensive surveys.” These surveys can involve water sampling for chemical and bacterial analysis, as well as biological sampling to evaluate water quality. Intensive surveys are conducted for a variety of purposes, including determination of total maximum daily loads (TMDLs), and to augment water quality information from the routine water quality monitoring networks for more accurate assessment of designated use support (ADEQ 2012c).

Through its nonpoint source management program, ANRC oversees water quality monitoring programs two watersheds in the NAWRPR, Illinois River and Upper White River. These programs involve universities, contractors, and nonprofit organizations. Parameters

monitored by these programs typically include nutrients and sediment, turbidity, and/or total suspended solids.

The monitoring and reporting requirements for surface water used for human consumption are authorized by both federal and state regulations. A summary of these requirements can be found in Chapter 5 of *Arkansas Public Water System Compliance Summary*, "Microbial Disinfection By-Products Rules" (ADH 2012). There are 74 public water supply systems in the NAWRPR that use surface water (ADH n.d.). Depending on the treatment methods used and the number of customers served by the public water supply utilizing surface water, the monitoring requirements for the raw surface water, or source water, will vary and may include turbidity, *Escherichia coli* (*E. coli*), cryptosporidium, total organic carbon (TOC), and alkalinity.

The USGS also routinely monitors surface water quality data in the NAWRPR. Data from USGS monitoring stations may also be used in the biennial assessment. There are 26 active USGS water quality monitoring stations in the NAWRPR (Figure 5.1). Samples are collected at these stations monthly, bi-weekly, or quarterly (USGS 2013a). The USGS National Water Quality Assessment Program Ozark Plateaus Study Unit includes areas within the NAWRPR, including the Black River, Illinois River, and White River watersheds. The USGS and its partners conducted an intensive study of water quality in these areas over the period from 1991 through 1995 (USGS 2008).

5.3.1.2 Groundwater

In the NAWRPR, groundwater quality monitoring is performed through programs ranging from ambient to research-oriented and mandated monitoring. Multiple agencies are responsible for the various groundwater monitoring programs, and numerous entities assist with monitoring activities. Divisions of ADEQ administer mandated groundwater monitoring programs at various sites that are regulated by state and federal programs. The purpose of this monitoring is to evaluate potential and actual impacts to groundwater resulting from human activities and natural phenomenon (ADEQ 2012c).

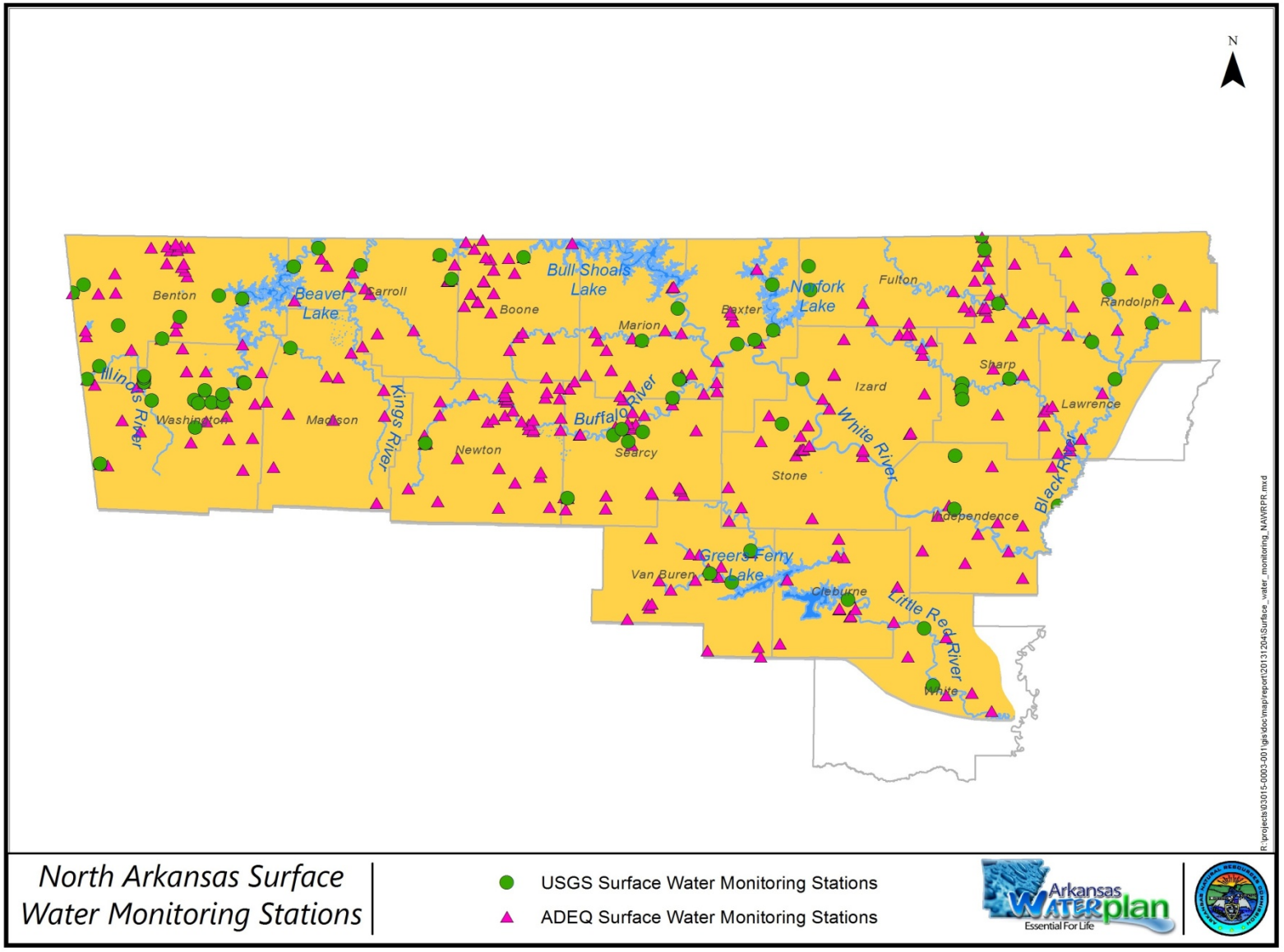

Figure 5.1. Surface water quality monitoring in the NAWRPR.

ADEQ developed the Arkansas Ambient Ground Water Monitoring Program in 1986, which currently consists of 12 monitoring areas and approximately 250 wells and springs throughout the state (Kresse, et al. 2013). Monitoring areas in NAWRPR are shown in Figure 5.2. These monitoring areas were selected to gather water-quality data from various representative aquifers and to evaluate impacts from multiple land uses. The monitoring areas are affected by agricultural, industrial, or a combination of both sources. Samples are collected on a three-year rotational basis and include a comprehensive suite of analyses. Data are presented in various ADEQ publications available on their website and in the EPA's STORET database (ADEQ 2012c).

The U of A has conducted a significant amount of groundwater research that has resulted in scientific data and information necessary to understand, manage, and protect water resources within the state (Kresse, et al. 2013). Hard-copy or digital reports, theses, dissertations, and journal articles are available at the U of A Mullin's Library, Arkansas Water Resources Center technical library, or through various online sources.

The Arkansas Department of Health (ADH) is the primary agency for implementation of the federal Safe Drinking Water Act (SDWA) and is responsible for monitoring public water-supply wells. ADH maintains a statewide database that consists of 1300 wells (Kresse, et al. 2013). Every three years, these wells are sampled for inorganic, organic (including pesticides, herbicides, synthetic organic compounds, and volatile organic compounds), and radiochemical contaminants. The Total Coliform Rule of the SDWA requires sampling on monthly basis, where the number of samples required is dependent upon the population size. Nitrate monitoring is performed on a yearly basis unless a sample greater than or equal to 50% of the maximum contaminant level (MCL) is detected and prompts the need for increased frequency. Additionally, the Disinfection Byproduct Rule of the SDWA requires monitoring of trihalomethanes and haloacetic acids (byproducts of chlorine and other disinfectants used to treat drinking water) on a quarterly or annual basis. While all of the programs above collect samples from treated drinking water, ADH also collects samples from untreated water sources (surface and groundwater) that include bacteria, particulates, algae, organics, pathogens, total organic carbon on a weekly or monthly basis as required by the SDWA (ADEQ 2008, 2012c).

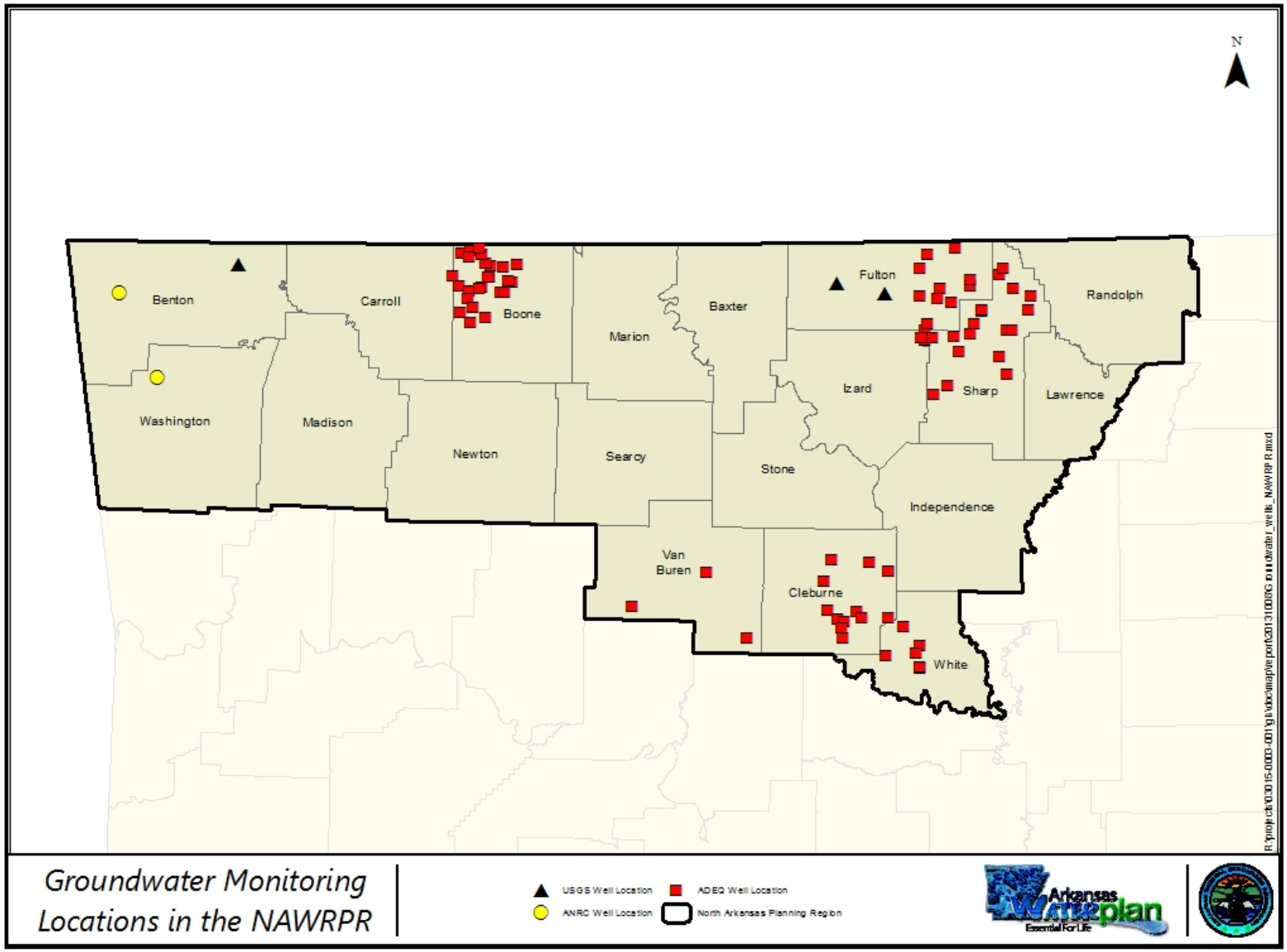

Figure 5. 2. Location of Groundwater Monitoriing Wells in the NAWRPR

Several ambient groundwater quality monitoring programs exist that involve cooperative efforts among the USGS, ANRC, and ADEQ. Figure 5.2 shows the locations where ambient groundwater monitoring is performed throughout the NAWRPR. Table 5.1 lists the monitoring areas, responsible agencies, most recent sampling event, aquifers monitored, and number of sampling sites for the various ambient groundwater monitoring programs. Groundwater-quality monitoring activities are primarily funded by USEPA grants under Sections 106 and Sections 319 of the Clean Water Act.

Table 5.1. Groundwater monitoring information for the NAWRPR (ADEQ 2012c)

Monitoring Area	Agency	Most recent sampling	Total number of wells/springs	Aquifer	Number of wells/springs
Omaha	ADEQ	2010	28	Springfield Plateau	11
				Ozark	17
Benton County	ANRC	2008	2	Springfield Plateau	1
				Ozark	1
	USGS	2012/2013*	3	Springfield Plateau	2
				Gunter Sand	1
Washington County	ANRC	2007	1	Springfield Plateau	1
North Central*	ADEQ	2010	30	Western Interior Confining Unit	30
Hardy	ADEQ	2008	24	Ozark	24
Fulton County	USGS	2011	2	Roubidoux	1
				Gunter Sand	1

* This area includes wells that are not in the planning region. Only wells within the NAWRPR were included.

ANRC collects groundwater data statewide in areas where water-level declines or water-quality degradation have been historically observed (Kresse, et al. 2013). In NAWRPR, ANRC performs groundwater monitoring at two locations in Washington (one well) and Benton (two wells) Counties. These wells were installed to evaluate the critical threat to groundwater quality in the karst terrain of northern Arkansas over an extended period of time and to assist in the establishment of groundwater quality standards. Samples are collected for the analysis of selected metals, nutrients, pesticides and other parameters (ANRC 2008). When collected, data

are published in the annual Arkansas Groundwater Protection and Management Report available on the ANRC website.

The USGS has 24 groundwater wells or springs that they monitor for water quality scattered throughout the state, with three of these sites located in the NAWRPR (Figure 5.2). Samples are collected on a 5-year rotational basis for a variety of constituents to include nutrients, metals, organics, radioactivity, and selected primary and secondary drinking water standards (Kresse, et al. 2013). In addition, the USGS samples many other wells and springs for purposes of water quality and quantity investigations or as part of other monitoring programs, such as the National Water Information System. Data from these investigations and monitoring programs are presented in reports or available for download online at the Arkansas Water Science Center (http://ar.water.usgs.gov/) or similar USGS websites (Kresse, et al. 2013, ADEQ 2008, 2012c).

5.3.2 Non-attainment of Surface Water Quality Standards

Although ADEQ conducted the required statewide water quality assessments for 2010, 2012, and 2014, at the time this report was prepared, the 2008 303(d) list was the most recent state list of impaired water bodies that had been approved by EPA. Therefore, the results of the 2008 assessment are discussed here.

In 2008, approximately 2,611 miles of the 3,010 miles of streams within the NAWRPR were assessed. Of the miles assessed, about 900 miles did not meet numeric water quality criteria or did not support all of their designated uses. Pathogens, low dissolved oxygen, sediment/siltation, and minerals (chloride, sulfate, and total dissolved solids [TDS]) were the primary causes of impaired water quality in the majority of the stream miles assessed (Table 5.2) (ADEQ 2009). Mercury and sediment/siltation were the sources of impairment for lakes in the NAWRPR. The cause of impairment was unknown for 531 acres of Swepco Lake in the NAWRPR. Figures 5.3 through 5.5 show locations of impaired waterbodies in the NAWRPR. A detailed listing of water quality impairments in the planning region identified in the 2008 303(d) list is included as Appendix A.

Table 5.2. Summary of 2008 impaired waters in the NAWRPR (ADEQ 2009)

Pollutant	Miles of impaired stream	Acres of impaired lakes
Sediment/Siltation	169.3	1,500
Dissolved Oxygen	198.4	0
Chloride	42.4	0
TDS	196	0
Pathogens	411.4	0
Zinc	22.3	0
Sulfate	69.6	0
Nitrate	17.1	0
Mercury	2	50
Total Phosphorus	47.6	0
Temperature	52.3	0
Unknown	0	531

It should be noted that while a waterbody may be impaired due to sediment, there is no numeric water quality standard for sediment/siltation. Arkansas has a numeric water quality standard for turbidity but not total suspended solids (TSS); thus turbidity is the chemical parameter that is assessed to determine if sediment impairment exists. There is currently no other method that is consistently used by EPA or ADEQ to measure sediment or siltation in water.

In cases where exceedances of water quality criteria are preventing the attainment of a designated use, a TMDL must be developed. A TMDL is the maximum amount of a pollutant that a waterbody can assimilate without exceeding the established water quality standard for that pollutant, resulting in the waterbody being listed as impaired. A TMDL allows for the allocation of pollutant loads between point sources and nonpoint sources discharging to the waterbody, as well as a margin of safety.

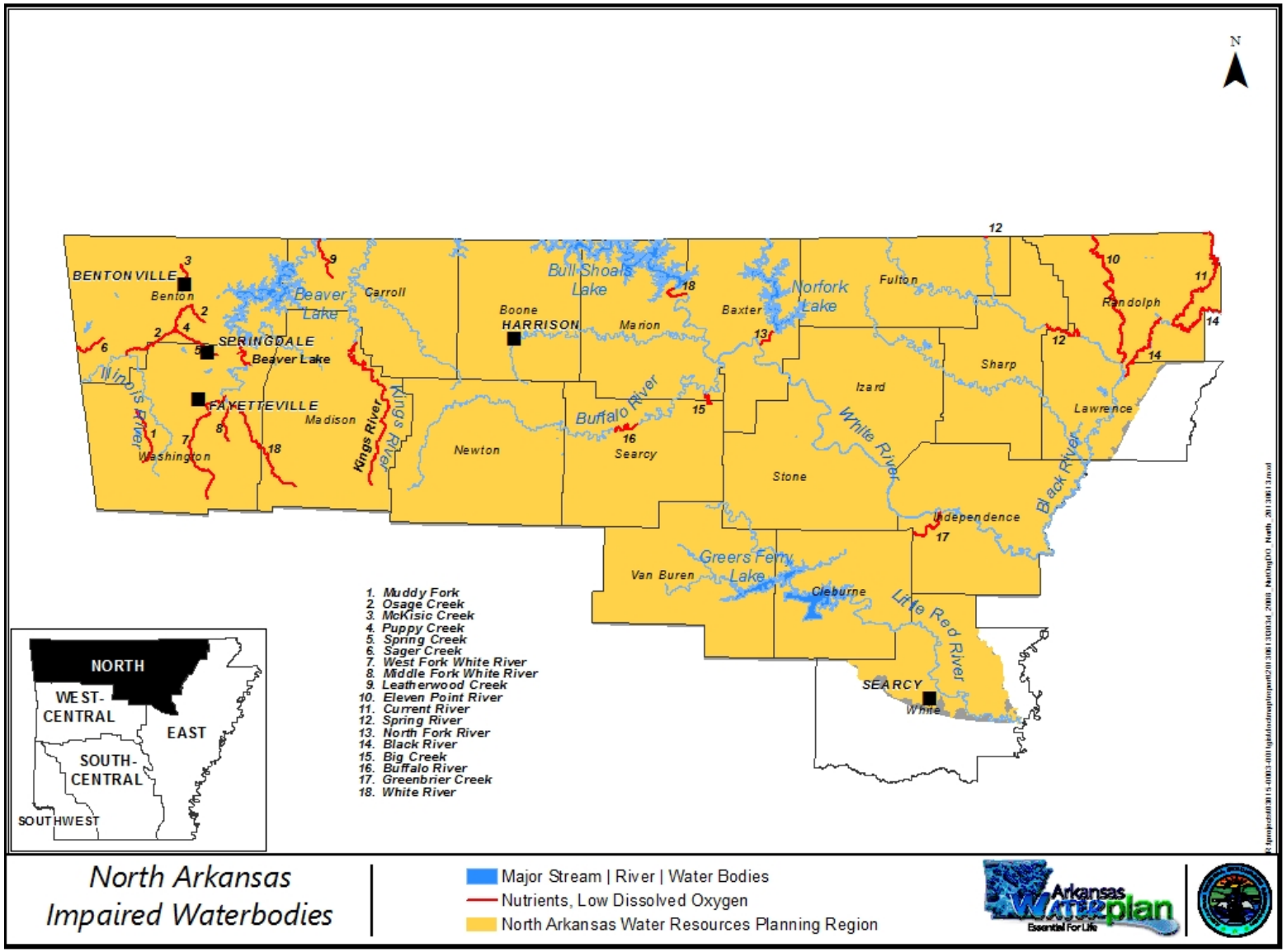

Figure 5.3. Waterbodies in the NAWRPR classified as impaired due to nutrients, and low dissolved oxygen in the 2008 303(d) list.

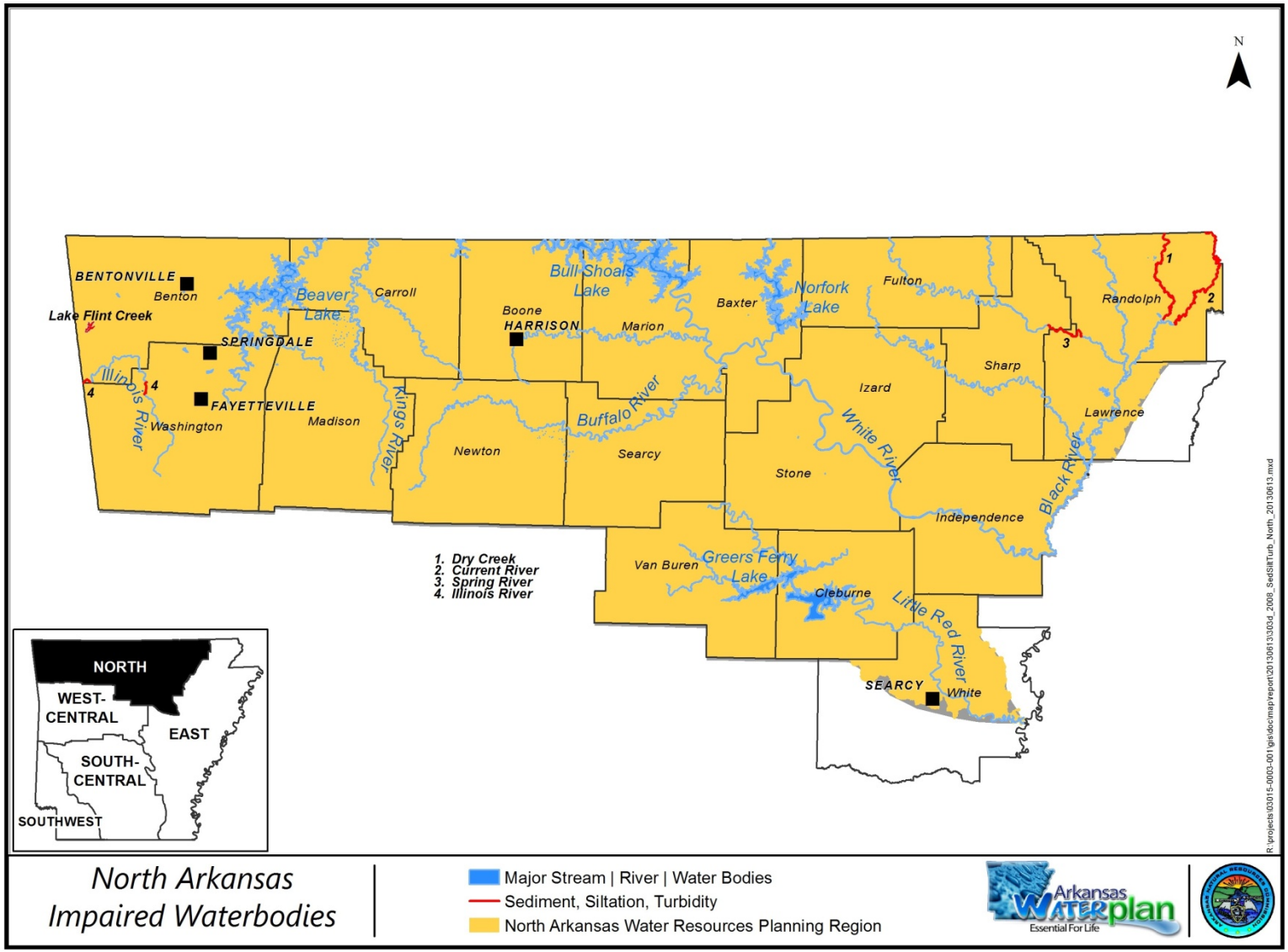

Figure 5.4. Waterbodies in the NAWRPR classified as impaired due to sedimentation, siltation, and turbidity in the 2008 303(d) list

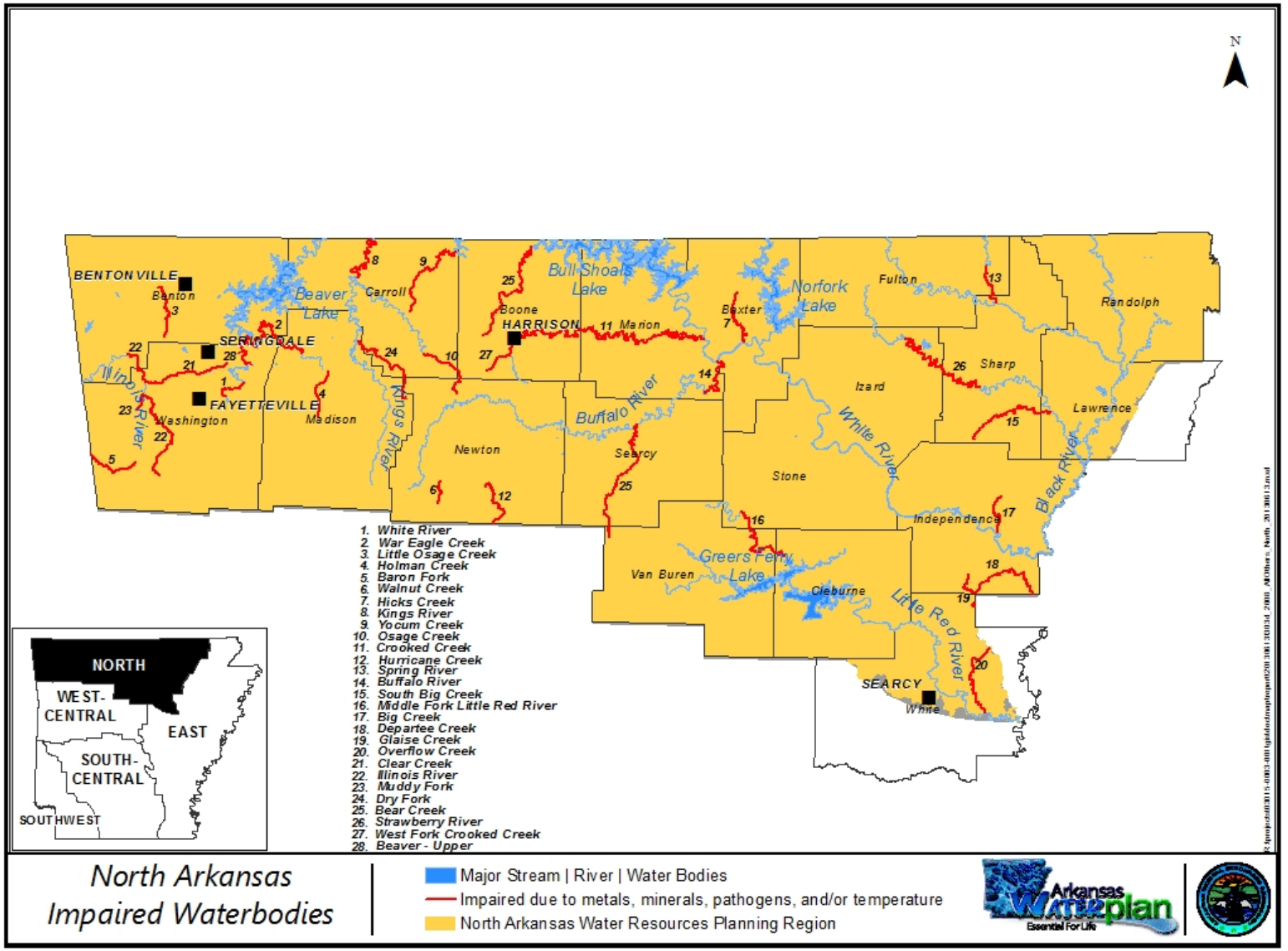

Figure 5.5. Waterbodies in the NAWRPR classified as impaired due to metals, minerals (chloride, sulfate, TDS), pathogens, and/or temperature in the 2008 303(d) list

TMDL reports have been prepared for a number of waterbodies in the NAWRPR addressing total phosphorus, pathogens, mercury, turbidity, nitrates, and dissolved oxygen (Table 5.3) (ANRC 2009).

The EPA is currently working on a TMDL for the Illinois River. Portions of the river and its tributaries in Oklahoma are included on the Oklahoma 2012 303(d) list for total phosphorus. Portions of three Illinois River tributaries in Arkansas are on the Arkansas 2008 303(d) list for phosphorus also. The TMDL project is currently in the modeling phase. Both Arkansas and Oklahoma have EPA-approved watershed management plans for the Illinois River (EPA 2013a).

Table 5.3. TMDLs for waterbodies in the NAWRPR

Waterbody	Impaired Uses	Pollutants	Status
Bull Shoals (White River) Tailwaters	Aquatic Life	Dissolved Oxygen	5/01/2009
Caney Creek	Primary contact recreation	Pathogens	6/01/2007
Clear Creek	Primary contact recreation	Pathogens	9/01/2009
Cooper Creek	Primary contact recreation	Pathogens	6/01/2007
Dota Creek	Primary contact recreation	Pathogens	6/01/2007
Hicks Creek	Drinking water use	Nitrate	12/08/2000
Holman Creek	Drinking water use	Nitrate	12/08/2000
Johnson Hole	Fish Consumption	Mercury -Fish Tissue	9/17/2002
Little Red River	Primary contact recreation	Pathogens	6/01/2007
Little Strawberry River	Primary contact recreation	Pathogens	6/01/2007
Middle Fork Little Red River	Primary contact recreation	Pathogens	6/01/2007
Mill Creek	Primary contact recreation	Pathogens	6/01/2007
Norfork (North Fork River) Tailwaters	Aquatic Life	Dissolved Oxygen	5/01/2009
Osage Creek near Berryville	Aquatic Life	Phosphorus	1/10/2006
Overflow Creek	Primary contact recreation	Pathogens	6/01/2007
Reeds' Creek	Primary contact recreation	Pathogens	6/01/2007
South Fork Little Red River	Fish Consumption	Mercury -Fish Tissue	9/17/2002
	Primary contact recreation	Pathogens	6/01/2007

Table 5.3. TMDLs for waterbodies in the NAWRPR (continued).

Waterbody	Impaired Uses	Pollutants	Status
Strawberry River	Aquatic Life	Turbidity	1/05/2006
	Primary contact recreation	Pathogens	6/01/2007
Ten Mile Creek	Aquatic Life	Turbidity	12/22/2005
	Primary contact recreation	Pathogens	6/01/2007
Town Branch	Fisheries	Total Phosphorus	Closed June 24, 2013
	Drinking water use	Nitrate	12/08/2000
West Fork White River	Aquatic Life	Turbidity	1/05/2006
White River	Aquatic Life	Turbidity	1/05/2006
Illinois River	Aquatic Life	Nutrients	On-going

5.3.3 Nutrient Surplus Areas

The 1990 AWP identified excess nutrients as a water quality issue in the upper White River basin (ASWCC 1987). During the 1990s, both point sources and manure from poultry and livestock were identified as nutrient sources in the area. A number of programs have since been implemented to reduce the impacts of these nutrient sources on water quality.

Nutrients issues in the Illinois River have become controversial because it is an interstate waterbody. The headwaters of the Illinois River are in Northwest Arkansas. From Arkansas, the river flows into Oklahoma and eventually forms Lake Tenkiller. Downstream of the lake, the river flows south and joins the Arkansas River.

The State of Oklahoma has designated the Illinois River as a scenic river, and phosphorus limits have been set at 0.037 mg/L. A U.S. Supreme Court ruling has stated that the downstream state's requirements be met at the state line. This requirement challenges the WWTP point source dischargers in the watershed in Arkansas. Many of these WWTPs dramatically reduced total phosphorus levels in their discharge between 2003 and 2010 in an effort to reduce phosphorus concentrations in the Illinois River to meet the Oklahoma standard at the state line. There are many factors contributing to phosphorus to the Illinois River including urban runoff, wild animals, fertilizer applications, poultry and cattle operations, and WWTPs. Recent agreements between the two states have led to a water quality pact that will allow Arkansas

10 years to study and implement programs in order to try to meet Oklahoma's phosphorus standards (Davis and Moritz 2013). In early 2013, the attorneys general of Arkansas and Oklahoma agreed to conduct a stressor response study of the Illinois River and other scenic rivers to determine what phosphorus levels keep algae to a minimum in these streams (Second Statement of Joint Principles 2013).

The controversy over phosphorus in the Illinois River prompted further actions to reduce nutrients in Northwest Arkansas streams, including declaring eight watersheds in Arkansas Nutrient Surplus Areas. The Illinois River, Spavinaw Creek, Little Sugar Creek, and the Upper White River (Washington, Benton, Madison, Carroll, Boone, Marion, and Baxter Counties) in the planning region have been designated as nutrient surplus areas (Figure 5.6) (Winthrop Rockefeller Foundation 2008). This designation requires that nutrient management practices be used in these areas to help to reduce nitrogen and phosphorus levels in the surface and ground water. Nutrient management training and planning is also required.

Long term monitoring of phosphorus concentrations in the Illinois River watershed shows that phosphorus loads to the Illinois River are declining (Haggard 2010). Wastewater treatment upgrades and implementation of nutrient management practices are having an effect (Haggard and Scott 2013).

5.3.4 Non-attainment of Drinking Water Quality Standards and Water Quality Guidelines by Groundwater

Most aquifers in the planning region are considered to have good to very good water quality. However, areas of poor water quality have been identified. In some areas, poor groundwater quality is a natural phenomenon. In other areas, human activities have caused contamination of the groundwater. In Arkansas, groundwater quality issues primarily occur in shallow aquifers (ADEQ 2008). For the most part, groundwater quality issues have not changed significantly since the 1990 AWP update (ADEQ 2008, Bryant, Ludwig and Morris 1985).

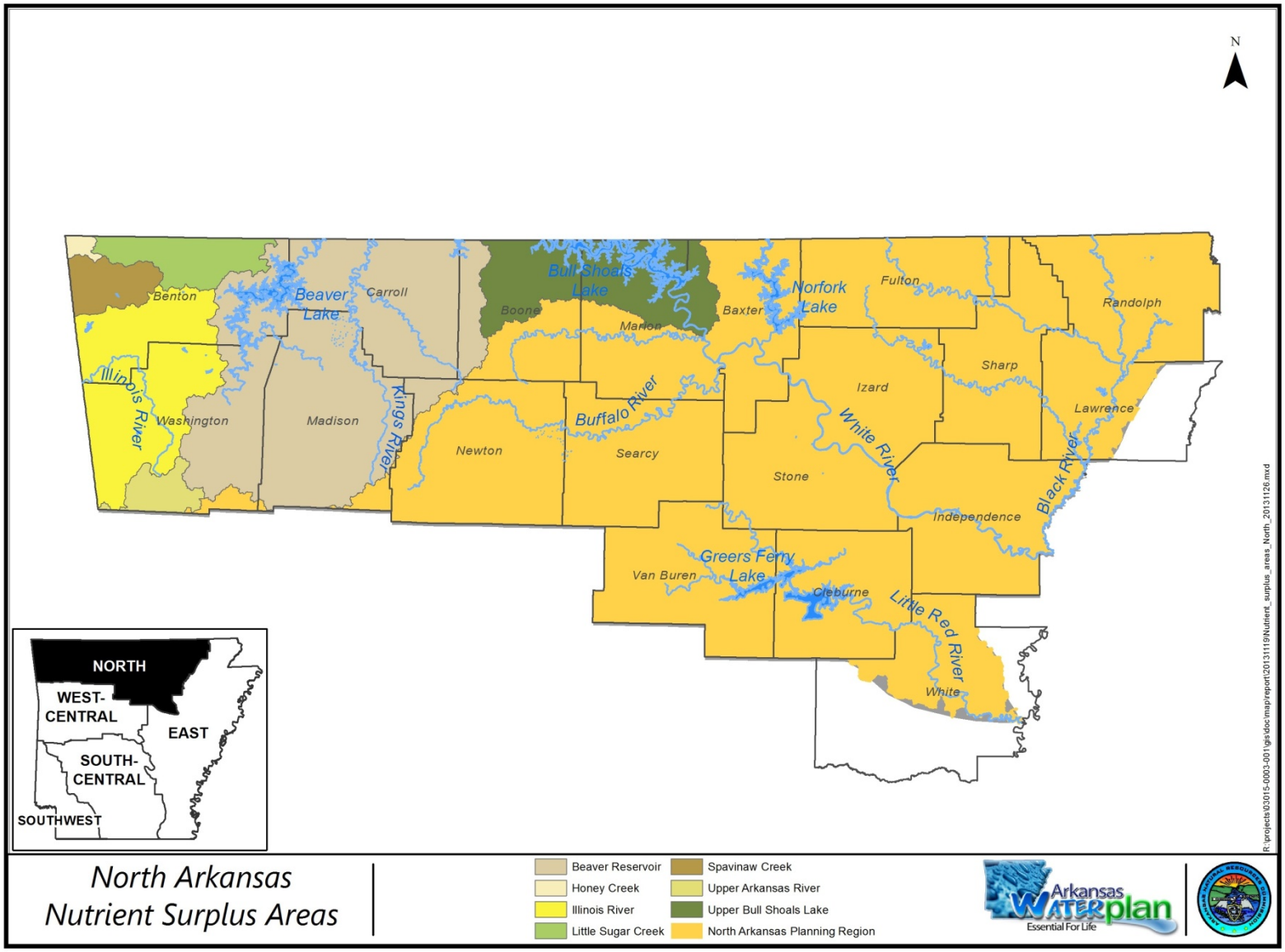

Figure 5.6. Nutrient Surplus Areas in the NAWRPR.

5.3.4.1 Springfield Plateau aquifer

Groundwater in the Springfield Plateau is generally of good quality, and the water can typically be used without treatment. The dominant water type is calcium-bicarbonate (Lamonds 1972). Published values of pH range from 6.0 to 9.1 su with a median of 7.2 su, and dissolved solids range from 58 to 515 milligrams per liter (mg/L), with a median of 193 mg/L. Analysis of pH and dissolved solids indicate that the aquifer is well buffered, which is typical of limestone aquifers (Kresse, et al. 2013). Studies have shown iron to frequently exceed Federal drinking water limits (Lamonds 1972, Steele 1981). It is postulated that mobilization of iron from the overlying regolith that contains abundant iron oxyhydroxide minerals is a likely source for the observed iron concentrations. In general, however, iron concentrations are low throughout the Springfield Plateau aquifer (Kresse, et al. 2013). Additionally, the Springfield plateau aquifer has naturally high water hardness related to the amount of carbonate minerals dissolved in the water resulting from water-rock interaction. Water hardness can present problems related to scaling of plumbing fixtures, which has been documented throughout the region (Imes and Emmett 1994, Adamski 2000).

Steep topography and poor soils result in agricultural operations (beef, swine, and poultry) as the dominant land use in Northern Arkansas. Nationally, Arkansas is ranked second in poultry production, with the top three counties for agricultural sales located in northwest Arkansas, and pollutants associated with agricultural activities are common contaminants found in the aquifer. A source of human derived contaminants is septic systems, which are the primary means of domestic waste disposal in rural and many suburban areas in the planning region. The Ozarks are characterized by thin, poorly developed soils that make installation of properly functioning septic systems difficult. Documented contaminants associated with septic systems and agricultural activities include nutrients (especially nitrate), fecal bacteria, and pesticides (Kresse, et al. 2013; Smith and Steele 1990; Steele and McCalister 1985; Davis, Brahana and Johnston 2000; Knierem, Pennington and Steele 2009).

Sediment problems are frequently found in karst environments associated with urban land-use as a result of denuding the landscape. In addition to facilitating bacterial transport, increased sediment loads can have adverse impacts on karst habitats and processes. In northwest

Arkansas, (Gillip 2007) observed large volumes of sediment move through caves near urban centers, where individual storm events deposited up to 3 feet of sediment adversely impacting cave ecosystem. Hays and others (1998) attributed fish kills at trout farms in Bella Vista, Rogers, and Springdale to increased sedimentation and resulting water quality degradation of springs (Kresse, et al. 2013).

5.3.4.2 Ozark aquifer

In general, water quality data for the Ozark aquifer in northern Arkansas are not as prevalent as data for the Springfield Plateau aquifer. The carbonate rocks of the Ozark aquifer yield a hard to very hard calcium-magnesium-bicarbonate water type. Published values of pH range from 4.8 to 8.7 su with a median of 7.3 su, and dissolved solids range from 52 to 1,735 mg/L, with a median of 285 mg/L. Analysis of pH and dissolved solids indicate that the aquifer is well buffered, which is typical of carbonate aquifers (Kresse, et al. 2013).

Like the Springfield Plateau, agricultural (beef, swine, and poultry) operations occur throughout the area. Although elevated nitrate concentrations have increased with increasing agricultural land use, similar to that for groundwater in the Springfield Plateau aquifer, mean and median nitrate concentrations are much lower in the Ozark Aquifer, and the Ozark aquifer appears to be less vulnerable to nitrate contamination. No definitive attributes have been identified to explain the higher affinity of the Springfield Plateau to nitrate contamination. It is postulated that the upper Ozark aquifer may have physical characteristics, such as lower permeability soils and regolith owing to lower chert abundance, thicker regolith, less fractures and bedding planes, which create a lower susceptibility to surface derived contaminants (Kresse, et al. 2013). Elevated nitrate concentrations found in the lower Ozark aquifer are anomalous owing to its depth, longer flow paths, and confinement. Elevated nitrate concentrations in the lower Ozark aquifer have been ascribed to the sensitivity of the karst landscape in the upper Ozark aquifer to surface derived contamination and the lack of adequate well design (Kresse, et al. 2013).

The Arkansas Department of Health has observed radium levels above the Federal maximum contaminant level of 5 picocuries per liter in public water supply systems. Currently,

elevated radium levels in the lower Ozark aquifer are considered naturally occurring and are attributed to the Paleozoic shales (Kresse, et al. 2013). In addition to radium, naturally occurring iron occasionally exceeds Federal drinking water standards (0.300 mg/L), but other naturally occurring inorganic constituents are generally low throughout the lower and upper aquifer.

5.3.4.3 Western Interior Plains Confining Unit

Due to the limited groundwater resources of the area, there is little groundwater quality data available for the WIP Confining Unit. Of the few groundwater quality studies published, most focus on the WIP Confining Unit in the northern portion of the Arkansas River Valley. Recent groundwater studies by Kresse and others (2012) that were conducted to evaluate impacts of the Fayetteville Shale gas play to water quality in central Arkansas provide the most comprehensive evaluation of the WIP aquifers. These studies coincided with the portion of the Arkansas River Valley in the NAWRPR.

In general, groundwater in the undifferentiated aquifers of the WIP is of good quality. Groundwater from the undifferentiated aquifers of the WIP system is typically a strongly calcium-bicarbonate to sodium bicarbonate water type. Groundwater with elevated iron, sulfate, and chloride may be encountered in localized areas, and occasionally exceed Federal secondary drinking water standards (Kresse, et al. 2012). Constituent concentrations were attributed to the rock type, groundwater residence times (degree of water rock interaction), and microbially mediated processes.

Compared to the Springfield Plateau and Ozark aquifers, nitrate concentrations in the WIP aquifers are relatively low; however, elevated nitrate concentrations were associated with shallow sandstone aquifers overlain by sandy soils. In these areas, the soil is more permeable and aquifers are more susceptible to surface-derived contamination (Kresse, et al. 2013). Since the Boston Mountains Plateau is not considered karst terrain, less impact from surface derived contaminates would be expected due to diffuse recharge allowing for natural attenuation to occur to a greater extent in the unsaturated zone.

Hydraulic fracturing in the Fayetteville Shale has raised concerns about the potential for groundwater quality impacts. A recent study by Kresse and others (2012) found groundwater quality in domestic wells in areas of gas development to be consistent with natural process.

5.3.5 Fish Consumption Advisories

There is one active fish consumption advisory for mercury in the NAWRPR. Details of this advisory are given in Table 5.4. The location of this waterbody is shown on Figure 5.6.

Table 5.4. Fish Consumption Advisories in the NAWRPR (ADH, AGFC, ADEQ 2011; ADEQ 2012c)

Waterbody	Miles Affected	Pollutant of Concern	Restrictions for high risk groups[1]	Restrictions for general public
Johnson Hole - South Fork Little Red River	2	Mercury	Should not eat largemouth bass (16 inches or longer) from this area	Should not eat largemouth bass (16 inches or longer) from this area

[1] Pregnant or breastfeeding women, women who plan to become pregnant, and children under 7 years of age

5.3.6 Nonpoint Source Pollution

Nonpoint source pollution (NPS) was identified as a water resources issue in the 1990 AWP (ASWCC 1990). NPS still contributes significantly to surface water and groundwater quality issues in the NAWRPR. As discussed in Sections 2 and 3, in this planning region, urbanization and poultry production are two sources of nonpoint source pollution. However, hazardous waste sites and resource extraction activities in the planning region also contribute nonpoint source pollution.

5.3.6.1 Nonpoint Source Priority Watersheds

In the 2011 – 2016 NPS Pollution Management Plan, three watersheds within the NAWRPR have been identified as priority watersheds for nonpoint source pollution issues; Beaver Lake, Illinois River, and Strawberry River (Figure 5.8). This program primarily addresses nutrients and sediment in runoff. The targeted sources of nonpoint source pollutants in these watersheds are summarized in Table 5.5 (ANRC 2011b).

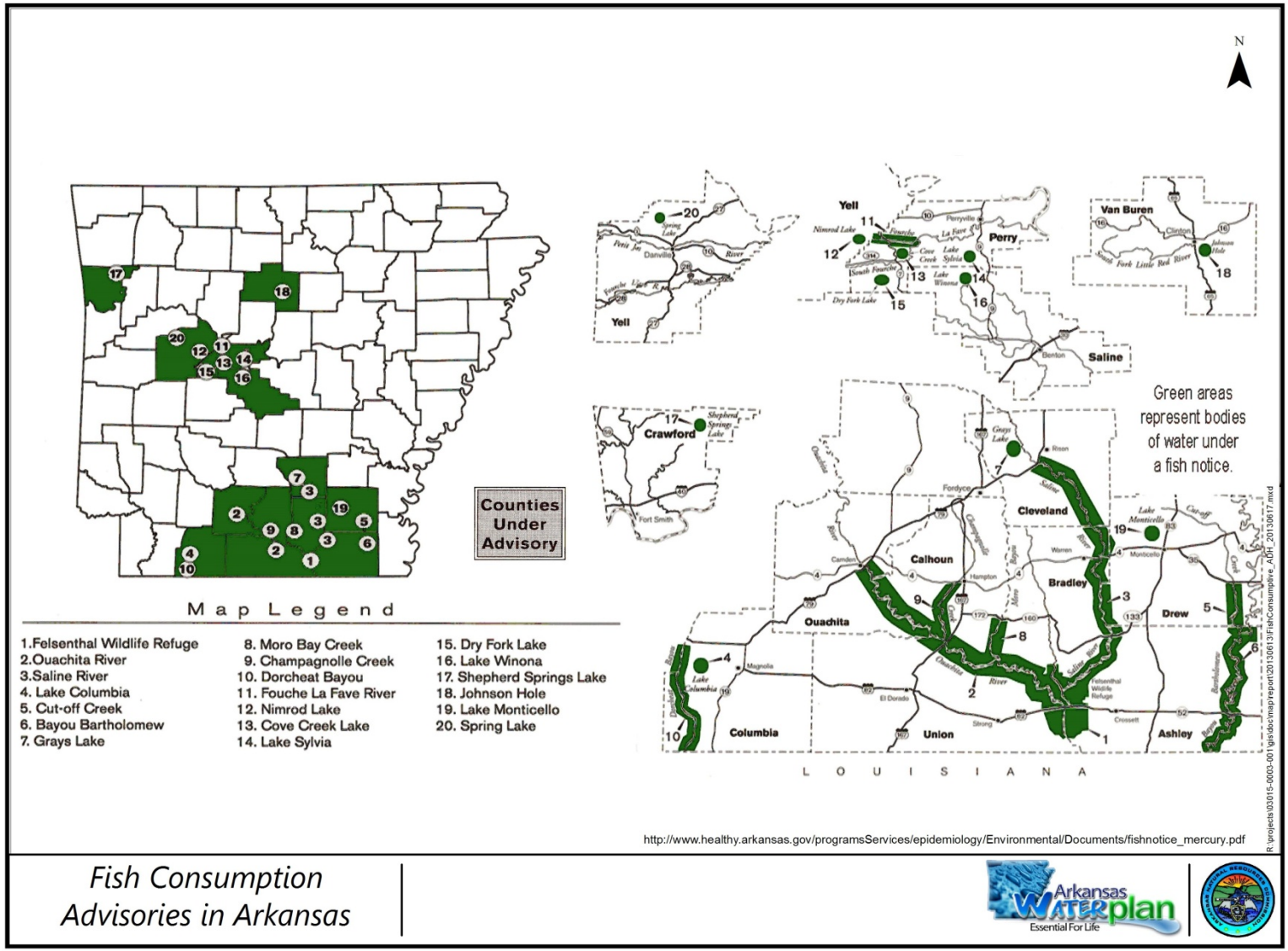

Figure 5.7. Waterbody in the NAWRPR for which fish consumption advisories have been issued (ADH, AGFC, ADEQ 2011)

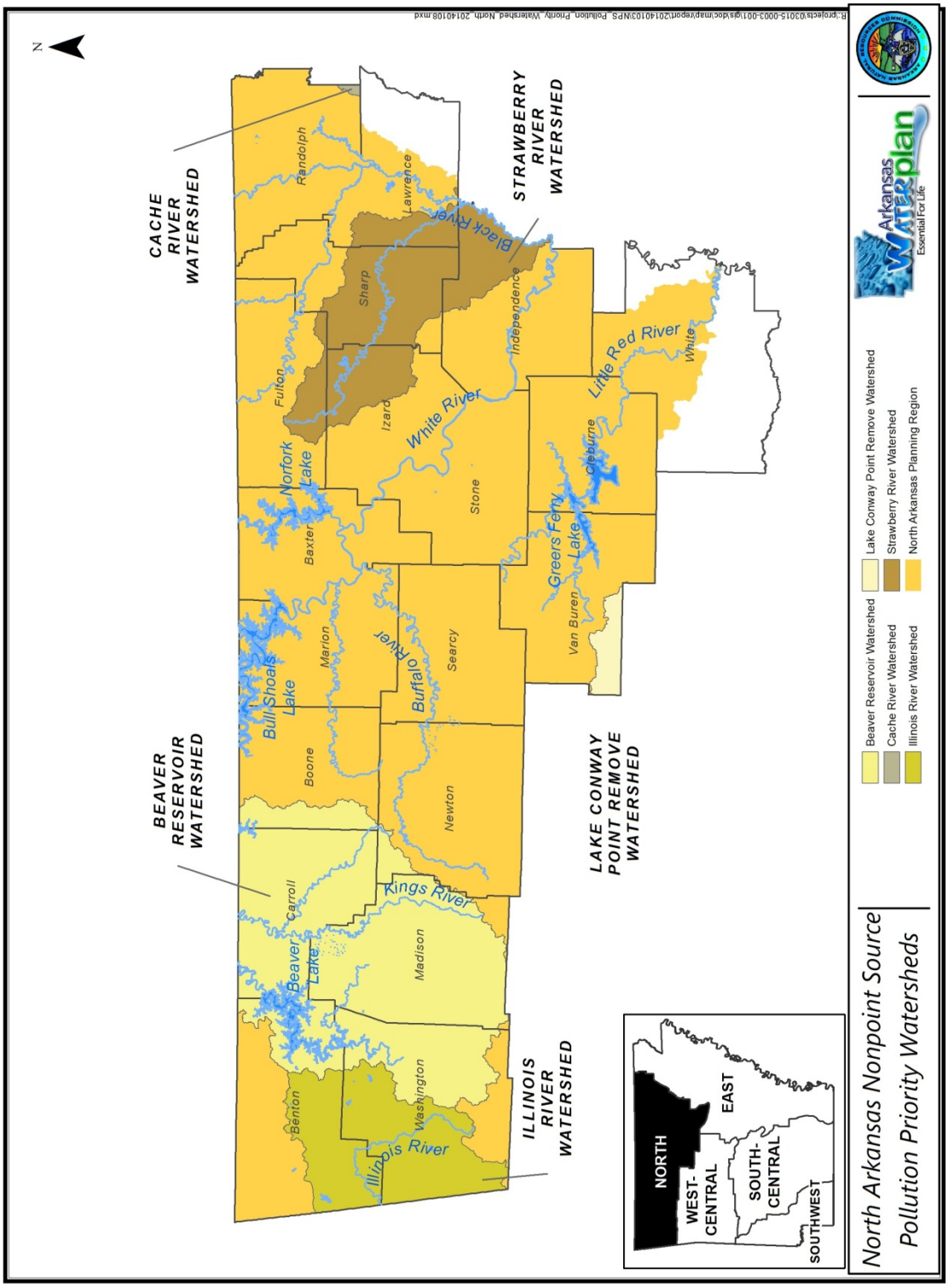

Figure 5.8. Nonpoint source pollution priority watersheds in the NAWRPR (ANRC 2011b).

Table 5.5. Targeted pollutants and sources in ANRC priority NPS watersheds (ANRC 2011b).

Watershed	Pollutant	Source
Beaver Lake	TSS, siltation/turbidity, nutrients, DO	Animal agriculture, urban areas, streambanks
Illinois River	Siltation/turbidity, nutrients, pathogens	Animal agriculture, urban areas, streambanks, surface mining
Strawberry River	Siltation/turbidity, nutrients	Unpaved roads, animal agriculture,

5.3.6.2 Hazardous Waste Remedial Action Priority Sites

There is one site in the NAWRPR identified as federal priority for hazardous waste cleanup (i.e., Superfund sites) due to contamination of water resources. The site, Arkwood, Inc., has been on the National Priority List (NPL) since 1989. Some phases of remediation have been completed, but others are still ongoing (EPA 2013b).

Three hazardous waste remediation sites in the NAWRPR are currently on the state priority list (SPL), and one has been removed from the SPL. All of these sites have had, or have, groundwater contamination issues. Surface water contamination has been an issue at four of these sites. Table 5.6 summarizes the information about these sites.

Table 5.6. Status of Superfund sites in the NAWRPR with water quality issues.

Site name	EPA ID	Site Location	Pollutants of concern	Contaminated water resources	Remediation complete	List
Arkwood, Inc.	ARD084930148	Boone County	Pentachlorophenol (PCP), creosote	New Cricket Spring; groundwater	Ongoing	NPL
Baldwin Piano & Organ	ARD006337620	Fayetteville (Washington Co)	Chlorinated, non-chlorinated organic compounds	Fawn Creek; groundwater	Ongoing	SPL
Fulton Class 3C Landfill	N/A	Rogers (Benton County)	Iron, manganese, other organic/inorganics	Springs near Beaver Lake; groundwater	Ongoing	SPL
R& P Electroplating	ARD051961829	Fayetteville (Washington County)	Various hazardous substances	West Fork White River; groundwater	Aug. 2010	SPL
Swift Chemical Co. Farm Site	ARR000011122	Rogers (Benton County)	Trichloroethene (TCE)	Groundwater	Aug. 2012	Removed from SPL

5.3.6.3 Resource Extraction

There is concern that natural gas extraction from the Fayetteville Shale Play could affect groundwater quality. However, a study conducted in 2011 did not find evidence of groundwater contamination associated with natural gas extraction in north-central Arkansas (Warner, et al. 2013, EPA 2013c).

Gravel mining occurs on several streams in the NAWRPR. Gravel mining has been found to affect stream habitat. It can be a direct cause of stream bank erosion, which can lead to both water quality and ecological problems. One study on the Illinois River, Kings River, and Crooked Creek found that biomass and density of invertebrates decreased as a result of mining. Distribution of biota was also affected (Brown, Lyttle and Brown 1998). Commercial gravel mining operations are no longer permitted along the Kings River, but are permitted to operate in its tributaries (Kings River Watershed Partnership 2009). Gravel mining had been allowed in Crooked Creek, but future permits were denied and current in-stream permits suspended in 2007 due to the placement of the entire assessed length of Crooked Creek on the 303(d) list (USGS 2010).

5.3.6.4 Buffalo National River

Concern has arisen in recent years over water quality of the Buffalo National River, particularly the potential for nonpoint source pollution from animal operations in the watershed. In 1992, there were 39 confined animal operations in the watershed. The Buffalo River Swine Waste Demonstration Project was started in 1995 by ADEQ in order to look into any issues in the watershed associated with swine production, and establish best management practices (BMPs) at several sites. A project to improve manure management on dairy farms in the Buffalo River watershed was initiated in 1997. In 1994 there were 27 dairy facilities operating in the watershed (EPA 2012d). In 2013, nine commercial animal farms were operating in the watershed, one of which was large enough to be classified as a Confined Animal Feeding Operation under the Clean Water Act. The siting of the first Confined Animal Feeding Operation in the state in the watershed of the Buffalo National River has become controversial.

5.3.1 Contaminants of Emerging Concern

There is growing interest, nationally and in Arkansas, in the occurrence of a group of chemicals called contaminants of emerging concern, which include pharmaceuticals, personal care products (e.g., soap and shampoo), natural and synthetic hormones, surfactants, pesticides, fire retardants, and plasticizers primarily in surface waters, but also starting to be measured in groundwater across the nation. The risks to human health and the environment from the majority of these chemicals are unknown, which is why they are referred to as "contaminants of emerging concern." Contaminants of emerging concern have been detected in surface waters in the NAWRPR (Galloway, et al. 2005). Detection, however, does not indicate there is an effect.

5.4 Loss of Aquatic Biodiversity

In a 2002 report, NatureServe ranked Arkansas 13th in the nation for the level of reportedly extinct species (NatureServe 2002). In 2005, 369 animal species of greatest conservation need were identified for Arkansas by a team of specialists. These species of greatest conservation need include 144 species associated with aquatic and semi-aquatic habitats that occur in the NAWRPR (Anderson 2006, ANHC 2013). This is more than any other region of the state. Figures 5.9 through 5.12 show the number of aquatic species of greatest conservation need that are present in watersheds within the NAWRPR. The greater the number of aquatic species of greatest conservation need present in a watershed, the more important it is to protect and restore water resources and their aquatic habitats in the watershed. Critical characteristics of aquatic habitats include water levels and flow volumes, and the seasonal variation in them. The majority of the watersheds in the NAWRPR have high numbers of species of greatest conservation need. The Spring River has the highest number of species of greatest conservation need in the planning region (Figure 5.12).

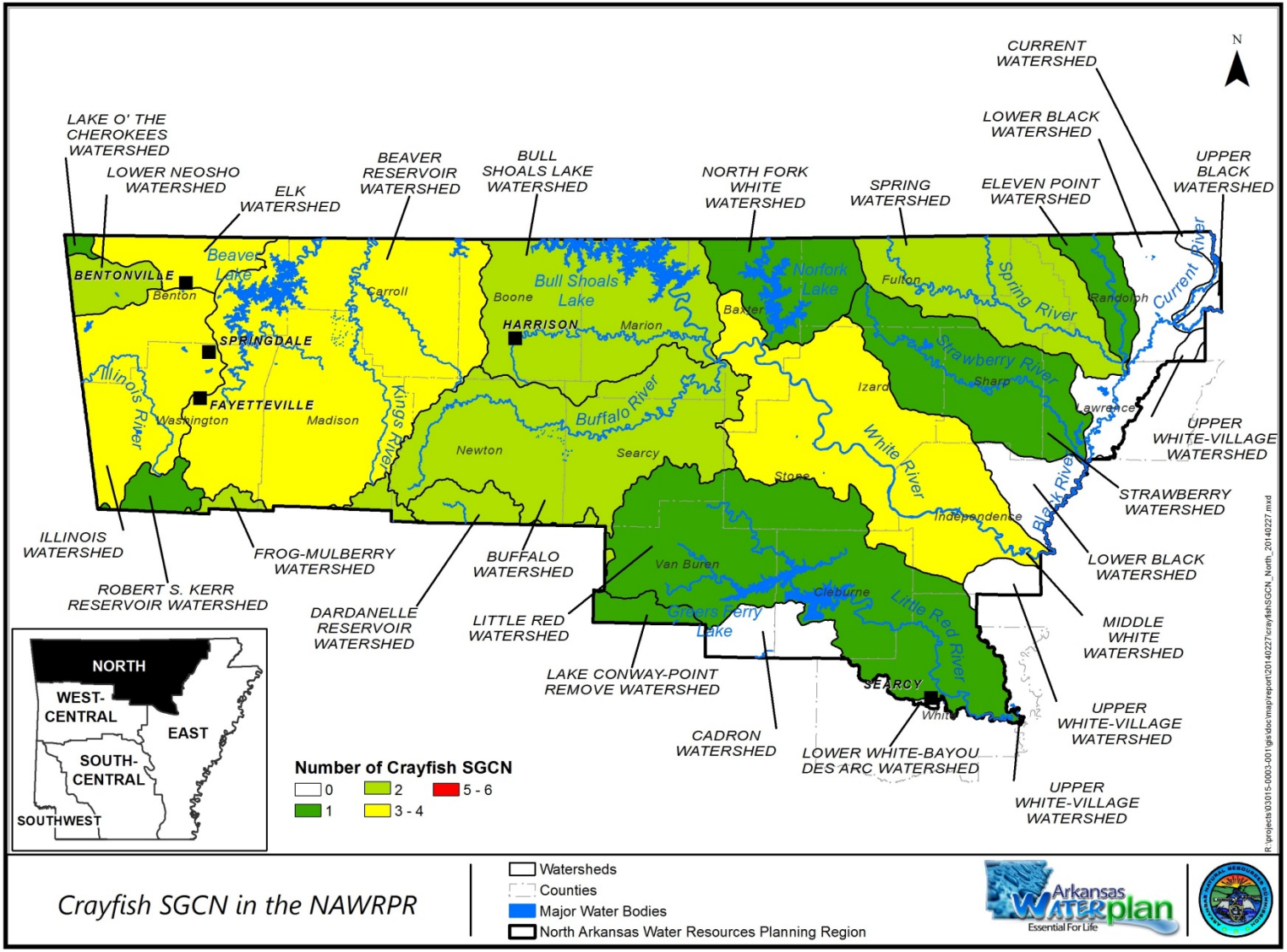

Figure 5.9. Numbers of crayfish Species of Greatest Conservation Need (SGCN) in watersheds of the NAWRPR.

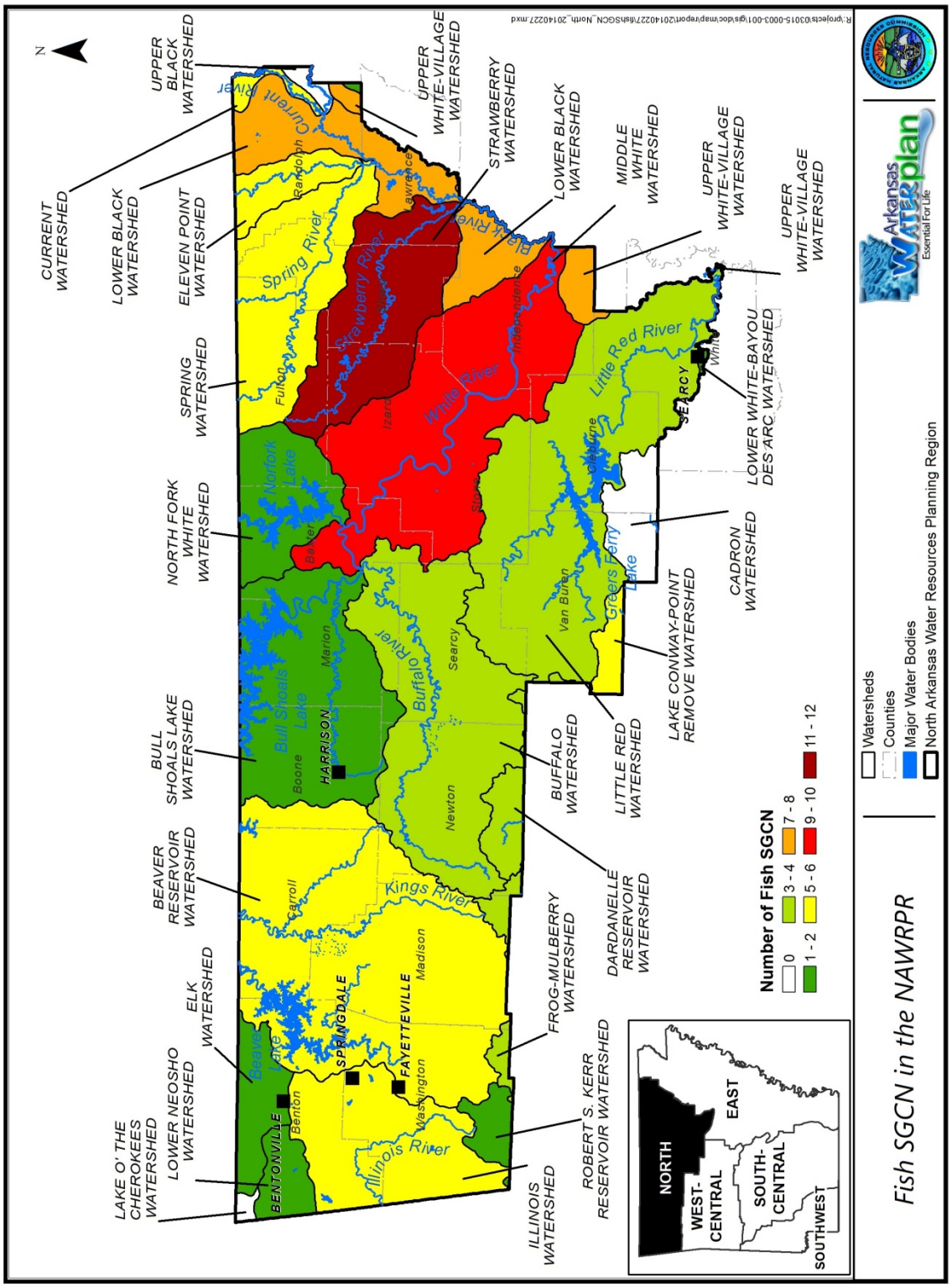

Figure 5.10. Numbers of fish SGCN in watersheds of the NAWRPR.

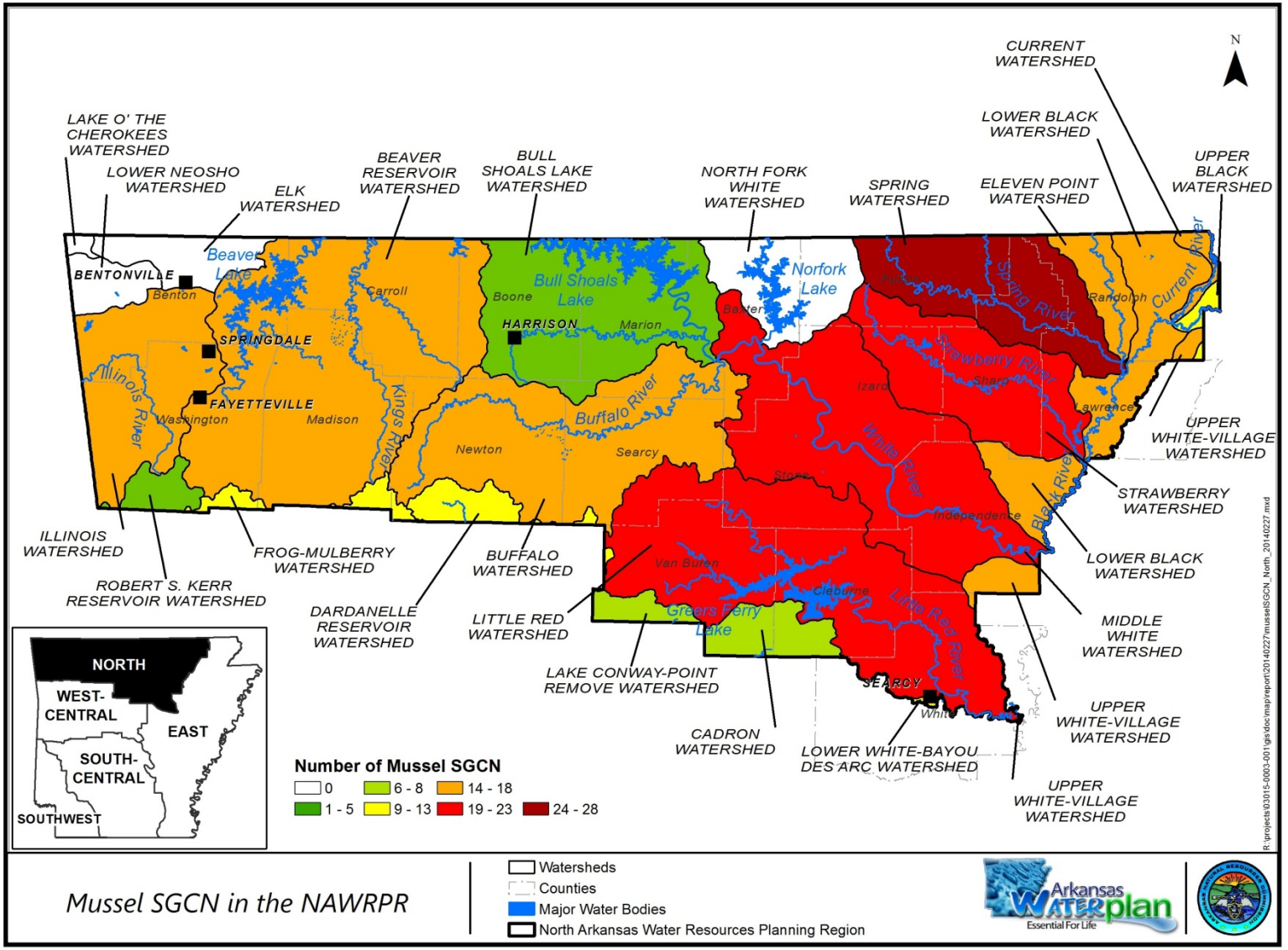

Figure 5.11. Numbers of mussel SGCN in the watersheds of the SCAWRPR.

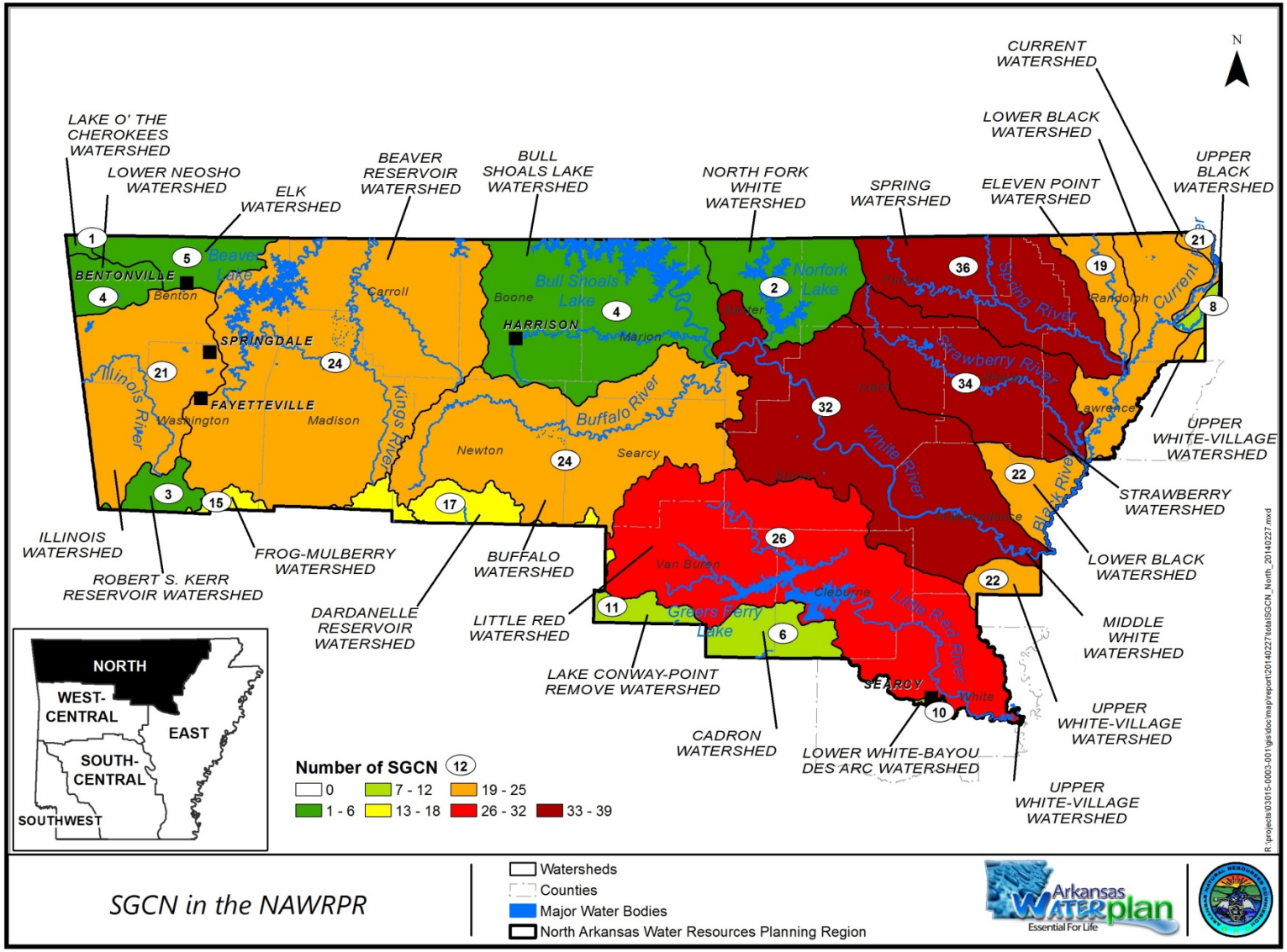

Figure 5.12. Total numbers of crayfish, fish, and mussel SGCN in the watersheds of the SCAWRPR.

In addition to these animal species of greatest conservation need, the Arkansas Natural Heritage Commission has identified 73 species of rare aquatic and semi-aquatic plants that are present in the NAWRPR. Fourteen of the aquatic and semi-aquatic species present in the planning region are on the federal list of threatened and endangered species (Table 5.7). Eleven semi-aquatic plant species present in the planning region are on the state threatened and endangered plant species list (Table 5.8). Many of the species of concern are affected by water quality, water levels, flow rates, and/or seasonal changes in water levels or flow

Table 5.7. Federally-listed threatened and endangered species occurring in aquatic and semi-aquatic habitats in the NAWRPR (ANHC 2013, AGFC 2011b, USFWS n.d., Anderson 2006)

Common Name	Species Name	Status	NAWRPR habitat
Arkansas Darter	Etheostoma cragini	Candidate Species	Neosho River drainage area of NWA
Curtis Pearlymussel	Epioblasma florentina curtisi	Endangered	Spring River at Hardy, Salem, and near confluence of Black River
Missouri bladderpod	Physaria filiformis	Endangered	Izard and Washington Counties
Neosho Mucket	Lampsilis rafinesqueana	Proposed Endangered/Proposed Critical Habitat	Illinois River
Ozark Cavefish	Amblyopsis rosae	Threatened	Ozark Mountain caves in Northwest AR
Pink Mucket	Lampsilis abrupta	Endangered	Spring and White Rivers
Pondberry	Lindera melissifolia	Endangered	Lawrence County
Rabbitsfoot	Quadrula cylindrica	Proposed Endangered/Proposed Critical Habitat	Newton, Searcy, Sharp, Van Buren, Washington, and White Counties
Running buffalo clover	Trifolium stoloniferum	Endangered	Independence County
Scaleshell	Leptodea leptodon	Endangered	Some streams in Fulton and Lawrence Counties
Snuffbox	Epioblasma triquetra	Endangered	Some streams in Baxter, Independence, Izard, Lawrence, Marion, Randolph, and Sharp Counties
Speckled Pocketbook	Lampsilis streckeri	Endangered	Middle Fork of Little Red River (six miles)
Turgid Blossom	Epioblasma turgidula	Endangered	Spring Creek, Black River, White River

Table 5.7. Federally-listed threatened and endangered species occurring in aquatic and semi-aquatic habitats in the NAWRPR (continued).

Common Name	Species Name	Status	NAWRPR habitat
Yellowcheek Darter	Etheostoma moorei	Endangered	Devils, Middle, South, and Archey forks of Little Red River

*This list is not finalized and will be updated in the future.

Table 5.8. State threatened and endangered species occurring in aquatic and semi-aquatic habitats in the NAWRPR counties (ANHC 2013).

Common Name	Species Name	Status
Sedge	Carex opaca	Endangered
Showy lady's-slipper	Cypripedium reginae	Endangered
Spinulose wood fern	Dryopteris carthusiana	Threatened
Small-headed pipewort	Eriocaulon koernikianum	Endangered
Winterberry	Ilex verticillata	Threatened
Pondberry	Lindera melissifolia	Endangered
Heart-leaf plantain	Plantago cordata	Threatened
Southern tubercled orchid	Platanthera flava	Threatened
Purple fringeless orchid	Platanthera peramoena	Threatened
Rose pogonia	Pogonia ophioglossoides	Threatened
Silky willow	Salix sericea	Endangered

In some cases, the presence of non-native aquatic species is believed to affect aquatic biodiversity. There are 35 non-native aquatic animal species known to occur in the NAWRPR (Table 5.9). The majority of the non-native fish species present in the region are sportfish species that have been introduced purposely and are regularly stocked. The impact of many of these species on native species is unknown. Some species, such as carp, are suspected to affect native species as a result of modifying aquatic habitats, e.g., removing vegetative cover and increasing turbidity. Other species, such as non-native sportfish and exotic clams, are suspected to affect native species by competing with them for food and/or habitat (USGS 2013b).

Table 5.9. Non-native aquatic species in the NAWRPR (USGS 2013b).

Species Common Name	Species Scientific Name	Origin	Location	Dates Identified	Method of Introduction	Impact
Freshwater jellyfish	Craspedacusta sowerbyi	China	Beaver Lake, Bull Shoals Lake, Greers Ferry Reservoir, Lake Norfork, rock quarry, White River	1999	Accidental	Preys on native species
Rock Bass	Ambloplites rupestris	Great Lakes, Atlantic, Missouri	Crooked Creek, Norfork Lake, White River, Illinois drainage, Little Sugar Creek, Spavinaw Creek, Elk River, Greers Ferry Lake, White River, Kigns River, War Eagle Creek, North Sylamore Creek, Buffalo River, Current River	1888, 1955, 1959, 1960, 1962, 1963, 1965, 1966, 1968, 1969, 1970, 1971, 1972, 1982, 1997	Stocked	Competition, hybridization with natives
White Catfish	Ameiurus catus	Atlantic and Gulf	Illinois Drainage	1988	Stocked	--
Goldfish	Carassius auratus	Eastern Asia	Bull Shoals Lake, Beaver Reservoir, Flint Creek, Kings River, Greers Ferry Reservoir, Black River, White River, Spring River, Illinois River, Richland Creek	1988	Accidental	--
Unidentified pacu	Colossoma or Piaractus sp.	Tropical America	Beaver Reservoir, White River	1992, 2006	Accidental	Unknown
Asian clam	Corbicula fluminea	Southern Asia, eastern Mediterranean, Africa	Beaver Lake, Little Red River, Greers Ferry Reservoir, Spring River, Strawberry River	1975, 1978, 1979, 1985	Accidental	Biofouling, diet modification
Grass Carp	Ctenopharyngodon idella	Eastern Asia	Norfork Lake, Illinois drainage, lower Neosho drainage, Little Sugar Creek, Beaver Reservoir, Bull Shoals Lake, Piney Creek, Lake Wedington	1988, 1995, 2004	Stocked	Habitat modification
Common Carp	Cyprinus carpio	Eurasia	Throughout the region	1963, 1965, 1985, 1988, 1991, 1992, 1995, 1998	Stocked	Habitat modification
Waterflea	Daphnia lumholtzi	East Africa, Australia, India	Beaver Lake	1995	Accidental	Unknown
Threadfin Shad	Dorosoma petenense	Ohio River, Mississippi River Basin, Atlantic Slope	Beaver Lake, Flint Creek, White River, Black River	1980, 1988	Stocked	Habitat modification
Zebra mussel	Dreissena polymorpha	Black, Caspian, Azov Seas	White River (Bull Shoals Lake)	2007	Accidental	Biofouling

Table 5.9. Non-native aquatic species in the NAWRPR (continued).

Species Common Name	Species Scientific Name	Origin	Location	Dates Identified	Method of Introduction	Impact
Northern Pike	Esox lucius	Atlantic, Arctic, Pacific, Great Lakes, Mississippi River basins	Norfork Lake, Beaver Reservoir, Big Creek, Illinois drainage	1976, 1988	Stocked	Competition, hybridization with natives
tiger muskellunge	Esox lucius x E. masquinongy	Great Lakes Region	Spring River	1992	Stocked	Competition, hybridization with natives
Muskellunge	Esox masquinongy	St. Lawrence River - Great Lakes	Norfork Lake, Bull Shoals Lake	1988	Stocked	Competition, habitat modification
Blue Catfish	Ictalurus furcatus	Mississippi River basin, Gulf Slope	Throughout region, especially Benton County	1988, 1997	Stocked	Hybridication with natives
Redbreast Sunfish	Lepomis auritus	Atlantic, Gulf Slope drainages	Devils Fork Little Red River, Spring River, Sylamore Creek, Upper White drainage	1962, 1964, 1966, 1980, 2002	Stocked	Competition with native species
Green Sunfish	Lepomis cyanellus	Great Lakes, Hudson Bay, Mississippi River	White River	2007	Accidental	Decline of native species
Redeye Bass	Micropterus coosae	Savannah, Chattahoochee, Mobile Bay basins	Spring River downstream from Mammoth Spring	1988	Stocked	Decline of native species
Wiper	Morone chrysops x M. saxatilis	None - artificial hybrid	Norfork Lake, Beaver Lake, Greers Ferry Reservoir, Little Red River	1981, 1988, 1992	Stocked	Hybridication with natives
Striped Bass	Morone saxatilis	Atlantic drainages	Norfork Lake, Beaver Lake, Bull Shoals, English Creek, White River	1967, 1968, 1969, 1975, 1976, 1980, 1984, 1988, 1992, 1997	Stocked	Preys on native species
Nutria	Myocastor coypus	South America	Little Red, Lower Black drainages	1978	Imported	Habitat modification
Ozark Shiner	Notropis ozarcanus	White and Black River systems	Osage Creek	1979	Unknown	Unknown
Cutthroat Trout	Oncorhynchus clarkii	Pacific Coast	North Fork, Beaver Lake, White River	1988, 1992, 1997	Stocked	Hybridication with natives
Rainbow Trout	Oncorhynchus mykiss	Pacific Slope	Throughout the region	1950, 1976, 1988, 1992, 1997, 2007	Stocked	Hybridication with natives
Gap ringed crayfish	Orconectes neglectus chaenodactylus	--	Spring River	1998, 2003, 2005, 2006	--	--

Table 5.9. Non-native aquatic species in the NAWRPR (continued).

Species Common Name	Species Scientific Name	Origin	Location	Dates Identified	Method of Introduction	Impact
Yellow Perch	Perca flavescens	Atlantic, Arctic, Great Lakes, Mississippi River basins	Black River, Bull Shoals Lake	1905, 1999	Stocked	Competition with native species
pirapatinga, red-bellied pacu	Piaractus brachypomus	Tropical America	Pond at Fairview Memorial Gardens, Fayetteville	1995	Aquarium releases	Unknown
Fathead Minnow	Pimephales promelas	North America	Greers Ferry Reservoir, South Fork Spring River, Spring River, Strawberry River	1950, 1988	Introduced as bait fish	Unknown
Brown Trout	Salmo trutta	Europe, Northern Africa	Bull Shoals, North Fork, Beaver Lake, Little Red River, White River, Spring River	1988, 1992, 1997	Stocked	Decline of native species
tiger trout	Salmo x Salvelinus trutta x fontinalis	None - artificial hybrid	Little Red River	2005	Stocked	Unknown
Brook Trout	Salvelinus fontinalis	Canada	North Fork River, White River	1988, 1992, 1997	Stocked	Decline of native species
Lake Trout	Salvelinus namaycush	Canada	Beaver Lake, Greers Ferry Reservoir, Little Red River	1986, 1988, 1997	Stocked	Decline of native species
Sauger	Sander canadensis	St. Lawrence River - Great Lakes	Greers Ferry Reservoir	1980	Stocked	Competition with native species
Saugeye	Sander canadensis x vitreus	--	Crown Lake	1992	--	Competition with native species
Walleye	Sander vitreus	St. Lawrence River - Great Lakes	Beaver Lake, Greers Ferry Reservoir, Bull Shoals Lake	1976, 1988	Stocked	Decline of native species

There are also 10 species of invasive aquatic plants known to occur in the planning region (Table 5.10) (University of Georgia - Center for Invasive Species and Ecosystem Health 2013). In addition to the species listed in Table 5.9, a nonnative algae has been identified at locations within the NAWRPR. *Didyomsphenia geminata* is a type of algae that attaches to cobble in streams and secretes fibrous stalks that can be swept downstream and accumulate as debris. This type of algae has been found in recent years in the White River below Beaver, Bull Shoals, and Norfork Dams and below the dam at Greers Ferry on the Little Red River (AGFC 2008, 2013c). A study performed by ADEQ found that the growth of this algae and its stalks below Bull Shoals Dam could cause negatively affect growth and reproduction of the trout population. The algae could make conditions unsuitable for fish spawning and could cause dissolved oxygen levels to fall below the necessary levels for maximum trout growth (Shelby 2006).

5.5 Water Infrastructure

Communities throughout the state struggle to maintain drinking water and wastewater infrastructure, including treatment plants and distribution lines. A few communities in the NAWRPR are experiencing growth that is requiring expansion of water supply and wastewater capacity. For example, new drinking water infrastructure was recently completed, providing a new supply of water to north-central Arkansas (Grant 2013, Ozark Mountain Regional Public Water Authority n.d.). In other areas within the planning region, maintaining aging infrastructure with limited financial resources is more likely an issue.

Another concern is the recent increased focus on nutrients in wastewater discharges. Historically, permitted point source discharges in Arkansas were not limited with regard to the amount of nutrients in the wastewater they discharged. Current regulations require that all point source discharges in watersheds of waterbodies included on the Arkansas list of impaired waters due to phosphorus, be limited in the amount of phosphorus that can be present in their discharge (Arkansas Regulations 2.509). Point source discharges located in the designated nutrient surplus watersheds in the NAWRPR are subject to limits for phosphorus in their discharge under this regulation. There have been a number of expensive changes made to the wastewater treatment

Table 5.10. Invasive aquatic plants of the NAWRPR (University of Georgia-Center for Invasive Species and Ecosystem Health 2013).

Species Common Name	Species Scientific Name	Origin	Locations	Dates Identified	Method of introduction	Impact
Common water hyacinth	*Eichhornia crassipes*	South America	Washington	1988	Accidental	Habitat modification
Yellow iris	*Iris pseudacorus L.*	Asia, Africa, Europe	Washington	1988	Accidental	--
Purple loosestrife	*Lythrum salicaria*	Europe and Asia	Baxter, Izard, Randolph	2010	Introduced	Displacement of native species
Parrotfeather	*Myriophyllum aquaticum*	South America	Cleburne, Independence, Fulton, Benton	1988	Introduced	Competition with native species
Brittleleaf naiad	*Najas minor*	Europe	Baxter	1979	--	--
Watercress	*Nasturtium officinale*	Europe, Asia, Africa	All but Searcy, Van Buren, Cleburne, White	--	--	--
Yellow floating heart	*Nymphoides peltata*	Europe, Asia	Benton, Washington	1954, 1988, 2010	--	--
Reed canarygrass	*Phalaris arundinacea*	North America	Washington	1988	Accidental	Excludes other vegetation
Curly-leaved pondweed	*Potamogeton crispus*	Africa	Benton	1988	Accidental	--
Narrow-leaved cattail	*Typha angustifolia*	--	Carroll, Baxter	1988	--	--

infrastructure in these watersheds to reduce nutrient discharges and meet these limits. There are also a number of wastewater treatment plants in other areas of the NAWRPR that have current discharge permits with monitoring requirements for phosphorus and/or nitrate (ADEQ 2013d).

Two dam failures have occurred in recent years in the NAWRPR. In June 2000 a dam in Ponca Creek, a tributary to the Buffalo River, failed. There were no injuries and no structural damage. Washout from the dam washed into the river and national park. A second dam failure occurred in July 2004 in Decatur on a small earthen dam that did not require state regulation (Arkansas Department of Emergency Management 2010).

6.0 INSTITUTIONAL AND REGULATORY SETTING

This section provides a description of the regulatory and institutional framework for water resources management in NAWRPR. It includes general descriptions of federal and state laws, regulations, and programs that deal with water resources management in the region, as well as a listing of federal, state, and local governmental and nonprofit institutions that are involved in water resources management in the region. In addition, the interrelationships between regulations and institutions at the federal, state, and local levels in the NAWRPR are illustrated.

6.1 Legal Framework

The legal framework for management and use of water resources in Arkansas is based on court case law, laws enacted by the Arkansas General Assembly, and rules and regulations enacted by state agencies. Federal laws and regulations also influence the regulation of water resources in the state (ANRC 2011a). The discussion below identifies and summarizes the laws and regulations and associated programs that guide water management in NAWRPR, and summarizes changes that have occurred in this legal framework since the 1990 AWP update.

6.1.1 Federal Laws and Regulatory Programs

Federal policy recognizes that states have primary authority for regulation of water usage within their borders. Therefore, the federal laws, regulations, and associated programs that influence water resources management in the NAWRPR primarily relate to water quality. Federal legislation and programs also deal with other aspects of management of water resources in the region such as conservation and protection of waterbodies, flood control, and navigation.

6.1.1.1 Water Quality

The current federal laws and programs that guide management of water quality in the NAWRPR are summarized in Table 6.1. The Clean Water Act (CWA) of 1972 (most recently amended in 2002) and the Safe Drinking Water Act (SDWA) of 1974 (most recently amended in 1996) are two important pieces of federal water quality legislation that authorize a number of

Table 6.1. Federal laws and regulatory programs that affect NAWRPR water quality. Highlighted laws and programs were promulgated after the 1990 AWP update.

Federal Law	Federal Water Quality Regulatory Programs	Responsible Federal Agency
Clean Water Act	Ambient nutrient water quality standards	EPA
	Biosolids regulations	
	Impaired waters	
	Nonpoint source pollution management	
	NPDES point source permitting	
	NPDES stormwater permitting	
	NPDES pesticide application permitting	
	NPDES confined animal feeding operations permitting	
	State ambient water quality standards	
	State biennial water quality assessment	
	Total maximum daily loads (TMDL)	
	Dredge and fill permitting	USACE
Safe Drinking Water Act	Source water protection	EPA
	Underground injection wells	
Underground storage tank regulations	Underground storage tank program	EPA
Resource Conservation and Recovery Act (RCRA)	Hazardous waste management	EPA
	Solid waste management	
	Subtitle D	
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	Hazardous waste site clean up	EPA
Federal Insecticide, Fungicide, and Rodenticide Act	Endangered species protection program	EPA
	Labeling requirements	
	Registration	
Surface Mining Control and Reclamation Act	Mine reclamation	US Department of the Interior (USDI)
	Surface mining control	
Toxic Substances Control Act	Polychlorinated Biphenyls (PCB) Program	EPA
Soil and Water Resources Conservation Act	Conservation Effects Assessment Program	US Department of Agriculture
Arkansas Wilderness Act	National forests	USFS
National Forest Management Act		
Weeks Act		
Oil Pollution Act	Oil spill response planning	EPA
Pollution Prevention Act	Pollution prevention planning	EPA
National Environmental Policy Act (NEPA)	Environmental impact analysis of Federal projects, with mitigation	EPA, Council on Environmental Quality

federal water quality programs. Legislation related to forest conservation, such as the Cooperative Forestry Assistance Act, is included here because forests can protect and improve water quality. The EPA is responsible for administering the majority of these laws and programs; however, EPA has delegated some of this authority to state agencies such as ADEQ and the Arkansas Department of Health.

The CWA of 1972 established the NPDES that regulates point source discharges through a permit program. The NPDES program is managed by EPA, but ADEQ has been delegated authority to issue NPDES permits. NPDES permits are based on a combination of technology-based and water quality based standards. Technology-based standards are developed by EPA for certain categories based on the performance of pollution control technologies available to the industry without regard for the receiving water body. Water quality based standards are developed after consideration of the designated uses of the receiving water body and the water quality criteria necessary to protect those uses. In 1987, Congress amended the CWA to include nonpoint sources of pollution such as stormwater runoff from industries, construction sites, and municipalities. NPDES permits for the NAWRPR are summarized in Section 4. The 1987 amendments also addressed management of biosolids (sewage sludge). The CWA also requires permits for dredge and fill activities in wetlands, lakes, streams, rivers, and other waters of the US. These permits are issued by the USACE.

The TMDL program was established by the CWA in 1972; however, TMDLs were rarely developed for waterbodies until the 1990s, after environmental groups began suing the EPA over the lack of TMDLs being performed (EPA 2008). The CWA requires that a TMDL study be conducted for waterbodies identified as having impaired water quality. The TMDL study is conducted to determine the maximum amount of a pollutant that a waterbody can receive and still meet ambient water quality standards. This maximum load is split between point sources and nonpoint sources. These loads are then compared to the estimated existing point source and nonpoint source loads to determine the amount of reduction required for the waterbody to meet its water quality standards. The first TMDLs for waterbodies in the NAWRPR were completed in 2000. Prior to this, beginning in the 1980s, ADEQ routinely performed Wasteload Allocation Studies as part of the NPDES permitting process to determine the amount of a pollutant that

could be discharged to a waterbody. Since 2001, 26 TMDLs have been completed for waterbodies in the NAWRPR (see Section 5).

In 1998, EPA initiated a program to develop ambient water quality criteria for nutrients, i.e., nitrogen and phosphorus. At the time, nutrients were identified as a leading cause of water quality issues across the nation, including such high profile events as the hypoxic zone in the Gulf of Mexico and algal blooms along the national seacoast. In 2001, EPA published recommended criteria development plans (EPA 2013d).

The drinking water source water protection program was initiated as a result of the 1996 amendment to the SWDA. The purpose of this program is to prevent the need for increased treatment of drinking water (resulting in increased treatment costs and costs to customers) due to water quality degradation, by protecting the quality of the drinking water source. In the majority of cases, the cost of protecting drinking water sources from pollution is far lower than the cost of upgrading water treatment to remove increased pollution. There are approximately 310 public water utilities in the NAWRPR that are subject to SDWA regulations (ADH n.d.). More information on source water protection in the region is included in Section 5.1.2.

Subtitle D of the 1991 amendment of the Resource Conservation and Recovery Act (RCRA) introduced specifications for how landfills were to be constructed and managed to protect water quality. This led to sweeping changes in solid waste management across the country and in Arkansas (ADEQ 2011a).

6.1.1.2 Water Resources Management

The federal regulations and programs that address non-water quality aspects of water resources management are summarized in Table 6.2. These include regulations and programs that address flood control, river navigation, wetlands tracking, or water-based recreation. Programs related to drinking water infrastructure are also included in Table 6.2 and discussed below. Some of the legislation and programs that address water quality also address other aspects of water resources management. For example, preservation of forest lands protects water quality and hydrology. As a result, there is some duplication in Tables 6.1 and 6.2. Federally appropriated water, such as the water required to maintain navigation on the McClellan-Kerr

Table 6.2. Federal laws and programs that affect aspects of NAWRPR water resources other than water quality.

Federal Law	Federal Program	Responsible Federal Agency	Water Plan Relevance
Clean Water Act	Wetland and stream mitigation	USACE	Physical protection of waterbodies, including wetlands
Safe Drinking Water Act	Consumer confidence reports	EPA	Protects/improves public water supply
	Finished water criteria	EPA	Protects human health
	Operator certification	EPA	Informs the public
Endangered Species Act	Freshwater species protection	USFWS	Mechanism for physical protection of waterbodies that are habitats for endangered species
	Waterfowl protection		
Soil and Water Resources Conservation Act	Census of Agriculture	USDA	Irrigation and agriculture
	Conservation Effects Assessment Program	USDA	Water resources protection/improvement
	Natural Resources Inventory	USDA	Characterize water resources
National Environmental Policy Act	Environmental Impact Statements and Mitigation	EPA, Council on Environmental Quality	Water resources protection/mitigation
Flood Control Act/Water Resources Development Act	Dam safety	USACE	Water storage, water supply, flood reduction, flow management, restoration of physical aquatic habitat
	Flood control reservoirs		
	Levees		
	Navigation systems		
Arkansas Wilderness Act	National forests	USFS	Well managed forestlands improve and protect water resources
National Forest Management Act			
Weeks Act			
Rivers and Harbors Act	Navigation	USACE	Federal navigation systems in Arkansas
	Section 10	USACE	Protects waterbodies, including wetlands
Migratory Bird Hunting and Conservation Stamp Act	Small wetland acquisition program	USFWS	Protects wetlands
Emergency Wetlands Resources Act	National Wetlands Inventory	USFWS	Track wetland resources
Dam Safety and Security Act	National Dam Safety Program	Federal Emergency Management Agency (FEMA)	Protection of lives and property
Wild and Scenic Rivers Act	National Wild and Scenic Rivers	USFS	Preservation of water resources for recreation
National Parks Acts	National Parks	USDI National Park Service	Protection of water resources associated with national parks

Table 6.2. Federal laws and programs that affect aspects of NAWRPR water resources other than water quality (continued).

Federal Law	Federal Program	Responsible Federal Agency	Water Plan Relevance
Migratory Bird Conservation Act	Acquisition of lands for wildlife refuges	Migratory Bird Conservation Commission	Preservation of water resources for bird habitat
National Wildlife Refuge System Improvement Act	National Wildlife Refuges	USFWS	Preservation of water resources for habitat
Pittman-Robertson Wildlife Restoration Act	Wildlife and sport fish restoration	USFWS	Preservation of water resources for fish and wildlife habitat
National Flood Insurance Act	National Flood Insurance Program	FEMA	Insurance against flood losses
	Floodplain management	FEMA	Reduction of flood damage
	Flood hazard mapping	FEMA	Identification of flood hazard areas
None	Climate monitoring	NOAA	Tracking precipitation and evaporation – water availability
	Climate prediction	NOAA	Future water availability
	Drought status	NOAA	Enactment of water shortage specific management

Highlighted programs were initiated after the 1990 AWP update.

Arkansas River Navigation System, is not available for other uses. Federal water appropriations preempt other beneficial water uses, such as irrigation.

An important federal program for mitigating impacts to wetlands and streams is part of the dredge and fill permitting program of the CWA (Section 404), overseen by the USACE. This mitigation program was initiated in 1990, when the EPA and the USACE signed a memorandum of agreement establishing a process for determining the need for mitigation of impacts to wetlands, streams, and other water resources under the CWA Dredge and Fill Permitting program. This program provides a means for dredge and fill permit applicants to compensate for unavoidable destruction of aquatic habitat by either restoring or creating similar habitat either on site or at another location (EPA 2013e). There are five sites within the NAWRPR that have been designated as commercial mitigation banks for CWA dredge and fill permitting (Table 6.3) (USACE n.d.). The program is a mechanism for implementing the federal policy of no-net-loss of wetlands (EPA 2013e). Revised regulations governing this mitigation program were issued in 2008.

Table 6.3. Commercial mitigation banks within and serving areas within the NAWRPR.

Name of site	Location	Year Established	Area (acres)	Primary service area	Secondary service area	Sponsor	Credits
Little Horse Creek	Benton County	2011	70	Benton, Crawford, Washington Counties		Natural State Streams LLC	20106.5 stream
Kings River Mitigation Bank	Madison County	2008	274	Benton, Washington, Carroll, Boone, Marion, Madison Counties	Newton, Marion, Searcy, Stone, Izard, Fulton, Independence Counties	Natural Resources Investment Group	29736.25 stream
Davis Creek Mitigation Bank	Searcy County	2010	319	Newton, Searcy, Stone, Marion, Izard, Baxter, Independence	Baxter, Marion, Boone, Fulton, Van Buren, Cleburne, White, Independence, Jackson	Mitigation Solutions LLC	93778.7 stream
Hartsugg Creek	Searcy County	2010		Stone, Searcy, Newton, Johnson, Pope, Van Buren, Cleburne, White	Baxter, Stone, Izard, Independence	Advanced Ecology, Ltd	
Little Red River	White County	1999	50	Stone, Searcy, Van Buren, Cleburne, White	none		0.74 bottomland hardwood

The 1996 amendments to the SDWA directed EPA and the states to develop requirements for certification of water treatment system operators (EPA 2012e). These amendments also initiated a program that required public water suppliers that operate community water systems to provide annual reports to drinking water utility customers on the quality of their drinking water (EPA 2013c).

The Endangered Species Act provides for protection and recovery of imperiled terrestrial, freshwater, and marine plant and animal species (except pest insects) (USFWS 2013b). The NAWRPR contains aquatic and semi-aquatic habitat important for a number of endangered species (See Tables 5.4 and 5.5).

The upper Buffalo River and North Sylamore Creek are included in the National Wild and Scenic Rivers system. The purpose of this program is to preserve free-flowing rivers with outstanding natural, cultural, or recreational characteristics. The designated portion of the Buffalo River extends from the headwaters to the boundary of the Ozark National Forest. The designated portion of the North Sylamore Creek extends from the boundary of the Clifty Canyon Botanical Area to the confluence with the White River. These designated stream reaches are managed by the USFS (ANHC 2012, Interagency Wild and Scenic Rivers Council n.d.).

Under the National Flood Insurance Act, flood hazard maps have been completed for the entire NAWRPR, and half of the mapping has been, or is in the process of being, modernized, within the last 8 years. The counties that have not been modernized are Madison, Newton, Marion, Searcy, Van Buren, Stone, Cleburne, Izard, and Fulton (Figure 6.1). Flood hazard maps for these counties are more than 25-years old. Modernized flood hazard maps typically include updated Special Flood Hazard Areas (SFHAs), and are created in a digital countywide format. For the communities participating in the National Flood Insurance Program (NFIP), the flood hazard maps identify the regulatory SFHA whereby the community floodplain administrator applies the locally adopted and enforced floodplain management ordinance. Participation the NFIP is voluntary, however non-participation results in federal flood insurance not being available to residents and limits post-disaster financial assistance. All of the counties included in the NAWRPR except Baxter, Boone, Carroll, Cleveland, Marion, and Stone are participating in the program (FEMA 2013b). Though these counties do not participate, some of the communities within the counties do. These communities are listed in Table 6.4.

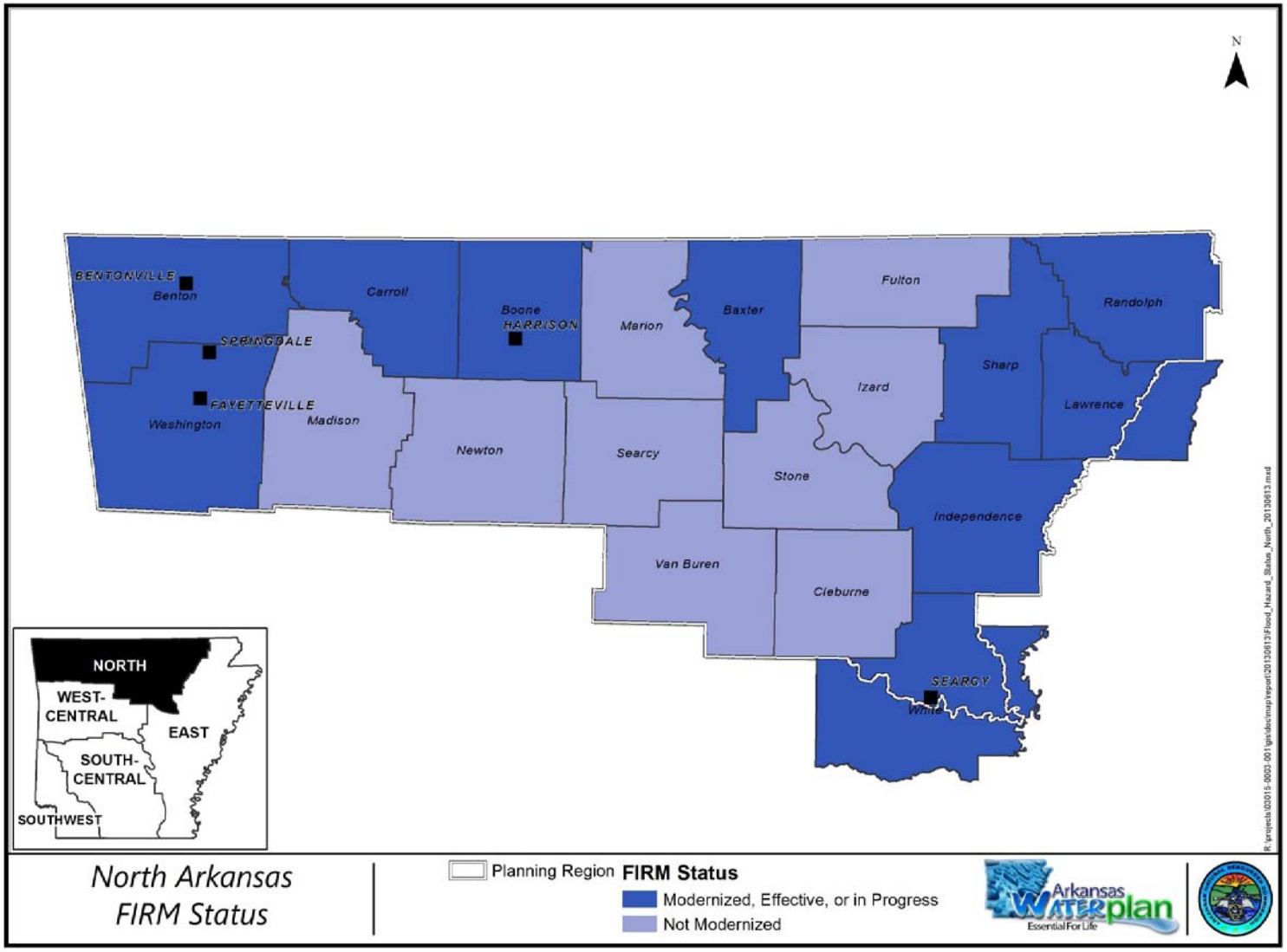

Figure 6.1. Status of flood hazard mapping in the NAWRPR.

Table 6.4. Communities participating in the NFIP not located in a participating county.

County	Participating Community
Baxter	Gassville
	Mountain Home
	Norfork
	Salesville
Boone	Bellefonte
	Bergman
	Harrison
Carroll	Beaver
	Eureka Springs
Cleveland	Kingsland
Marion	Bull Shoals
	Flippin
	Yellville
Stone	Mountain View

Federally appropriated water, such as the water allocated for hydropower at the dams along the White River, is not available for other uses. Surface waters in the NAWRPR that are under some degree of federal management include the White and Little Red Rivers (Beaver, Bull Shoals, TableRock, Greers Ferry, and Norfork Lakes), the Black River (Clearwater Lake in Missouri), and the Buffalo River (National River, National Wild and Scenic River) and North Sylamore Creek (National Wild and Scenic River).

6.1.2 Federal Laws and Assistance Programs

Federal laws have also established a number of programs to provide technical and financial assistance for water resources management, that are available in Arkansas. Assistance programs for management of water quality and other aspects of water resources are discussed in the following sections.

6.1.2.1 Water Quality

Table 6.4 summarizes current federal assistance programs available in the NAWRPR and the associated federal laws. The majority of the federal assistance programs listed in Table 6.5 originated through the Farm Bill. The Farm Bill has been amended four times since 1990, most recently in 2013 (National Agricultural Law Center 2012). New conservation programs that are intended to assist farmers in protecting and restoring water quality have been added with each amendment. In 2012, over 166,300 acres in the counties of the NAWRPR were enrolled in Farm Bill programs, and over $18.7 million in funding provided to those counties for water quality practices (Table 6.6) (NRCS 2012).

The Illinois River Sub-Basin and Eucha-Spavinaw Lake Watershed Initiative is a program funded by the USDA NRCS with the purpose of improving water quality in the Illinois River and Eucha-Spavinaw Lake Watersheds while maintaining food production in the area. 43.8% of the included land area in Northwest Arkansas, with the remaining area in Oklahoma. Conservation practices in the area are planned to aid in the water quality improvement efforts, including land treatments and addition of structures (NRCS 2013).

The CWA authorizes EPA to provide federal funding assistance to states and local entities through three funding programs. Through the Clean Water State Revolving Fund, federal funds are provided to ANRC to fund a low interest loan program for wastewater treatment, nonpoint source pollution control, and watershed management projects in the state. Grants for nonpoint source pollution control projects are authorized under Section 319 of the CWA. Finally, Section 106 of the CWA authorizes federal funding assistance to states and interstate agencies through grants for pollution control programs such as discharge permitting and water quality monitoring.

Table 6.5 Federal water quality assistance programs available in the NAWRPR.

Federal Law	Federal Water Quality Funding Assistance Programs	Responsible Federal Agency
CWA	Clean water state revolving fund	EPA
	Nonpoint source pollution management grants	
	Water pollution control program grants	
Comprehensive Environmental Response, Compensation, and Liability Act	Hazardous waste site clean up	EPA
Cooperative Forestry Assistance Act	Forest Stewardship Program	USFS
	Forest Legacy Program	
	Urban and Community Forestry Program	
Housing and Community Development Act	Community development block grants programs	US Department Housing and Urban Development (HUD)
Consolidated Farm and Rural Development Act	Water and waste disposal systems for rural communities	USDA Rural Utilities Service
	Water and Waste Disposal Loans and Grants	
	Solid Waste Management Grants	
	Grant Program to Establish a Fund for Financing Water and Wastewater Projects	
Farm Bill	Agricultural Water Enhancement Program	NRCS
	Conservation Reserve Program (CRP)	USDA Farm Services Agency
	Conservation Innovation Grants Program	NRCS
	Conservation Stewardship Program (CSP)	
	Cooperative Conservation Partnership Initiative	
	Environmental Quality Incentives Program (EQIP)	
	Farm and Ranch Land Protection Program	
	Grassland Reserve Program	
	Grazing Lands Conservation Initiative	
	Mississippi River Basin Healthy Watersheds Initiative	
	Illinois River Sub-Basin and Eucha-Spavinaw Lake Watershed Initiative	
	National Water Management Center	
	National Water Quality Initiative	
	Organic Initiative	
	Wetlands Reserve Program	
	Wildlife Habitat Incentives Program	
American Recovery and Reinvestment Act	Clean water state revolving fund, clean up of leaking underground storage tanks	Recovery Accountability and Transparency Board
Clean Vessel Act	Funding for pumpout stations and waste reception facilities for recreational boaters	USFWS

Note: Highlighted laws and programs were promulgated after the 1990 AWP update.

Table 6.6. NRCS conservation programs summary for 2012 (NRCS 2012).

County	Conservation Stewardship Program			Environmental Quality Incentives			Wildlife Habitat Incentive Program			Emergency Watershed Protection Program		Environmental Quality Incentives Program		
	Contracts	Acres	FY12 Obligations	Contracts	Acres	FY12 Obligations	Contracts	Acres	FY12 Obligations	FY12 Obligations	Project Type	Contracts	Acres	FY12 Obligations
Baxter	--	--	--	--	--	--	9	1,170	$129,047	--	--	10	1,588	$110,546
Benton	--	--	--	--	--	--	--	--	--	$111,623	Stream Bank Restoration	94	7,560.3	$2,232,264
Boone	--	--	--	--	--	--	--	--	--	--	--	11	534.3	$117,323
Carroll	--	--	--	--	--	--	1	65	$5,690	--	--	25	828.3	$518,892
Cleburne	--	--	--	1	54.5	$7,146	12	876.7	$80,531	--	--	25	1,626.3	$505,106
Fulton	--	--	--	--	--	--	25	2,950.1	$457,055	--	--	74	12,311.9	$1,204,130
Independence	14	22,535.1	$496,506	--	--	--	4	615.0	$48,113	$36,995	Debris Removal	36	8,297.3	$136,179
Izard	2	598.9	$ 8,781	--	--	--	5	356.4	$31,532	--	--	39	6,917.8	$759,393
Lawrence*	68	52,330.3	$2,326,961	--	--	--	1	200	$48,628	$59,287	Stream Bank Stabilization	8	6,559	$149,718
Madison	--	--	--	--	--	--	--	--	--	--	--	27	1,835.9	$405,230
Marion	4	1094	$13,648	--	--	--	6	1,247	$136,971	--	--	--	--	--
Newton	--	--	--	7	392.3	$60,430	3	86	$17,541	--	--	--	--	--
Randolph	4	2,687.0	$80,125	--	--	--	1	750	$ 28,001	$23,153	Auxiliary Spillway Repair (PL-566 dam)	--	--	--
Searcy	9	3,525.1	$22,833	4	719.9	$78,591	20	2,038	$424,462	--	--	--	--	--
Sharp	4	1,697.2	$18,934	--	--	--	--	--	--	--	--	--	--	--
Stone	1	39.3	$688	--	--	--	13	923.4	$258,744	--	--	--	--	--
Van Buren	1	524.5	$6,741	9	901.1	$166,823	11	936.4	$68,784	$52,000	Landslide Stabilization	--	--	--
Washington	--	--	--	--	--	--	--	--	--	--	--	--	--	--
White*	2	1,964.3	$50,600	--	--	--	1	880	$29,326	--	--	--	--	--
Totals	**109**	**84,308.7**	**$3,025,817**	**21**	**2,067.8**	**$312,990**	**109**	**12,479**	**$1,715,797**	**$283,058**		**349**	**48,059.1**	**$5,243,209**

*Part of this county is in another planning region; value reported is for the entire county and may not reflect what is in the planning region

Table 6.6. NRCS conservation programs summary for 2012 (NRCS 2012) (continued).

County	Little Red River Irrigation District AWEP project			Illinois River/Eucha Spavinaw Watershed Initiative			Point Remove Wetlands Reclamation and Irrigation District			The Nature Conservancy Cache/White River			Strike Force Initiative			Wetlands Reserve Program		
	Contracts	Acres	FY12 Obligations	Contracts	Acres	FY12 Obligations	Contracts	Acres	FY12 Obligations	Contracts	Acres	FY12 Obligations	Easements	Acres	FY12 Obligations	Easements	Acres	FY12 Obligations
Baxter	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benton	--	--	--	72	5,548	$1,795,389	--	--	--	--	--	--	--	--	--	--	--	--
Boone	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carroll	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cleburne	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fulton	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Independence	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	578.8	$698,590
Izard	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lawrence*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Madison	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Marion	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Newton	--	--	--	--	--	--	--	--	--	--	--	--	1	243	$14,938	--	--	--
Randolph	--	--	--	--	--	--	--	--	--	--	--	--	10	1,099	$182,041	--	--	--
Searcy	--	--	--	--	--	--	--	--	--	--	--	--	21	2,455	$778,710	--	--	--
Sharp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Stone	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Van Buren	--	--	--	--	--	--	4	171	$26,178	--	--	--	--	--	--	--	--	--
Washington	--	--	--	61	5,294.4	$2,384,654	--	--	--	--	--	--	--	--	--	--	--	--
White*	28	2,559.6	$818,519	--	--	--	--	--	--	2	131	$118,490	--	--	--	5	1,310.4	$1,680,140
Totals	**28**	**2,559.6**	**$818,519**	**133**	**10,842.4**	**$4,180,043**	**4**	**171**	**$26,178**	**2**	**131**	**$118,490**	**32**	**3,797**	**$975,689**	**6**	**1,889.2**	**$2,378,730**

* Part of this county is in another planning region; value reported is for the entire county and may not reflect what is in the planning region

There are additional federal laws that authorize programs that provide assistance for community waste treatment and management to protect water quality. HUD grants for construction and upgrading of wastewater infrastructure were also authorized by the Housing and Community Development Act. Several programs to provide financial assistance for wastewater systems and solid waste programs in rural areas were authorized by the Consolidated Farm and Rural Development Act.

The American Recovery and Reinvestment Act was promulgated in 2009 to save and create jobs during the recession that began in 2008. This act initiated several programs that provide money to states for a range of activities, including improvements to wastewater treatment systems and clean up of leaking underground storage tanks and hazardous waste sites (EPA 2013f). Over $25 million of recovery money was awarded to the Arkansas State Clean Water Revolving Loan Fund, and $1.6 million was awarded to the ADEQ Leaking Underground Storage Tank Program. Recovery money was awarded to three wastewater projects and three leaking underground storage tank remediation projects in the planning region (EPA n.d.).

The Clean Vessel Act was promulgated in 1992. This act established a program to provide grants to states to pay for construction, maintenance, operation, or renovation of boat pumpout stations and waste reception facilities (US Congress 1992). Money from this program was used to install fixed pumpout facilities at an Arkansas River marina near Pine Bluff (ADH 2011).

Forestry assistance programs are included in Table 6.5 because forest improvement can improve water quality.

6.1.2.2 Water Resources Management

The federal assistance programs that address non-water quality aspects of water resources management are summarized in Table 6.7. These include programs that address flood control, water conservation, water supply systems, fisheries, and aquatic habitat for wildlife. Some of the programs that provide assistance for addressing water quality, also address other aspects of water resources management. For example, some Farm Bill programs support practices that conserve water, as well as practices that protect water quality. As a result, there is some duplication in Tables 6.5 and 6.7.

Table 6.7 Federal assistance programs for aspects of water resources other than water quality that are active in the NAWRPR.

Federal Law	Federal Program	Responsible Federal Agency	Water Plan Relevance
Safe Drinking Water Act	Drinking water state revolving fund	EPA	Protects human health
Farm Bill	Agricultural Water Enhancement Program	NRCS	Water conservation
	Cooperative Conservation Partnership Initiative	NRCS	Water conservation
	Conservation Innovation Grants Program	NRCS	Water conservation
	Emergency Watershed Protection	NRCS	Flooding reduction, recovery
	National Water Management Center	NRCS	Waterbody protection/restoration
	On-farm Energy Initiative	NRCS	Water conservation
	Watershed protection and flood prevention	NRCS	Flooding management
	Wetlands Reserve Program	NRCS	Physical waterbody protection/restoration
	Wildlife Habitat Incentives Program	NRCS	Physical waterbody protection/restoration
Cooperative Forestry Assistance Act	Urban and Community Forestry Program	USFS	Trees in communities reduce stormwater runoff, improving hydrology
	Forest Stewardship Program	USFS	Well-managed forestlands improve and protect water resources
	Forest Legacy Program		
Flood Control Act/Water Resources Development Act	Habitat restoration	USACE	Water storage, water supply, flood reduction, flow management, restoration of physical aquatic habitat
	White River Studies		
Housing and Community Development Act	Community development block grants programs	HUD	Protects/improves public water supply
American Recovery and Reinvestment Act	Funding for drinking water state revolving fund	Recovery Accountability and Transparency Board	Protects/improves public water supply
Consolidated Farm and Rural Development Act	Water and wastewater disposal systems for rural communities, Water and wastewater disposal loans and grants, Household water well system grant program, Grant program to establish a fund for financing water and wastewater projects, Emergency community water assistance grants	USDA Rural Development	Protects/improves public water supply

Table 6.7 Federal assistance programs for aspects of water resources other than water quality that are active in the NAWRPR (continued).

Federal Law	Federal Program	Responsible Federal Agency	Water Plan Relevance
Land and Water Conservation Fund Act	Matching grants for acquisition and development of public recreation areas and facilities	USDI National Park Service	Preservation of water resources for recreation
Pittman-Robertson Wildlife Restoration Act	Wildlife restoration grant program	USFWS	Preservation of water resources for fish and wildlife habitat
Sport Fish Restoration Act	Boating infrastructure grants	USFWS	Recreational boating and fishing
	Multistate conservation grants	USFWS	Aquatic habitat research and education
	Sports fish restoration grants	USFWS	Preservation of water resources for fish and wildlife habitat

Note: Highlighted laws and programs were initiated after the 1990 AWP update.

The 1996 amendment of the Safe Drinking Water Act established the Drinking Water State Revolving Fund to assist drinking water utilities in financing infrastructure improvements. Using this fund, states can offer utilities low-cost loans and other types of assistance. Funds available through the American Recovery and Reinvestment Act were awarded to the Arkansas Drinking Water State Revolving Fund (EPA n.d.).

Farm Bill amendments and associated assistance programs, as well as the Conservation Effects Assessment Program, the assistance programs associated with the Consolidated Farm and Rural Development Act, and the HUD Community Development Block Grant Program, were discussed in Section 6.1.2.1. Farm Bill programs address water conservation (e.g., Groundwater Decline Initiative), flood control (e.g., Watershed protection and Flood prevention), and conservation and restoration of aquatic habitat (e.g., Wetlands Reserve Program, Wildlife Habitat Incentives Program).

Several water resources projects have been authorized in Arkansas since 1990 under the Water Resources Development Act (WRDA). The White River Comprehensive Study includes the entire White River, and was started in 1986 with updates in 2000 and 2007. This study includes identifying water resources needs and opportunities for water supply, flood control, navigation, recreation, power generation, wastewater management, and environment. The White

River Minimum Flow Reallocation Study was authorized by the 1999 and 2000 WRDA, and finalized in 2009. This study evaluated potential effects of reallocating storage from Beaver, Table Rock, Bull Shoals, Norfork, and Greers Ferry lakes to maintain minimum flows downstream of the dams to sustain the introduced trout fisheries. Reallocation was authorized only for Bull Shoals Lake and Norfork Lake (USACE Little Rock District 2009). Bull Shoals Dam has a target minimum release of 800 cfs. Norfork Dam has a target minimum release of 300 cfs (USACE Little Rock District n.d.). Other WRDA projects in the region include several Arkansas Highway and Transportation Department projects and other structure and bank updates. These projects are located in Washington, Benton, Stone, Van Buren, and Lawrence Counties.

6.1.3 State Laws and Regulatory Programs

Arkansas has primary authority for regulation of water usage within the state. Many of the state laws and agency regulations related to water quality implement federal laws. The federal government has delegated authority to the state for a number of regulatory administrative activities of both the Clean Water Act and the Safe Drinking Water Act.

6.1.3.1 Water Use Regulations

State water use law is based on a policy where riparian land owners, i.e., persons owning land that abuts a waterbody, have the right to reasonable use of the water within that waterbody. The reasonable use policy means that all landowners along a stream have the right to free and unrestricted use of the stream flow, provided that their use does not negatively affect the availability of water for other riparian users. Similarly, landowners have the right to reasonable use of groundwater under their property, as long as that use does not adversely affect the ability of other landowners to use the groundwater. In addition to water rights related to water withdrawals and consumptive use, Arkansas regulations address water rights related to public recreational uses of surface water such as boating and fishing (ANRC 2011a).

In Arkansas, at the state level, regulations and programs authorized by the General Assembly that are related to water use are generally administered by ANRC. In addition, the

Arkansas Water Well Construction Commission promulgates rules for construction of water supply wells, and the Arkansas Public Services Commission regulates private water utility fees. State incentive programs for water conservation, as well as funding for water resources development projects, have also been legislated. Table 6.8 summarizes selected Arkansas water use regulations that apply in the NAWRPR.

Table 6.8. State regulations related to water use.

State Water Use Regulations	Subjects Addressed by Regulations	Related State Legislation
Title 3: Rules for the Utilization of Surface Water[1]	Registration of surface water withdrawals	Arkansas Code §15-22-215
	Minimum streamflows	Arkansas Code §15-22-222
	Surface water transfers to non-riparian users	Arkansas Code §15-22-304
	Regulation of dam construction	Arkansas Code §15-22-210 - 214
	Allocation during periods of water shortage	Arkansas Code §15-22-217
Title 4: Rules for the Protection and Management of Groundwater[1]	Registration of groundwater withdrawals	Arkansas Code §15-22-302
	Groundwater protection program	Arkansas Groundwater Protection and Management Act (Arkansas Code §15-22-901 et seq.)
Arkansas Water Well Construction Commission Rules and Regulations[2]	Licensing of water well contractors	Arkansas Code §17-50-201 et seq.
	Construction requirements	
	Well reporting requirements	
Affiliate Transaction Rules[3]	Requirements for utility rates	Arkansas Code §23-2-101 et seq.
General Service Rules[3]	Standards of service for utilities	
Special Rules Water[3]	Standards of service for water utilities	

1 Enforcement by ANRC
2 Enforcement by Arkansas Water Well Construction Commission
3 Enforcement by Arkansas Public Service Commission
Note: Highlighted legislation was promulgated after the 1990 AWP update.

State law requires ANRC to "establish and enforce minimum stream flows for the protection of instream water needs" (Arkansas Code § 15-22-222). Minimum streamflow is defined by Arkansas Code §15-22-202(6) as "…the quantity of water required to meet the largest of [specified] instream flow needs as determined on a case-by-case basis." The needs to be met that are specified in the statute are interstate compacts, navigation, fish and wildlife, water

quality, and aquifer recharge. This definition is used to set minimum streamflows by rulemaking under Arkansas Code §15-22-222. Where no minimum flow is set by rule, these factors are used to make a case-by-case determination of minimum flow. ANRC has adopted minimum streamflow by rule for the main stem of the White River (2009).

The minimum streamflow, set by rule or determined on a case-by-case basis, represents the trigger point for a "shortage" requiring allocation of water use. Because of the critical low flow conditions which may exist at the minimum streamflow level, the 1990 AWP recommended taking steps to reduce water withdrawals before water levels drop to minimum streamflow levels. The ANRC may allocate water among uses during a shortage.

Prior to adoption of Act 593 of 2013, minimum streamflows were classified as a "reserved" use when allocating water during a shortage, along with drinking water use and federal water rights. The legislation removed this reserved status and demoted minimum streamflows to a position below agriculture and industry in the allocation hierarchy, and ahead of hydropower and recreation. The intent was to ensure that agricultural and industrial surface water use is not curtailed during a shortage in an effort to protect instream flow needs (interstate compacts, navigation, fish and wildlife, water quality, and aquifer recharge). This change, especially as it applies a state law limitation on federal interests in navigation, interstate compacts and water quality, including wastewater discharge permits for sewer systems and industries, has not been tested.

In 1985, the Arkansas General Assembly adopted a departure from traditional riparian law by allowing transfer of water for use on non-riparian land. Prior to determining how much water is available to transfer, ANRC must first calculate the amount of water that must remain in the stream. The amount of water that must remain in the stream must be enough to cover: (1) existing riparian water rights as of June 28, 1985; (2) water needs of federal water projects as they existed on June 28, 1985; (3) firm yield of all reservoirs in existence on June 28, 1985; (4) maintenance of instream flows for fish and wildlife, water quality, aquifer recharge requirements, and navigation; and (5) future water needs of the basin of origin as projected in the AWP. The General Assembly limited the amount of excess surface water that may be permitted for non-riparian transfer to 25% of the average annual yield from the watershed after the greatest

of the instream needs listed above is met. In the White River Basin, Arkansas Code§15-22-304(e) further limits excess to an amount not to "exceed on a monthly basis an amount which is 50% of the monthly average of each individual month of excess surface water."

Minimum streamflow is often mistakenly equated with fish and wildlife flow requirements. Fish and wildlife flows are one of the 5 elements of minimum streamflow, which also includes interstate compacts, navigation, water quality, and aquifer recharge. Two different methods are used to calculate fish and wildlife flows for different situations. For case-by-case determinations of minimum flow for use in characterizing shortage and allocating water during a shortage, fish and wildlife flow requirements are estimated using a modified Tennant Method (ASWCC 1988). To calculate fish and wildlife flow requirements when determining the amount of excess water available for transfer to nonriparian users, the "Arkansas Method" (Filipek, Keith and Giese 1987) is used.

In 1991, the Arkansas Ground Water Protection and Management Act (Arkansas Code §15-22-901 et seq.) was signed into law, providing ANRC with authority to designate critical groundwater areas. This law also mandated that ANRC evaluate the condition of the state's aquifers on a biennial basis, and make recommendations concerning safe yield and the designation of critical groundwater areas (ANRC 2011a). ANRC publishes annual reports on the condition of the state's groundwater resources, including recommendations concerning aquifer safe yield and designation of critical groundwater areas. There are no critical groundwater areas designated in the NAWRPR, however, legislation passed in 2001 requires the use of water meters on all non-domestic wells withdrawing water from sustaining aquifers, which include the Roubidoux and Gunter aquifers, beginning in 2006.

6.1.3.2 Water Quality Regulations

Water quality regulations are promulgated by the General Assembly, Arkansas Pollution Control and Ecology Commission (APCEC), the State Board of Health, and ANRC. Table 6.9 identifies state regulations and laws, along with associated federal laws, that address water quality.

Table 6.9. State regulations that protect water quality.

State Regulation	Subjects/Programs	Related State Legislation	Related Federal Legislation
Regulation 1: Prevention of Pollution by Salt Water and Other Oil Field Wastes Produced by Wells in All Fields or Pools[1]	Environmental protection during oil drilling	Arkansas Water and Air Pollution Control Act (Arkansas Code § 8-4-201 et seq.)	Clean Water Act
Regulation 2: Water Quality Standards for Surface Waters of the State of Arkansas[1]	Water quality standards (designated uses and numeric criteria)	Arkansas Water and Air Pollution Control Act (Arkansas Code § 8-4-201 et seq.)	Clean Water Act
Regulation 3: Licensing of Wastewater Treatment Operators[1]	Licensing program for wastewater treatment operators	Arkansas Water and Air Pollution Control Act (Arkansas Code § 8-4-201 et seq.)	Clean Water Act
Regulation 4: Disposal Permits for Real Estate Subdivisions in Proximity to Lakes and Streams[1]	State wastewater permit	Arkansas Water and Air Pollution Control Act (Arkansas Code § 8-4-201 et seq.)	Clean Water Act
Regulation 5: Liquid Animal Waste Systems[1]	State wastewater permit	Arkansas Water and Air Pollution Control Act (Arkansas Code § 8-4-201 et seq.)	Clean Water Act
Regulation 6: Regulations for State Administration of the NPDES Program[1]	Federal wastewater permits (NPDES)	Arkansas Water and Air Pollution Control Act (Arkansas Code § 8-4-201 et seq.)t	Clean Water Act
Regulation 15: Open-Cut Mining and Land Reclamation Code[1]	Environmental protection during non-coal mining activities, restoration of non-coal mining sites	Arkansas Open Cut Land Reclamation Act (Arkansas Code §15-57-301 et seq.) Arkansas Quarry Operation, Reclamation, and Safe Closure Act (Arkansas Code §15-57-401 et seq.)	None
Regulation 17: Underground Injection Control Code[1]	Underground injection of wastewater	Arkansas Water and Air Pollution Control Act (Arkansas Code § 8-4-201 et seq.)	Safe Drinking Water Act
Regulation 22: Solid Waste Management[1]	Landfill construction specifications, acceptable materials for landfill disposal, regional solid waste management districts, pollution prevention	Arkansas Solid Waste Management Act (Arkansas Code § 8-6-201 et seq.), Arkansas Pollution Prevention Act (Arkansas Code § 8-10-201 et seq.)	Resource Conservation and Recovery Act, Pollution Prevention Act

Table 6.9. State regulations that protect water quality (continued).

State Regulation	Subjects/Programs	Related State Legislation	Related Federal Legislation
Regulation 23: Hazardous Waste Management[1]	Hazardous waste management, pollution prevention	Arkansas Hazardous Waste Act (Arkansas Code § 8-7-201 et seq.), Arkansas Hazardous Materials Transportation Act (Arkansas Code § 27-2-101 et seq.), Arkansas Pollution Prevention Act (Arkansas Code § 8-10-201 et seq.)	Resource Conservation and Recovery Act, Pollution Prevention Act
Regulation 27: Licensing of Landfill Operators and Illegal Dumps Control Officers[1]	Licensing of landfill operators, licensing of illegal dumps control officers	Arkansas Code § 8-6-901 et seq., Illegal Dump Eradication and Corrective Action Program Act (Arkansas Code § 8-6-501 et seq.)	Resource Conservation and Recovery Act
Regulation 29: Brownfields Redevelopment[1]	Clean-up and redevelopment of contaminated sites	Arkansas Hazardous Waste Act (Arkansas Code § 8-7-201 et seq.), Remedial Action Trust Fund Act, Arkansas Voluntary Clean-up Act (Arkansas Code § 8-7-1101 et seq.)	Comprehensive Environmental Response, Compensation, and Liability Act
Regulation 32: Environmental Professional Certification[1]	Certification program for professionals involved in clean-up of contaminated sites	Phase I Environmental Site Assessment Consultant Act (Arkansas Code § 8-7-1301 et seq.)	Comprehensive Environmental Response, Compensation, and Liability Act
Regulation 34: State water permit regulation[1]	Regulation of systems with the potential to pollute water resources, that are not otherwise regulated	Arkansas Water and Air Pollution Control Act (Arkansas Code § 8-4-201 et seq.)	Clean Water Act
Title 19: Rules Governing the Poultry Feeding Operations Registration Program[2]	Registration of poultry feeding operations	Arkansas Poultry Feeding Operations Registration Act (Arkansas Code § 15-20-901 et seq.)	Clean Water Act
Title 20: Rules Governing the Arkansas Nutrient Management Planner Certification Program[2]	Training and certification of nutrient management planners	Arkansas Soil Nutrient Management Planner and Applicator Certification Act (Arkansas Code § 15-20-1001 et seq.)	Clean Water Act

Table 6.9. State regulations that protect water quality (continued).

State Regulation	Subjects/Programs	Related State Legislation	Related Federal Legislation
Title 21: Rules Governing the Arkansas Nutrient Management Applicator Certification Program[2]	Training and certification of nutrient applicators	Arkansas Soil Nutrient Management Planner and Applicator Certification Act (Arkansas Code § 15-20-1001 et seq.)	Clean Water Act
Title 22: Rules Governing the Arkansas Soil Nutrient and Poultry Litter Application and Management Program[2]	Nutrient surplus areas, nutrient management plans, poultry litter management plans, poultry litter transport	Arkansas Water and Air Pollution Control Act (Arkansas Code § 8-4-201 et seq.), Arkansas Poultry Feeding Operations Registration Act (Arkansas Code § 15-20-901 et seq.), Arkansas Soil Nutrient Management Planner and Applicator Certification Act (Arkansas Code § 15-20-1001 et seq.), Arkansas Soil Nutrient Application and Poultry Litter Utilization Act (Arkansas Code § 15-20-1101 et seq.)	Clean Water Act
Rules and regulations pertaining to general sanitation[3]	Groundwater pollution, surface water pollution, sewage treatment	Arkansas Sewage Disposal Systems Act (Arkansas Code § 14-236-101 et seq.)	Clean Water Act
Rules and regulations pertaining to public water systems[3]	Safety of drinking water supplied by public water systems	Arkansas Code § 20-7-101 et seq.	Safe Drinking Water Act
Rules and regulations pertaining to semi-public water systems[3]	Safety of drinking water supplied by semi-public water systems	Arkansas Code § 20-7-101 et seq.	Safe Drinking Water Act
Rules and regulations pertaining to water operator licensing[3]	Licensing for drinking water treatment systems	Arkansas Code § 17-51-101 et seq.	Safe Drinking Water Act
Rules and regulations pertaining to onsite wastewater systems, designated representative, and installers[3]	Permitting of onsite wastewater treatment systems (septic systems), licensing of designated representatives for onsite wastewater treatment systems, licensing of installers of onsite wastewater treatment systems	Arkansas Sewage Disposal Systems Act (Arkansas Code § 14-236-101 et seq.)	Clean Water Act

Table 6.9. State regulations that protect water quality (continued).

State Regulation	Subjects/Programs	Related State Legislation	Related Federal Legislation
Rules and regulations pertaining to mobile home and recreational vehicle parks[3]	Water supply, wastewater disposal, solid waste management	Arkansas Code § 20-7-101 et seq.	Clean Water Act, Safe Drinking Water Act, Resource Conservation and Recovery Act
Arkansas regulations on pesticide classification[4]	Pesticide classification	Arkansas Pesticide Control Act (Arkansas Code § 2-16-401 et seq.), Arkansas Pesticide Use and Application Act (Arkansas Code § 20-20-201 et seq.)	Federal Insecticide, Fungicide, and Rodenticide Act
Arkansas regulations on pesticide applicator licensing[4]	Licensing of pesticide applicators	Arkansas Pesticide Use and Application Act (Arkansas Code § 20-20-201 et seq.)	Federal Insecticide, Fungicide, and Rodenticide Act
Arkansas Water Well Construction Commission Rules and Regulations	Specifications for construction of water wells to provide safe drinking water	Water Well Construction Act (Arkansas Code § 17-50-101 et seq.)	Safe Drinking Water Act
Rules and Regulations pertaining to outdoor bathing places[3]	Swim beach water quality	Arkansas Code § 20-7-101 et seq.	Clean Water Act
Marine sanitation[3]	Marine sanitation	Arkansas Code § 27-101-401 et seq.	Clean Vessel Act

Note: Highlighted regulations, programs, and legislation were promulgated after the 1990 AWP update.
1 Responsible state agency is ADEQ-2 Responsible state agency is ANRC
3 Responsible state agency is Arkansas Department of Health 4 Responsible state agency is Arkansas State Plant Board

Table 6.9 illustrates that there are myriad state regulations, covering a range of activities, that address water quality. The most basic of these are the regulations that set criteria for the quality of state surface waters and groundwater. These regulations identify the uses that state waterbodies should support, and specify narrative and numeric criteria for water quality to ensure the identified uses can be supported. In Arkansas, numeric water quality criteria for dissolved oxygen, turbidity, temperature, and minerals are ecoregion-based (APCEC 2011). Arkansas is in the process of developing numeric criteria for nutrients in surface water to meet federal requirements (ADEQ 2012b). State numeric water quality criteria for groundwater are in development.

As specified in the CWA, state water quality standards consist of designation of uses for water bodies, narrative or numeric criteria for selected parameters to ensure the designated uses are supported, and an anti-degradation policy to protect water bodies with water quality that is better than the standards. The state water quality standards are reviewed every three years. A summary of the designated uses assigned to surface waterbodies in the NAWRPR under Regulation 2 is provided in Table 6.10. Numeric surface water quality criteria for the water bodies in the planning region are listed in Tables 6.11 through 6.13. Ozark Highlands and Boston Mountain numeric water quality criteria apply in the NAWRPR. Figure 6.2 shows the ADEQ Water Quality Planning Segments that are located in the planning region.

Table 6.10. State designated uses for surface waters in the NAWRPR (APCEC 2011).

Designated Use	Waterbodies
Extraordinary Resource Waters	Current River Eleven Point River Strawberry River Spring River South Fork Spring River Buffalo River Kings River Devils Fork and Middle Fork of Little Red River Bull Shoals Reservoir North Sylamore River Archey River Lee River Salado Creek Richland Creek
Natural and Scenic Waterways	Strawberry River Kings River Buffalo River North Sylamore Creek Richland Creek
Ecologically Sensitive Waterbodies	Numerous springs Strawberry River Spring River Eleven Point River Current River Illinois River Devils River Middle and South Forks of Little Red River Upper White River Foshee Cave
Primary Contact Recreation	All streams with watersheds of greater than 10 square miles All lakes/reservoirs

Table 6.10. State designated uses for surface waters in the NAWRPR (APCEC 2011).

Designated Use	Waterbodies
Secondary Contact Recreation	All waters
Domestic, Industrial, and Agricultural Water Supply	All waters
Fishery	All Lakes/reservoirs White River North Fork River Spring River Upper White River Little Red River (portions of)
Seasonal Fishery	Boston Mountain and Ozark Highlands seasonal streams
Perennial Fishery	Boston Mountain and Ozark Highlands perennial streams

Table 6.11. Temperature and turbidity numeric criteria that apply in the NAWRPR.

Water body	Temperature (F^o)	Turbidity – base flow (NTU)	Turbidity – all flows (NTU)
Ozark Highlands	84.2	10	17
Boston Mountains	87.8	10	19
Lakes and Reservoirs	89.6	25	45
Trout Waters	68.0	10	15

Table 6.12. Dissolved oxygen numeric water quality criteria that apply in the NAWRPR.

Water body	DO Primary (mg/L)	DO Critical (mg/L)
Streams with watershed < 10 square miles	6	2
Ozark Highland streams with watershed 10 – 100 square miles	6	5
Boston Mountain streams with watershed 10 – 100 square miles	6	6
Streams with watershed > 100 square miles	6	6
Lakes and reservoirs	5	-
Trout Waters	6	6

Table 6.13. Numeric water quality criteria for minerals that apply in the NAWRPR.

Water body	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
Black and Strawberry Rivers	20	30	270
Spring River – Eleven Point River, South Fork Spring River, Myatt Creek	20	30	270
Stennitt Creek	ER[1]	ER[1]	456[2]
White River (Dam #3 to Missouri Line – includes Bull Shoals Reservoir)	20	20	180
Buffalo River	20	20	200
Crooked Creek	20	20	200
White River (Missouri line to headwaters, includes Beaver Resrvoir)	20	20	160
Kings River	20	20	150
West Fork White River	20	20	150
Illinois River	20	20	300

1. ER – Ecoregion Standard
2. Based on critical background flow of 4 cfs

To protect surface water and groundwater quality, there are state regulations and laws that regulate discharge of wastewater, discharge of stormwater, underground storage tanks, underground injection of fluids, management of livestock, and disposal of solid waste.

The state source water and wellhead protection programs address protection of the quality of surface waters and aquifers used as public drinking water supplies. There are just over 200 active public water supply utilities in the NAWRPR. Approximately 100 of these utilities use groundwater from their own wells, and are subject to the state wellhead protection program. Seventeen use surface water and are subject to the state source water protection program. The remainder of the water utilities in the planning region purchase groundwater and/or surface water to supply to their customers (ADH n.d.).

6.1.3.3 Floodplain Management Regulations

Arkansas Code provides that it is the policy of the state to encourage and support actions to prevent and lessen flood hazards and losses. The state has the authority to adopt measures that will discourage development in flood-prone land, assist in reducing damage caused by floods, and improve long-range land management in flood-prone areas (Arkansas Code §14-268-101 et seq.).

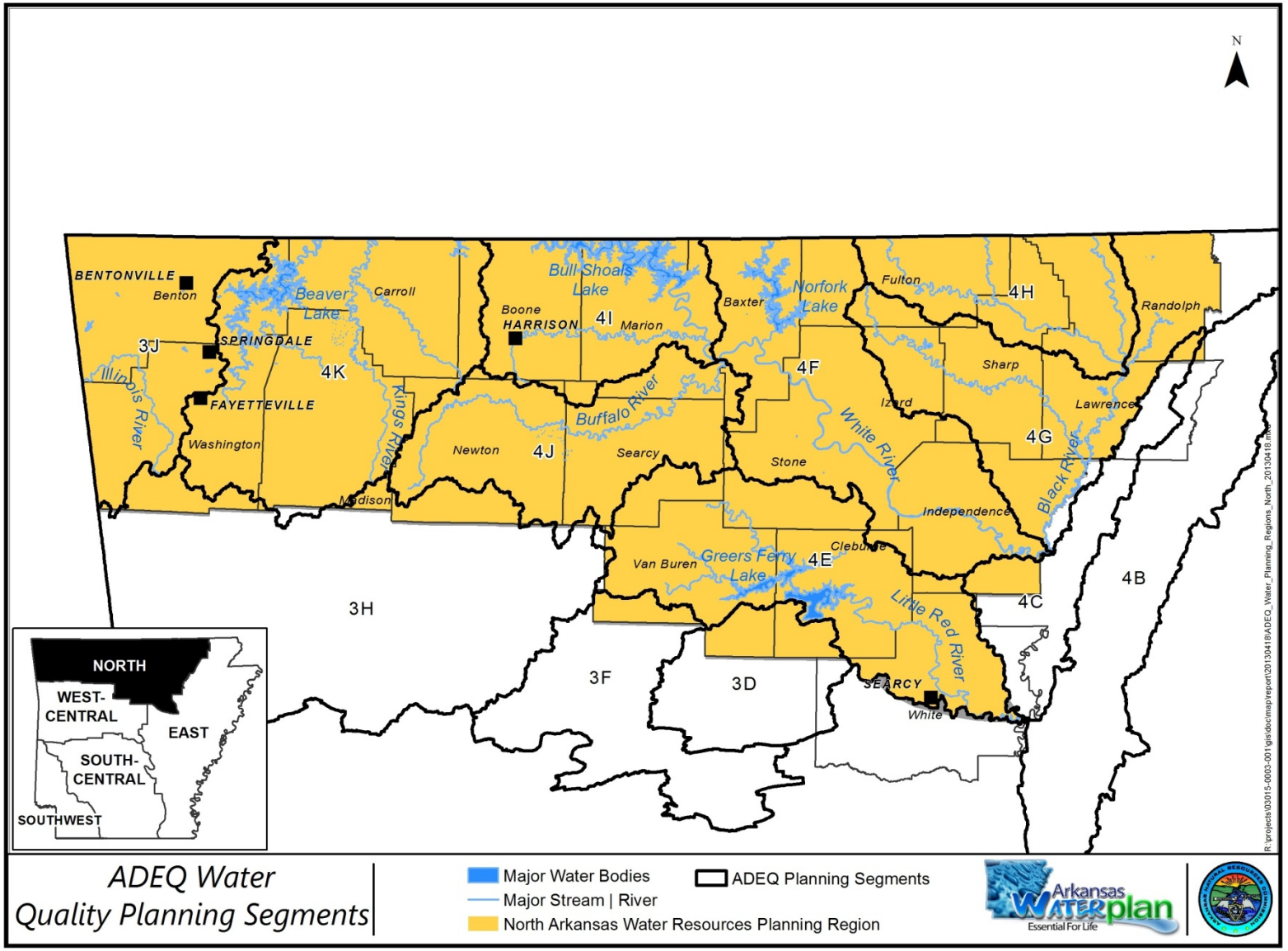

Figure 6.2. ADEQ water quality planning segments included in the NAWRPR

Arkansas statute also requires each county, city, or town that is participating in the National Flood Insurance Program to designate a "person to serve as the floodplain administrator to administer and implement the ordinance and any local codes and regulations relating the management of flood-prone areas." The designated floodplain administrator must also be accredited by ANRC under the commission's authority regarding flood control. State accreditation of floodplain administrators is regulated under ANRC Title 18 rules. Continuing education for the floodplain administrator is an especially important component of the state's accreditation program (Arkansas Code §14-268-106, §15-24-102, and §15-24-109).

6.1.3.4 Water Management Regulations

Other state regulations and programs address additional aspects of water resources and their management. Table 6.14 summarizes these regulations, and the associated federal legislation.

Table 6.14 State regulations relating to water management.

State Water Resources Regulation	Subjects/Programs	Related State Legislation	Related Federal Legislation
Title 6: Water plan compliance review procedures[1]	AWP	Arkansas Code § 15-22-503 and 504	None
Title 7: Rules governing design and operation of dams[1]	Dam safety	Arkansas Code § 15-22-201 et seq.	Water Resources Development Act/Dam Safety and Security Act
Title 12: Rules governing the Arkansas wetland mitigation bank program[1]	Wetland mitigation bank	Arkansas Wetlands Mitigation Bank Act (Arkansas Code § 15-22-1001 et seq.)	Rivers and Harbors Act, Clean Water Act
Rules and regulations of the Arkansas Natural Heritage Commission	Arkansas Natural and Scenic Rivers System	Arkansas Natural and Scenic Rivers System Act (Arkansas Code § 15-23-301 et seq.)	Wild and Scenic Rivers Act
Arkansas Wildlife Resources Regulations[2]	Allowance for fish passage at dams.	Arkansas Code § 15-44-110	
	Screens required on surface water intakes to protect fish	Arkansas Code § 15-44-111	

1 Responsible state agency is ANRC
2 Responsible agency is AGFC
Highlighted regulations, programs, and legislation were promulgated after the 1990 AWP update

The Arkansas Wetland Mitigation Banking Program (Arkansas Code §15-22-1002), authorized in 1995, is a state-sponsored initiative that promotes, in cooperation with federal, state, non-profit, and other interested entities, the restoration, creation, enhancement, and conservation of aquatic resources, including wetlands, streams, and deep-water aquatic habitat. This legislation authorizes ANRC to operate wetland and stream mitigation banks and to sell mitigation "credits" to private, nonprofit, and public entities required to provide mitigation for dredge and fill activities under the Clean Water Act. The "credits" represent the accrual or attainment of aquatic resource function at the mitigation bank site which results from restoration, creation, enhancement, or conservation efforts. The state wetland mitigation bank provides a cost-effective alternative for mitigating impacts. The USACE regulates both public and private mitigation banking and is responsible for approving the number of "credits" available within any individual bank. When an individual or entity is required to provide compensatory mitigation for unavoidable loss of function, the USACE can approve the purchase of "credits" from the state mitigation bank to satisfy all regulatory mitigation requirements. In 2013, there were no Arkansas Wetland Mitigation Banking Program sites within the NAWRPR (USACE n.d.).

6.1.4 State Financial Assistance Programs

Arkansas has several state programs that provide financial incentives and assistance for water resources management. The federal government has also delegated authority to the state to administer federal assistance programs of the Clean Water Act, and the Safe Drinking Water Act.

6.1.4.1 Financial Assistance for Public Water and Wastewater Projects

ANRC is responsible for managing and distributing monies from several federal assistance programs intended to assist communities in constructing and maintaining drinking water and wastewater systems (Table 6.15). There are also state-funded programs that provide financial assistance for drinking water and wastewater systems (Table 6.16). Programs shown in both Table 6.14 and 6.15 utilize both federal and state funds.

Table 6.15. Federal assistance programs for public water projects that are administered by ANRC.

Federal Program	Federal funding source	State Program
Community Development Block Grant Program	Housing and Urban Development	Arkansas Community and Economic Development Program
Drinking water state revolving fund, Clean water state revolving fund	EPA	Water resources cost share revolving fund program, Construction assistance revolving loan fund

Table 6.16 State programs for public water system assistance (administered by ANRC).

State Water Use Regulations	State Assistance Programs	Related State Legislation
Title 5: Administrative rules and regulations for financial assistance	Water resources development general obligation bond fund; Water development fund program; Water resources cost share revolving fund program; Water, sewer, and solid waste management systems program; and Water, waste disposal, and pollution abatement facilities general obligation bond fund program	Arkansas Water Resources Cost Share Finance Act (Arkansas Code § 15-22-801 et seq.), Arkansas Water, Waste Disposal, and Pollution Abatement Facilities Financing Act (Arkansas Code § 15-20-1301 et seq.)
Title 15: Rules governing loans from the safe drinking water revolving loan fund	Safe drinking water revolving loan fund program, Construction assistance revolving loan fund	Arkansas Code § 15-5-901 et seq., 15-22-1101 et seq.
Title 16: Rules governing the Arkansas clean water revolving loan fund program	Clean water revolving loan fund, Construction assistance revolving loan fund	Arkansas Code §15-5-901 et seq.
Title 23: Rules governing water and wastewater project funding through the Arkansas community and economic development program	Funding for construction or improvement of community treatment facilities for drinking water and wastewater treatment	Arkansas Code § 15-5-901 et seq.

6.1.4.2 State Financial Incentive and Assistance Programs for Promoting Water Quality and Water Resources Management

ADEQ and ANRC administer a number of incentive and assistance programs related to water resources management (Table 6.17). These include programs to assist with clean-up of hazardous waste contamination, reduction of nonpoint source pollution, and management of solid wastes to protect water quality. In addition, there are state programs to encourage water

conservation and preservation of wetlands. All but one of the programs listed in Table 6.16 are funded by state sources. The state nonpoint source pollution management grant program is federally funded under the authority of the Clean Water Act Section 319.

Table 6.17 State incentive and assistance programs that protect water quality.

State Regulation	State Assistance Programs	Related State Legislation	Related Federal Legislation
Regulation 11: Solid Waste Disposal Fees, Landfill Post-Closure Trust Fund, and Recycling Grants Programs[1]	Recycling Fund	Solid Waste Management Recycling Fund Act (Arkansas Code §8-6-601 et seq.)	Resource Conservation and Recovery Act
Regulation 12: Storage Tank Regulations[1]	Petroleum storage tank trust fund	Petroleum Storage Tank Trust Fund Act (Arkansas Code § 8-7-901 et seq.)	Clean Water Act, Underground Storage Tank Regulations, including Energy Policy Act of 2005
Regulation 29: Brownfields Redevelopment[1]	Clean-up funding	Arkansas Hazardous Waste Management Act (Arkansas Code § 8-7-201 et seq.), Remedial Action Trust Fund Act (Arkansas Code § 8-7-501 et seq.)	Comprehensive Environmental Response, Compensation, and Liability Act
Regulation 30: Remedial Action Trust Fund, Site Priority List[1]	Clean-up funding, prioritization of contaminated sites for clean-up	Remedial Action Trust Fund Act (Arkansas Code § 8-7-501 et seq.)	Comprehensive Environmental Response, Compensation, and Liability Act
Title 5: Administrative rules and regulations for financial assistance[2]	Sewer and solid waste management systems program; Waste disposal and pollution abatement facilities general obligation bond program; Water, waste disposal and pollution abatement facilities general obligation fund program	Arkansas Code § 14-230-101 et seq., § 15-22-601 et seq., § 15-22-701 et seq.	None
Title 10: Rules governing the Arkansas water resource agricultural cost-share program[2]	Arkansas water resources agricultural cost-share program	Arkansas Code § 15-22-913 through 914, § 15-22-507	None
Title 11: Surplus Poultry Litter Removal Incentives Cost-Share Program[2]	Transport of poultry litter from nutrient surplus areas	Surplus Nutrient Removal Incentives Act (Arkansas Code § 15-20-1201 et seq.)	Clean Water Act

Table 6.17 State incentive and assistance programs that protect water quality (continued).

State Regulation	State Assistance Programs	Related State Legislation	Related Federal Legislation
Title 13 – Rules governing the tax credit program for the creation and restoration of private wetland and riparian zones[2]	Wetlands and Riparian Zone Tax Credit Program	Arkansas Private Wetland Riparian Zone Creation and Restoration Incentive Act (Arkansas Code § 26-51-1501 et seq.)	None
Title 14:Rules for implementing the Water Resources Conservation and Development Incentives Act[2]	Groundwater conservation tax incentives	Water Resource Conservation and Development Incentives Act (Arkansas Code § 26-51-1001 et seq.)	None
None	Nonpoint source pollution grant program[2]	None	Clean Water Act (Section 319)

Note: Highlighted regulations, programs, and legislation were promulgated after the 1990 AWP update.
1 Responsible state agency is ADEQ
2 Responsible state agency is ANRC

6.1.5 State Non-regulatory Water Resources Management Programs

There are state agency programs for natural resources protection and management that apply to water resources. These include planning, guidance, and incentive programs. These programs do not necessarily have regulations associated with them. However, they guide the activities of state agencies related to water resources. The AWP is one such program. Others are described below.

6.1.5.1 Arkansas Wildlife Action Plan

A state wildlife action plan was prepared by the AGFC, and approved by USFWS in 2007. This plan prioritizes activities to protect species of concern and their habitats throughout the state. This plan addresses amphibians, birds, fish, crayfish, insects, mammals, mussels, and reptiles. There are 231species of greatest conservation need identified for Arkansas in this plan that are found in the NAWRPR. The biggest problems faced by these species in the NAWRPR are urban development, grazing, dam locations, road construction, resource extraction, and

forestry activities, among others. The most highly recommended conservation activity for this planning region is habitat restoration and improvement (Anderson 2006).

6.1.5.2 Arkansas State Wetland Strategy

A state wetland strategy was ed in 1995 by a team of Arkansas agencies. This strategy consisted of 10 elements that addressed conservation and restoration of wetlands, and improving understanding of wetlands, both by the scientific and natural resources community and by the public. Implementation of this strategy resulted in legislation that created the Arkansas Mitigation Banking Program, and the Arkansas Riparian Zone and Wetland Creation Tax Credit Program.

6.1.5.3 Arkansas Nonpoint Source Pollution Management Plan

ANRC regularly prepares a state nonpoint source pollution management plan. The purpose of this plan to provide a guide and focus for public agencies, nonprofit organizations, interest groups, and other stakeholders to work together to "develop, coordinate, and implement programs to reduce, manage or abate" nonpoint source pollution. The plan is updated every 5 years. The current plan was updated in 2010.

6.1.5.4 Arkansas Forestry Best Management Practices

The Arkansas Forestry Commission has prepared a booklet of approved guidelines for conducting forest management practices in a way that minimizes water quality impacts. Implementation of these best management practices is voluntary. These management practices are applicable to commercial and private timber operations on public or private land.

6.1.6 Local Regulations

There are also local regulations that influence management of water resources. These can include zoning laws; regulations promulgated by municipalities, counties, water and wastewater utilities; and regulations promulgated by irrigation, drainage, water, and sewer districts.

6.1.7 Regional Water Resources Management

Several agencies and organizations have developed management or restoration programs for areas within the NAWRPR. The purpose of some of these programs is to implement a state or federal regulation or policy, such as ambient water quality standards, no net loss of wetlands, or conservation of wildlife. These programs constitute a framework that provides opportunities for leveraging resources (personnel and funding) to accomplish water resources management goals.
Nine-element Watershed Plans

Watershed plans are required by the CWA to guide activities for reducing pollution in waterbodies for which TMDLs have been developed. EPA has prepared guidance describing the nine elements that should be included in watershed plans to achieve TMDLs calculated for impaired waterbodies. A nine-element watershed plan must be completed and approved by EPA before restoration projects in the watershed can receive funding from the CWA Nonpoint Source Program (Section 319 funding). There are two watersheds in the planning region for which nine-element watershed management plans have been approved by EPA. The Illinois River Watershed Management Strategy and the Upper White River update were both completed in 2004. Both were completed in order to provide a strategy for controlling nonpoint source pollution (Arkansas Water 2013).

6.1.7.1 Arkansas River Basin Compact

The State of Arkansas and State of Oklahoma signed the Arkansas River Basin Compact in 1970. This compact is an agreement concerning the waters of the Arkansas River and its tributaries. In the compact, the states outline water apportionment and cooperative efforts regarding pollution and water resource maintenance in these waters. As part of the apportionment agreement, water rights for each tributary and the main river are given as a percentage of the annual yield, which is defined in the compact as the computed annual gross runoff. Part of two sub-basins included in the compact are within the NAWRPR (Figure 6.3). According to the compact, the State of Arkansas has the right to “develop and use” waters of the Spavinaw Creek Sub-Basin as long as the annual yield is not depleted more than 50%. The State of Arkansas also has the rights to “develop and use” waters of the Illinois River Sub-Basin as

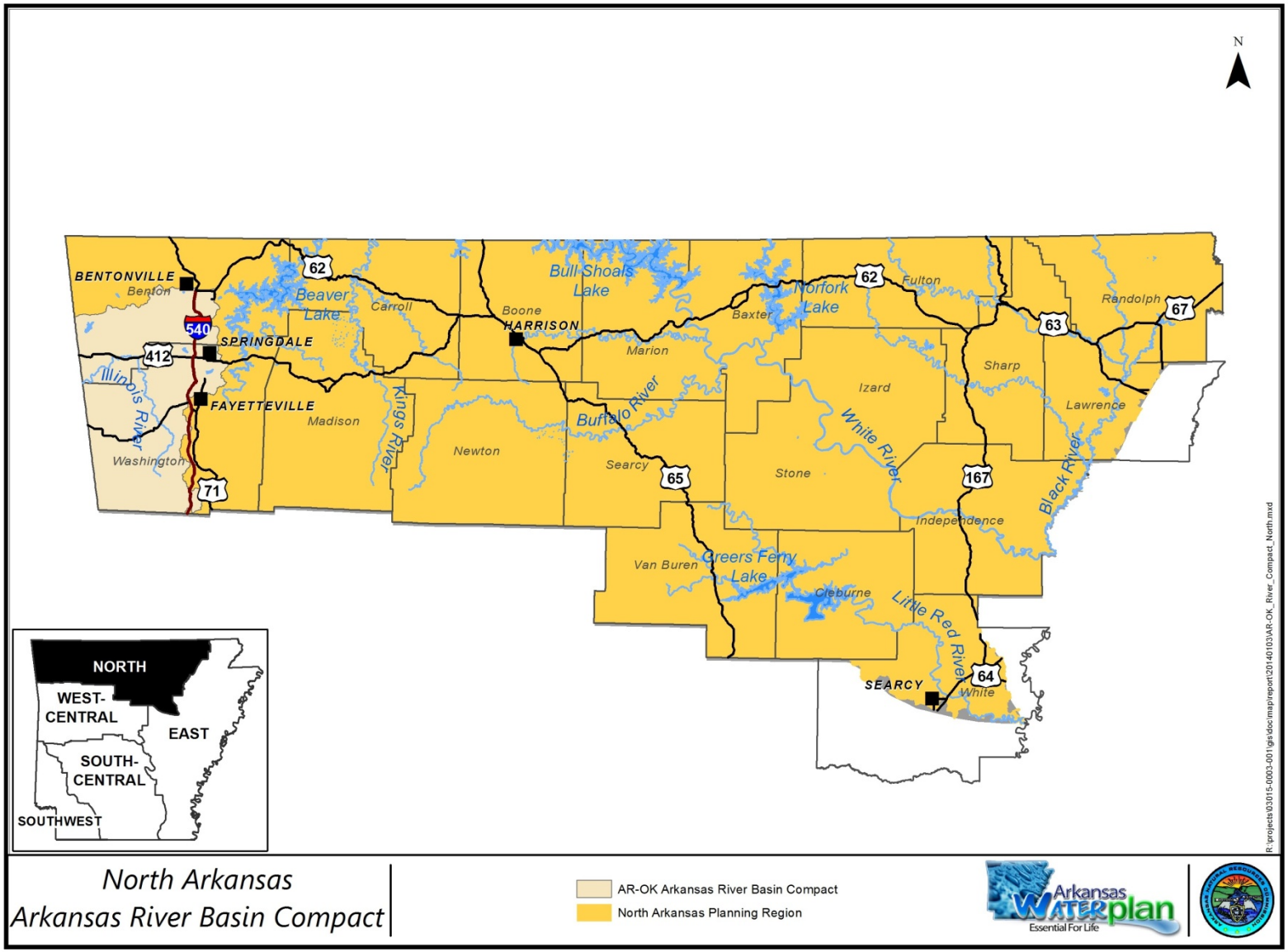

Figure 6.3. Sub-basins of the Arkansas River Basin Compact within the NAWRPR

long as the annual yield is not depleted more than 60% (Arkansas River Compact Committee 1970).

6.1.7.2 Fayetteville Shale Best Management Practices

A team consisting of multiple agencies has developed BMPs for natural gas activities in the Fayetteville Shale area intended to protect natural resources, including water quality (USFWS 2007).

6.1.7.3 Non-Profit Organizations

There are several non-profit organizations that have active programs within the NAWRPR. These include The Nature Conservancy, The Illinois River Watershed Partnership, and the Walton Family Foundation.

The Nature Conservancy has been working since 1978 on their Ozark Highlands Karst Program. They have worked to clean up and protect caves as well as the creatures within them, specifically endangered bats and cavefish. They also have an Ozark Rivers Program that involves conservation work along the Little Red and Kings Rivers. They manage preserves along the Kings River and Crooked Creek, and at Bear Hollow Cave near Bella Vista and Baker Prairie near Harrison (The Nature Conservancy 2013).

The Illinois River Watershed Partnership (IRWP) is a group of individuals and local programs that works to better the Illinois River and its watershed. It has conservation, restoration, and water quality monitoring programs, and has partnered with other organizations such as the Walton Foundation to perform research as well as obtain and restore areas of land in the watershed. For example, the Walton Foundation gave a challenge grant to help create a watershed sanctuary at Cave Springs (IRWP 2013b).

Audubon Arkansas is a chapter of the National Abandon Society and works on conservation and restoration projects. It is helping to plan and implement a NPS pollution management program along the West Fork of the White River (Audubon Arkansas 2013, ANRC 2011b).

There are also a host of other groups that support conservation in the White and Illinois River Watersheds, including the Friends of the North Fork and White Rivers (Friends of the Rivers 2013) and the Arkansas Sierra Club (Arkansas Sierra Club 2011).

6.2 Institutional Framework

Governmental responsibility for water resources management in the NAWRPR is split among many agencies on three levels (federal, state, and local). As a result, management of water resources in the NAWRPR can require coordination among a number of government entities. In addition, there are a number of Non-profit organizations that participate in water resources management in the planning region.

6.2.1 Federal Agencies

There are 16 federal agencies involved in water resources management in the NAWRPR. These federal agencies are listed in Table 6.18, along with their respective activities in this planning region.

Table 6.18. Federal agencies with water resources-related responsibilities in the NAWRPR.

Federal Agency	Responsibility in Arkansas
EPA	• Oversees state agencies in implementation of management and funding programs under o Clean Water Act, o Safe Drinking Water Act, o RCRA, o Superfund, o Federal Insecticide, Fungicide, and Rodenticide Act, and o Surface Mining Control and Reclamation Act • Conducts TMDL studies and other water quality studies in the NAWRPR • Implements programs under the Toxic Substances Control Act
Federal Energy Regulatory Commission	Oversees environmental matters related to natural gas and hydropower projects in the NAWRPR
FEMA	Prepares flood hazard maps for the region and encourages local governments to guide development decisions away from defined flood hazard risk areas through participation in the National Flood Insurance Program
HUD	Provides funding for water and wastewater infrastructure improvements
NOAA	Participates in monitoring precipitation and climate in the NAWRPR

Table 6.18. Federal agencies with water resources-related responsibilities in the NAWRPR (continued).

Federal Agency	Responsibility in Arkansas

NRCS National Water Management Center	• Located in Little Rock
	• Serves as a water resources information exchange
	• Provides support and training related to
	  o environmental compliance,
	  o hydrology and hydraulics,
	  o stream geomorphology and restoration,
	  o water quality and quantity,
	  o watershed and dam rehabilitation, and
	  o technology outreach

Southwestern Power Administration	Markets and delivers hydroelectric power produced at USACE hydropower projects in the NAWRPR
USACE	• Manages federal water, flood control, and hydropower projects in the NAWRPR • Implements sections of the Clean Water Act related to impacts to navigable waters and wetlands • Constructs flood control, irrigation, and water supply projects authorized by the Water Resources Development Act • Conducts water resources studies • Oversees dam safety for federal dams
USDA	• Conducts the Census of Agriculture • Conducts the Natural Resources Inventory • Manages Conservation Effects Assessment Projects (watershed and regional)
USDA Farm Services Agency	Implements the Conservation Reserve Program for erosion control and habitat restoration in the NAWRPR
USFS	• Manages the Ozark National Forest and associated surface waters • Forest management incentive programs • Participates in forest inventory • Manages Urban and Community Forestry Program
NRCS	• Implements over 20 Farm Bill erosion control and habitat restoration funding and technical assistance programs in the NAWRPR • Appraises the status and trends of soil, water, and related resources on non-federal land in the state and assesses their capability to meet present and future demands
USDA Rural Development	• Implements USDA rural utilities financial assistance programs
USDI National Park Service	• Manages the two national parks within the NAWRPR (Buffalo National River and Pea Ridge National Military Park), and their associated water resources • Provides funds for land and water conservation projects

USFWS	• Implements the Endangered Species Act and programs to
	  o Promote management of ecosystems,
	  o Promote conservation of migratory birds,
	  o Promote preservation of wildlife habitat,
	  o Promote restoration of fisheries,
	  o Combat invasive species, and
	  o Promote international wildlife conservation
	• Manages two national wildlife refuges in the NAWRPR
	• Conducts the National Wetland Inventory
	• Oversees state wildlife planning through the State Wildlife Grant Program

Table 6.18. Federal agencies with water resources-related responsibilities in the NAWRPR (continued).

Federal Agency	Responsibility in Arkansas
USGS	• Flow and stage monitoring of rivers and streams • Groundwater level monitoring • Water quality monitoring • Groundwater modeling • Water quality modeling • National Water Quality Assessment Program • Water data storage and management

6.2.2 Arkansas Agencies

There are over 20 Arkansas agencies involved in water resources management in the NAWRPR. These state agencies are listed in Table 6.19, along with a description of their water resources management responsibilities within the planning region.

Table 6.19. Arkansas agencies and entities with responsibilities related to water resources in the NAWRPR.

State Entity	Responsibility
ADEQ	Implements state water quality policy and the Clean Water Act NPDES program Develops and enforces water quality standards Investigates citizen complaints regarding water pollution Oversees solid waste management Operates the hazardous waste management program Manages contaminated site clean-up and redevelopment programs Develops and enforces mining and mine site reclamation regulations Manages the storage tank regulation program Permits no-discharge facilities and underground injection operations Water quality monitoring and assessment

Table 6.19. Arkansas agencies and entities with responsibilities related to water resources in the NAWRPR (continued).

State Entity	Responsibility
ANRC	• Regulates, permits, and tracks water use and dam construction • Monitors climate • Administers federal water resources funding programs • Prepares water resources and nonpoint source pollution management plans • Develops and maintains mitigation banking and restoration incentive programs for aquatic resources • Supports conservation districts • Registers poultry feeding operations • Certifies nutrient management planners and applicators • Promotes public health and safety and minimize flood losses through o training, o education, o technical assistance in floodplain management, and o accrediting floodplain administrators
Arkansas Department of Health (ADH)	• Regulates public water supply systems • Implements the Safe Drinking Water Act source water protection programs • Issues fish consumption advisories • Implements state health rules and regulations that apply to water resources • Regulates septic tanks and licenses septic tank cleaners • outdoor bathing and swimming • Implements state marine sanitation program
Arkansas Department of Parks and Tourism	• Manages the 9 state parks and associated water resources • Prepares comprehensive outdoor recreation plan • Manages outdoor recreation grant program
Arkansas Forestry Commission	• Provides guidelines for protection of water resources in forestry operations • Monitors use of forestry BMPs • Participates in forest inventory • Implements forest management incentive programs • Implements Urban and Community Forestry program • Designates and manages state forests for a variety of purposes, including o watershed protection o erosion and flood control

Table 6.19. Arkansas agencies and entities with responsibilities related to water resources in the NAWRPR (continued).

State Entity	Responsibility
Arkansas Game and Fish Commission (AGFC)	• Manages protection, conservation and preservation of various species of fish and wildlife in Arkansas through o habitat management, o wildlife management areas, o fish stocking, o hunting and fishing regulations, and o education and outreach programs • Prepares state Wildlife Action Plan • Implements conservation grant program • Manages 16 lakes in the NAWRPR
Arkansas Geological Survey	• Participates in research of, and provides information and education about, state water resources • Mapping • Water well construction records
Arkansas Livestock and Poultry Commission	Regulates disposal of livestock carcasses
Arkansas Multi-agency Wetland Planning Team	Developed the State Wetland Strategy and is the lead for developing state numeric nutrient criteria for wetlands
Military Department Arkansas National Guard	Manages land and surface water resources within the boundaries of Camp Robinson
Arkansas Natural Heritage Commission (ANHC)	• Surveys and conducts research on natural communities in the state • Acquires natural areas for preservation • Manages the Arkansas Natural and Scenic Rivers system
Arkansas Oil and Gas Commission	• Provides technical assistance related to protection of water resources from wastes associated with production of o oil, o natural gas, and o brine • Issues permits for drilling and operation of o oil, natural gas, and brine production wells o injection and disposal wells

Table 6.19. Arkansas agencies and entities with responsibilities related to water resources in the NAWRPR (continued).

State Entity	Responsibility
Arkansas Pollution Control and Ecology Commission (APCEC)	Environmental policy-making body for the state
Arkansas Public Service Commission	Regulates rates and services of private water utilities, as well as utilities water crossings
Arkansas State Board of Health	Promulgates health rules and regulations for the state
Arkansas State Highway and Transportation Department (AHTD)	• Hazardous waste transportation permits • Stormwater management • Develops and implements construction BMPs
Arkansas State Plant Board	Implements • Insecticide, Fungicide, and Rodenticide Act programs, o pesticide registration o user and applicator training o dealer licensing • state pesticide management plan for groundwater protection, • groundwater quality monitoring, and • climate/weather monitoring
Arkansas Water Well Construction Commission	• Regulates development of groundwater through licensing water well contractors and registering drillers and pump installers • Regulates specifications for construction of water wells • Maintains water well construction records
Arkansas Waterways Commission	Studies and promotes navigable waterways for transportation and economic development
U of A Cooperative Extension Service	Provides technical assistance to Arkansans related to water conservation, and protection and restoration of water quality
U of A Water Resources Center	Participates in research related to water resources, and in water resources management projects

6.2.3 Federal-State Organizations

There are at least three federal-state organizations involved in water resources management in the NAWRPR:

- Arkansas-Oklahoma Arkansas River Compact Commission,
- Arkansas Conservation Partnership, and
- Arkansas Watershed Advisory Group.

The Arkansas-Oklahoma Arkansas River Compact Commission administers the Arkansas-Oklahoma Arkansas River Compact, which applies to Spavinaw Creek and Illinois River (see Section 6.1.7.1). The commission is made up of three representatives each from Arkansas and Oklahoma, the director of the state water agency and two residents appointed by the state governor, as well as one federal representative, appointed by the US president (Arkansas River Compact Committee 1970).

The Arkansas Conservation Partnership supports locally-led natural resources conservation through coordination of education, financial, and technical assistance to landowners. Water resources and implementation of Farm Bill programs are two of the six natural resource issues that are the focus of the partnership. Members of the partnership include the NCRS and other federal agencies, as well as ANRC, Arkansas Association of Conservation Districts, U of A Cooperative Extension, U of A at Pine Bluff, and Arkansas Forestry Commission. This partnership was formed in 1992 (ANRC 2011b, Cooperative Conservation America n.d.).

The Arkansas Watershed Advisory Group (AWAG) provides technical assistance to form local watershed groups, hosts an annual water quality conference, and facilitates quarterly discussions of voluntary water quality management approaches. AWAG is a consortium of federal and state agencies with private citizens (ANRC 2011b).

6.2.4 Regional and Local Entities

There are numerous regional and local entities in the NAWRPR that are involved in activities related to water resources management. Examples of the types of local and regional entities present in this planning region are shown in Table 6.20, along with descriptions of their activities related to water resources management.

Table 6.20. Some of the regional and local entities involved in water resources management in the NAWRPR.

Regional or Local Entity	Water Resources Involvement
Local Conservation Districts	Work with state and federal agencies to implements measures for the control of erosion and flooding, and conservation of soil and water resources
County Government	Responsible for unincorporated areas, sometimes including floodplain management and zoning
Drainage Districts	Usually created by circuit court order to plan, construct, and maintain a system to drain lands
Improvement Districts	Created by circuit court order to implement federal projects for improvement of any river, tributary, or stream bordering the state
Irrigation Districts	Created by circuit court order to distribute water resources
Regional Planning and Economic Development Districts	• Water supply and wastewater infrastructure improvements • Assist Regional Solid Waste Management Districts
Regional Solid Waste Management Districts	Manage collection, disposal, and recycling of solid waste
Regional Water Distribution Districts (e.g. Beaver Water District)	Public nonprofit organizations for distribution of water from USACE water projects (e.g. Beaver Lake)
Northwest Arkansas Regional Planning Commission	Stormwater management education and outreach
Universities	Water resources and management research, education, and outreach
Water districts and associations	• Water supply planning and management • Supply water and wastewater services

6.2.5 Non-Profit Organizations

There are several non-profit organizations that conduct activities in the NAWRPR that are related to water resources management. Examples of these organizations are listed in Table 6.21 with a description of their water resources related activities in the planning region.

Table 6.21. Non-profit organizations involved in water resources management in the NAWRPR.

Non-profit Organization	Water Resources Involvement
The Nature Conservancy	Ozark Highlands Karst Program Ozark Rivers Program Kings River Preserve Crooked Creek Preserve Bear Hollow Cave Preserve
Audubon Arkansas	West Fork-White River NPS Management Program
Ducks Unlimited	Conservation and restoration of aquatic habitat for waterfowl
Stream teams	Water quality monitoring, stream bank rehab, restoration of fish habitat
Watershed organizations	Water resources planning, Sponsor for water quality and quantity projects
Arkansas Wildlife Federation	Conservation of aquatic habitat for fish and wildlife
Arkansas Farm Bureau	Advocate for agriculture
Arkansas Environmental Federation	Advocate for Industry

6.2.6 Institutional Interactions in Water Resources Management

As noted at the beginning of this section, water resources management in the NAWRPR involves numerous entities at multiple scales. Examples of the interactions among federal, state, and local entities that occur in water resources management in the NAWRPR are presented in Table 6.22.

Table 6.22. Examples of interactions of federal, state, and local entities in water resources management within the NAWRPR.

State Water Resources Responsibility/Program	Involves:		
	Federal Entities	State Entities	Regional or Local Entities
Water use registration	USGS (houses registration database)	ANRC (program lead)	Water utilities, irrigation districts (water withdrawers)
Dam safety	USACE (federal dams) FEMA (oversight)	ANRC (program lead), AGFC (dam builder), Arkansas Department of Parks and Tourism (dam builder)	Water utilities, municipalities, counties (dam builders)

Table 6.22. Examples of interactions of federal, state, and local entities in water resources management within the NAWRPR (continued).

State Water Resources Responsibility/Program	Involves:		
	Federal Entities	**State Entities**	**Regional or Local Entities**
State climate monitoring	NOAA National Weather Service, NOAA National Climatic Data Center, USGS (precipitation monitoring), USACE (climate monitoring)	ANRC (state climatologist), Arkansas State Plant Board (monitoring)	Community Collaborative Rain, Hail & Snow Network
Safe Drinking Water Act funding	EPA (funding)	ANRC (program lead)	Water utilities, municipalities/ communities, water districts
Water Resources Conservation Tax Incentives	NRCS	ANRC (program lead), U of A Cooperative Extension Service	Conservation districts
Conservation district grants program	None	ANRC (program lead)	Conservation districts
Community development block water and wastewater grants	HUD (funding)	ANRC (program lead), Arkansas Economic Development Commission	Water utilities, wastewater utilities, water districts, sewer districts
Floodplain management	FEMA	ANRC (certification)	Levee districts, counties, and municipalities
Nonpoint source pollution management	EPA (funding), NRCS (conservation programs), USFS(BMPs), The Nature Conservancy (projects), USDA Farm Services Agency (conservation program)	ANRC (program lead), Universities, Arkansas Water Resources Center, Audubon Arkansas, U of A Cooperative Extension Service, Arkansas Farm Bureau, ADEQ (TMDLs)	Watershed organizations, Conservative districts, Water districts, Stream teams, Nonprofit organizations
Clean Water Act funding program (including nonpoint source and clean water revolving loan fund)	EPA (funding)	ANRC (program lead)	Watershed organizations, sewer districts, municipalities, Nonprofit organizations
Wetland and riparian zone tax credit program	None	ANRC (program lead)	Watershed organizations
Wetland and stream mitigation	USACE (lead)	ANRC (state mitigation bank), AHTD, AGFC, ADEQ, ANHC	Local conservation districts, Nonprofit organizations, Watershed organizations
Non-riparian water use permitting	None	ANRC (program lead)	Water utilities
Arkansas Recovery Act water and wastewater funding	Recovery Accountability and Transparency Board	ANRC (program lead)	Water utilities, wastewater utilities, water districts, sewer districts
State water utility funding	None	ANRC (program lead)	Water utilities, water districts
State wastewater utility funding	None	ANRC (program lead)	Wastewater utilities, sewer districts
NPDES discharge permits	EPA (oversight, guidance)	ADEQ (program lead)	Dischargers

Table 6.22. Examples of interactions of federal, state, and local entities in water resources management within the NAWRPR (continued).

State Water Resources Responsibility/Program	Involves:		
	Federal Entities	State Entities	Regional or Local Entities
Underground injection control	EPA	ADEQ (program lead), Arkansas Oil and Gas Commission (program lead)	Dischargers
Wastewater pretreatment program	EPA	ADEQ (program lead)	Dischargers
Water quality standards	EPA	APCEC (regulations), ADEQ (implementation, enforcement), ANRC (groundwater standards), Multi-agency Wetland Planning Team (nutrient criteria for wetlands)	Local governments, regulated entities, interest groups
Water quality assessment	EPA (oversight, guidance), USGS (data), USACE (data)	ADEQ (implementation)	None
TMDLs	EPA (oversight, guidance), USGS (data), USACE (data)	ADEQ (program lead)	None
Storage tank regulation	EPA	ADEQ (program lead)	None
Solid waste management	EPA (oversight)	ADEQ (program lead)	Regional solid waste management districts
Landfill post-closure trust fund	None	ADEQ (program lead)	Regional solid waste management districts
Hazardous waste management	EPA	ADEQ (program lead), AHTD (transport)	Interest groups
Remedial action trust fund	None	ADEQ	Interest groups
Brownfields	EPA	ADEQ	Municipalities
Superfund	EPA	ADEQ	Interest groups
Mining reclamation	US Department of the Interior	ADEQ	Interest groups
Water quality monitoring	EPA (oversight, studies), USGS (monitoring, studies), USACE (monitoring, studies)	ADEQ, ANRC, U of A Arkansas Water Resources Center (studies), AGFC (stream teams), Arkansas State Plant Board (groundwater monitoring)	Stream teams (monitoring), water utilities (monitoring)
Fish tissue sampling	None	ADEQ (program lead), ADH (consumption advisories), AGFC (sampling)	None
Stormwater management	EPA	ADEQ, U of A Cooperative Extension Service	Counties, municipalities
Spill prevention	EPA	ADEQ	None
Finished drinking water criteria	EPA	ADH	Water utilities, water districts
Source Water Protection	EPA	ADH, Arkansas Water Well Construction Commission	Water utilities (planning)
Consumer Information	EPA	ADH	Water utilities

Table 6.22. Examples of interactions of federal, state, and local entities in water resources management within the NAWRPR (continued).

State Water Resources Responsibility/Program	Involves:		
	Federal Entities	State Entities	Regional or Local Entities
Regulation of drinking water utilities	EPA	ADH, Arkansas Public Service Commission	Water utilities
Pesticide registration, labeling and classification	EPA	Arkansas State Plant Board	Pesticide distributors and users
Community Forestry	USFS	Arkansas Forestry Commission, Arkansas Urban Forestry Council	Municipalities
Forest stewardship	USFS, USDA Farm Services Agency, NRCS	Arkansas Forestry Commission, AGFC, ANRC, Arkansas Historic Preservation Program, U of A Cooperative Extension Service, Arkansas Natural Heritage Commission	Landowners
Forest Legacy	USFS(funding), Land Trust Alliance	Arkansas Forestry Commission	Landowners
State parks	USACE, National Park Service (funding)	Arkansas Department of Parks and Tourism	Northeast chapter Arkansas Master Naturalists
Stream teams	None	AGFC	North Central and Northwest chapters Arkansas Master Naturalists, IRWP, stream teams
Wildlife management areas, refuges	USFWS	AGFC	Volunteers, nonprofit organizations
Fishing and boating programs	USACE, USFWS	AGFC, Arkansas Department of Parks and Tourism	None
Pollution prevention program	EPA	ADEQ	None
Federal irrigation projects	USACE Little Rock District, NRCS	ANRC	Irrigation Districts, Regional Water Distribution Districts
Wild/natural and scenic rivers systems	USFS, USDI National Park Service	Arkansas Natural and Scenic Rivers Commission, ANHC, ADEQ	Nonprofit organizations

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APPENDIX A

2008 303(d) List of Impaired Waterbodies in the NAWRPR

ADEQ Planning Segment	Total miles	Stream miles assessed	Designated uses impaired	Stream miles impaired	Pollutant	Stream miles	Source
3C reaches 10-22	86.9	86.9	none	0			
3D reaches 14,15	41.2	41.2	none	0			
3F reaches 18,20,21	27.6	27.6	none	0			
3H reaches 11110202-22,23,902; 11110104-9-11	86.9	86.9	none	0			
3J – Grand Neosho Basin	223.2	209	Aquatic life	51.7	Sediment/siltation	4.1	Erosion
					Total phosphorus	47.6	Unknown
			Primary contact	293.3	Pathogens	293.3	Unknown, urban runoff
			Drinking water supply	8	Nitrate	8	Municipal WWTP
			Total	319.4			
4E – Little Red River	440.2	269.9	Fish consumption	2	Mercury	2	Unknown
			Aquatic life	22.3	Zinc	22.3	Agriculture
			total	24.3			
4F – White River between Black River and Buffalo River	334.3	277.1	Aquatic life	14.8	DO	14.8	Unknown, hydropower
			Primary contact	29.1	Pathogens	29.1	Unknown, municipal WWTP
			Total	33.3			
4G – Black River, Strawberry River & tributaries (partial)	459.9	393.6	Aquatic life	139.9	DO	53.1	Unknown
					Sediment/siltation	122.4	Erosion
			Primary contact	47.7	Pathogens	47.7	Unknown
			Total	187.6			
4H – Spring River, South Fork Spring River, and Eleven Point River	238.1	216.9	Aquatic life	54.9	DO	45.6	Unknown
					Sediment/siltation	9.4	Erosion
					Temperature	9.3	Unknown
			Agriculture & industrial water supply	3.1	TDS	3.1	unknown
			Total	54.9			
4I – White River from Crooked Creek to Long Creek	160.8	124.8	Aquatic life	70.9	DO	3	Hydropower
					Temperature	31.7	Resource extraction
			Agriculture & industrial water supply	67.9	TDS	67.9	Unknown
					Sulfate & chloride	36.2	Unknown
			Total	70.9			
4J – Buffalo River &	339.8	317.1	Aquatic life	20.8	DO	9.5	Unknown
					Temperature	11.3	Unknown

ADEQ Planning Segment	Total miles	Stream miles assessed	Designated uses impaired	Stream miles impaired	Pollutant	Stream miles	Source
tributaries			Agriculture & industrial water supply	23.9	TDS	23.9	Municipal WWTP
			Total	44.7			
4K – Upper White River and Kings River	484.3	473.6	Aquatic life	105.8	Sediment/siltation	33.4	Erosion
					DO	72.4	Unknown
			Drinking water supply	9.1	Nitrate	9.1	Municipal WWTP
			Agriculture & industrial water supply	101.1	TDS	101.1	Unknown, municipal WWTP
					Chloride	6.2	Unknown
					Sulfate	33.4	Unknown
			Total	140.3			
3H – Arkansas River and tributaries: State line to river mile 210	86.9	86.9	Primary contact recreation	20.5	Pathogens	20.5	Unknown
Total	3010.1	2611.5		895.9			