US Army Corps of Engineers ®

White River Basin Comprehensive Watershed Study:

Cache River Basin Watershed Management Plan

September 2015

Revised September 2016

Revised January 2017

Executive Summary

The Cache River Basin in northeastern Arkansas and southeast Missouri is important to its residents, the States of Arkansas and Missouri, the Nation and the international conservation community. The basin is one of the leading rice producing basins in the United States. The southern end of the basin is a wetland of international importance. The lower Cache River Basin together with the lower White River basin is the largest remaining contiguous expanse of bottomland hardwood (BLH) in North America north of the Atchafalaya Basin in southern Louisiana. The Cache River is part of the larger White River Basin of Missouri and Arkansas, and contributes much to the biologic and anthropogenic diversity in the larger basin. This Watershed Management Plan is an important piece of the overall White River Basin Comprehensive Study and will help to identify conditions, issues, and possible solutions for the delta portion of the White River Basin.

Many diverse and interrelated factors will challenge the basin's economic, social, and ecological future. Past actions in some areas of the basin have impacted other areas. Conservation projects have been done in some portions of the basin, but not others. In the next 30 years, groundwater levels are likely to reach critical low levels and threaten the economic future of the entire basin.

The Corps of Engineer's Engineering Circular 1105-2-411: Watershed Plans (dated 15 January 2012), established the integrated water resources management approach the Corps seeks in watershed planning. Specifically: "Watershed planning will address the identified water resources needs from any source in the watershed and provide a joint vision of a desired end state including potential solutions regardless of agency responsibilities and will reflect other Federal interests as well as potential Corps interest." The following plan was developed with federal, state, and local perspectives that were integral to the proposed recommendation.

There are some short-term actions that could improve the basin's water resource. Controlling the highest priority sediment sources to the east of the Cache River in the upper portion of the basin is the most important of these. Several Natural Resources Conservation Service programs are available to facilitate soil and water conservation on the landscape. There is potential to implement several Corps of Engineers Continuing Authorities Program projects in the basin. The Cache River National Wildlife Refuge's acquisition boundary would allow for expansion of the refuge for conservation.

An interagency comprehensive approach is needed to examine the basin-wide water resources issues and develop plans to address them and benefit multiple interests. The reliability of the future water supply should be addressed to maintain the agricultural economy of the basin. The channels and waterways of the basin should be stabilized and the floodplain reconnected to the river to ensure long-term sustainability and minimize maintenance costs. Arresting headcutting and stabilizing the river would benefit the landscape and reduce in-channel sediment. There are opportunities to manage the Cache River basin and restore some of its rich ecological history and provide more and better recreational opportunities.

A future vision has been developed by an interagency team. Stakeholders must work together with adequate resources and in full cooperation and collaboration to develop a plan forward. This future vision is to:

Maintain and enhance the globally significant Cache River BLH ecosystem within a sustainable agriculture-based landscape to balance ecological, economic and social interests.

Opportunities:

1. *Investigate the potential to implement Phase 2 of the Lower Cache River Meander Restoration*
2. *Investigate the potential to implement a small flood study for the City of McCrory and surrounding area*
3. *Investigate the potential to implement additional small scale ecosystem restoration*
4. *Various local entities could collaborate with Arkansas Natural Resources Commission and/or Natural Resource Conservation Service to implement local measures to control erosion in the basin*
5. *Resource Agencies could continue to implement their existing conservation and restoration programs*
6. *A Corps led basin-wide feasibility study is needed.*

The study would be designed to address these issues in a watershed systems approach:

- flooding,
- habitat and flood plain restoration, including
    - erosion control and sediment and nutrient reduction for where these issues impact the quality of the aquatic habitat.

7. *An additional basin wide study is needed.*

The study would be led by an unspecified group or agency and would address the following issues in a systems context:

- groundwater conservation and water supply,
- erosion control and sediment and nutrient reduction, and
- other needs such as recreation within the basin.

The cornerstone of current federal water resource policy is developing comprehensive watershed solutions that address multiple issues. No individual entity can implement the long-term recommendations to address the Cache River basin's challenges. Collaboration and participation of various federal, state, and local agencies to leverage knowledge, experience, and resources is necessary. Participating agencies[1] would include:

- U.S. Department of Agriculture via Natural Resource Conservation Service*, the Farm Service Agency, and the Agricultural Research Service
- U.S. Fish and Wildlife Service*
- Environmental Protection Agency
- U.S. Army Corps of Engineers*
- Arkansas Natural Resources Commission*
- Arkansas Game and Fish Commission*

[1] These agencies/organizations were provided the opportunity to participate in the development of this Watershed Management Plan. Those indicated with * provided input in the form of meeting participation, tour attendance, report review, and in some cases assistance in preparing entire sections of the document.

- Arkansas Natural Heritage Commission*
- Missouri Department of Conservation
- Missouri Department of Natural Resources
- The Nature Conservancy*
- The Cache River Non-Profit Association*
- Clay, Greene, Lawrence, Craighead, Jackson, Poinsett, Woodruff, Prairie, and Monroe Counties*
- Local Drainage, Conservation, and Irrigation Districts*

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Note: The information presented in this report provides a strategic framework of potential options to address problems within the watershed. Options identified will follow normal authorization and budgetary processes of the appropriate agencies. Costs presented were rough order magnitude estimates used for screening purposes only.

Introduction

Section 729 of the Water Resources Development Act (WRDA) of 1986, as amended by Section 202 of WRDA 2000 gave the U.S. Army Corps of Engineers (Corps of Engineers) its authority for watershed planning in the White River Basin. This plan was developed[2] in coordination with federal, state, and local authorities involved in the management of the water resources in the White River, and Cache River basins.

This document assesses the problems, needs, and opportunities of the water resources in the Cache River basin in Arkansas. It seeks to inform Congress, management agencies, and local groups of methods to address problems within the basin and the necessity for a study to determine the best federal course of action to implement improvements. Recommendations are made for the Corps of Engineers, the Natural Resources Conservation Service (NRCS), U.S. Fish and Wildlife Service (USFWS), Environmental Protection Agency (EPA), Arkansas Natural Resources Commission, Arkansas Game and Fish Commission, Arkansas Natural Heritage Commission, county governments, and local drainage and conservation districts. Further, information from this Cache River basin assessment will be used in the larger White River Basin Comprehensive Study.

Watershed boundaries follow drainage divides at the upstream boundaries and terminate in some larger receiving water body, such as a stream, river, bay or estuary, or ocean. Watersheds ignore political or national boundaries. John Wesley Powell described a watershed as, "…that area of land, bounded hydrologic system, within which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community."[3]

In the United States, the varied nature of portions of the country from arid to wet and the many varied uses of the rivers for commerce, manufacturing, agriculture, hydropower, natural resources, drinking water, recreation, etc., established the need for government involvement in the management of rivers and associated resources. Various federal agencies under Agriculture, Defense, and Interior Departments and the Environmental Protection Agency (EPA), participate in the management of these water resources. In a watershed, such as the White River Basin in Arkansas and Missouri, state agencies also have a role in the management of water resources.

The efforts by the Corps, seven study sponsors, and the interagency resource team on the White River Basin Comprehensive Study began in 2002 and have led to several important studies to define critical issues on the White River Basin, such as flood risk, reservoir use, and water quality issues in the Ozark portion of the basin, and bottomland hardwood hydrogeomorphic, sediment, and ecosystem restoration efforts in the delta portion of the basin. The original study plan developed by the Corps, sponsors, and interagency team identified the need to prioritize all eighteen 8-digit hydrologic units in the White River Basin and develop sub-basin watershed plans for the highest six ranked sub-basins to help inform water resource management for

[2] Please refer to the section on "Sources of Information" for a brief listing of some of the collaborative efforts taken during the production of this report. Individuals from several agencies helped provide input and editing assistance in the development of this report.

[3] EPA website: http://water.epa.gov/type/watersheds/whatis.cfm

the overall White River Basin. Due to renewed interest from the America's Great Outdoors initiative, the Cache River basin was selected as the first sub-basin management plan to be developed.

Management Plan Purpose and Authority

The Cache River Watershed Management Plan is part of the White River Basin Comprehensive Study, and is under the Corps of Engineers' General Investigations (GI) Program. The White River Basin Comprehensive Study is authorized by Section 729 of the Water Resources Development Act (WRDA) of 1986, as modified by Section 202 of WRDA 2000, reads as follows:

> *(a) IN GENERAL. –The Secretary may assess the water resources needs of river basins and watersheds of the United States, including needs relating to-*
>
> *(1) ecosystem protection and restoration;*
> *(2) flood damage reduction;*
> *(3) navigation and ports;*
> *(4) watershed protection;*
> *(5) water supply; and*
> *(6) drought preparedness.*
>
> *(b) COOPERATION.—An assessment under subsection (a) shall be carried out in cooperation and coordination with—*
>
> *(1) the Secretary of the Interior;*
> *(2) the Secretary of Agriculture;*
> *(3) the Secretary of Commerce;*
> *(4) the Administrator of the Environmental Protection Agency; and*
> *(5) the heads of other appropriate agencies.*

Section 2010 of the Water Resources Development Act of 2007, specifically added the White River Basin to the list of basins to be address under WRDA '86 Section 729 and modified the cost share percentage.

> *"(1) NON-FEDERAL SHARE.—The non-Federal share of the costs of an assessment carried out under this section on or after December 11, 2000, shall be 25 percent."*

The scope of Section 729 Comprehensive Watershed Studies can include any or all of the needs listed in a. above. This Cache River Assessment, under the White River Basin Comprehensive Study, applies a multi-purpose approach to watershed planning to accommodate flexibility and collaboration in the process. Areas of investigation specific to the Cache River include water supply, ecosystem restoration, environmental infrastructure, recreation, flood risk management, and regional economic development.

The primary objective of this assessment is to comprehensively analyze the Cache River basin problems and opportunities and recommend solutions. The team identified the significant resources in the basin. The assessment identifies the need for environmentally sustainable development of water resources within the Cache River Basin. The potential solutions to problems associated with significant resources within the basin were examined in a comprehensive manner because of the interrelationships among the resources. The assessment makes specific recommendations for implementation and for a study to determine the optimum federal path forward.

This Cache River Assessment will inform the development of a larger White River Basin Comprehensive Plan. An assessment of a watershed in the Ozark Plateau portion of the basin, like the James River basin between Springfield, Missouri, and Table Rock Lake, would be useful for the White River Basin study.

Related Authorizations and Guidance

Responding to the concerns of state agencies, local officials, and individuals, the Committee on Public Works and Transportation of the United States House of Representatives adopted a resolution on 23 September 1982, which authorized the Corps of Engineers to study the feasibility of developing water conservation and water supply projects in eastern Arkansas. The resolution, sponsored by former Congressman Bill Alexander, says:

> *"Resolved by the Committee on Public Works and Transportation of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is hereby requested to review the report of the Chief of Engineers on the Mississippi River and Tributaries Project, published as House Document Numbered 308, 88th Congress, and other pertinent reports, with a view to determining whether any modification of the recommendations contained therein are advisable at this time, with particular reference to the need and feasibility of improvements in the Bayou Meto, L'Anguille, St. Francis,* ***Cache,*** *and Lower White River Basins including their tributaries in the Alluvial Valley of Eastern Arkansas,* ***in the interest of water conservation and water supply of both surface and subsurface water for municipal, industrial and agricultural purposes.*** *These investigations will be fully coordinated with the State of Arkansas, appropriate local government entities, and interested federal agencies."*

The Corps of Engineers drafted the *Eastern Arkansas Region Comprehensive Study*, which identified five potential project areas: *Bayou Meto, L'Anguille, St. Francis, Cache, and Lower White River Basins.*

Engineering Circular 1105-2-411 (EC 1105-2-411) provides the guidance for the Corps' conduct of WRDA 1986 Section 729 studies. A specific requirement of EC 1105-2-411 is to conduct the watershed study with a systems approach with public involvement, collaboration, and coordination. The effects of water resources problems on ecological, climatic, physical (including geography), agricultural, socio-economic, and infrastructure systems are evaluated in this plan and discussed in the Existing Conditions section. Many meetings, tours, workshops, and other information exchanges with elected officials, the public, agencies, and other stakeholder groups were conducted during the development of this plan and are discussed in the Sources of Information section. The development of this plan followed a systems approach that included to perspectives of many interested parties.

White River Watershed Overview

The White River basin covers 27,765 square miles in northern and eastern Arkansas and southern Missouri (See Figure 1). It has diverse natural resources, internationally significant wetlands, and opportunities for ecosystem restoration. The basin offers recreation, hydropower, navigation, and agriculture.

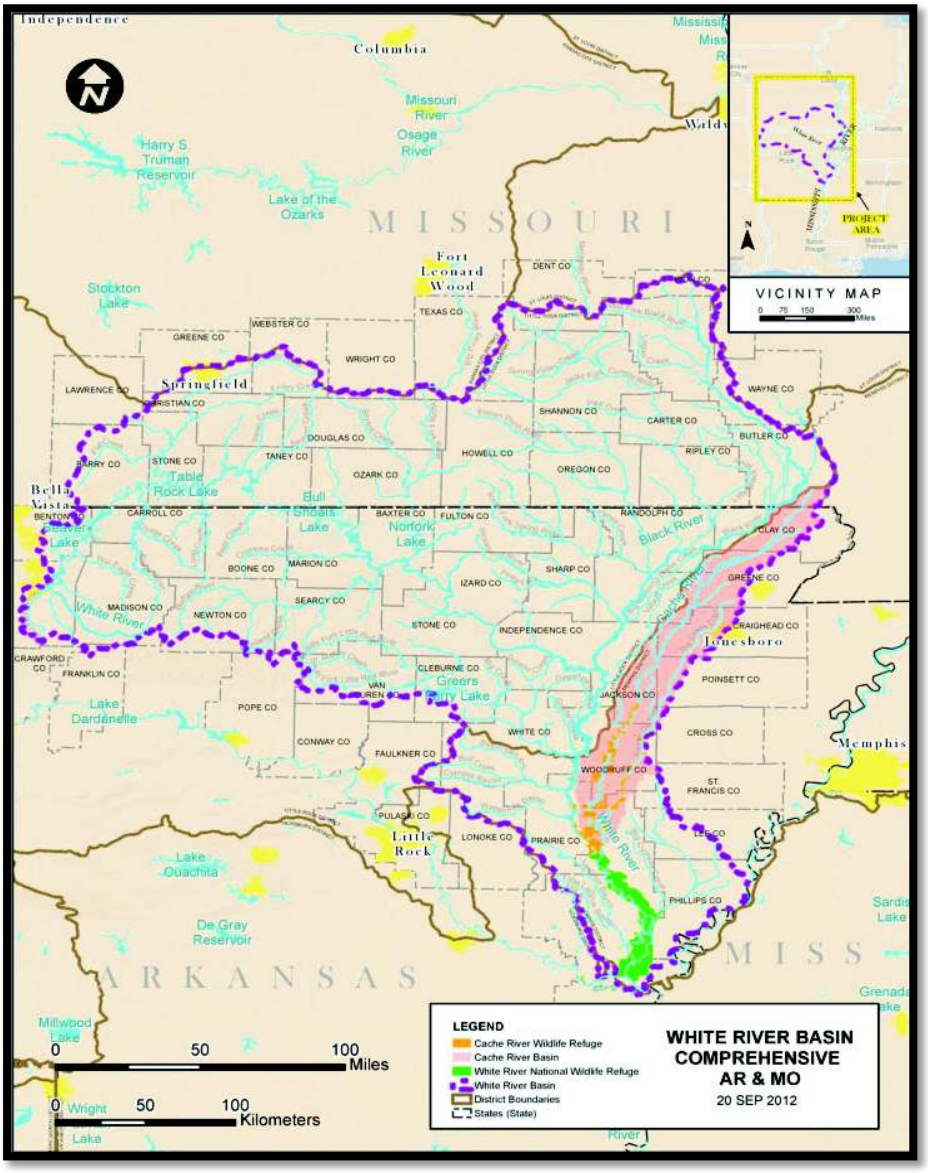


Figure 1. White River Watershed and Cache Basin (pink)

The basin has two distinct regions: a hilly region located in the Ozark Uplands in north and northwest Arkansas and southern Missouri and a deltaic region within the Mississippi Alluvial Valley (MAV) in eastern Arkansas. More than half of the Ozark Upland portion of the watershed lies within reaches where reservoir management controls the water level. The northeastern portion of the Ozark Uplands contains undammed

rivers including the upper and lower Black, Strawberry, Eleven Point, Current, and Spring Rivers (See Fig. 2). These areas fall within the boundaries of the Little Rock District of the Corps of Engineers. The delta portion of the basin includes the Lower White/Bayou Des Arc, Cache River and Bayou DeView, Big Creek, and Lower White River basins, and falls within the boundary of the Memphis District, Corps of Engineers. At its southern end, the White River empties into the Mississippi River, connecting it to the nation's extensive inland waterway system.

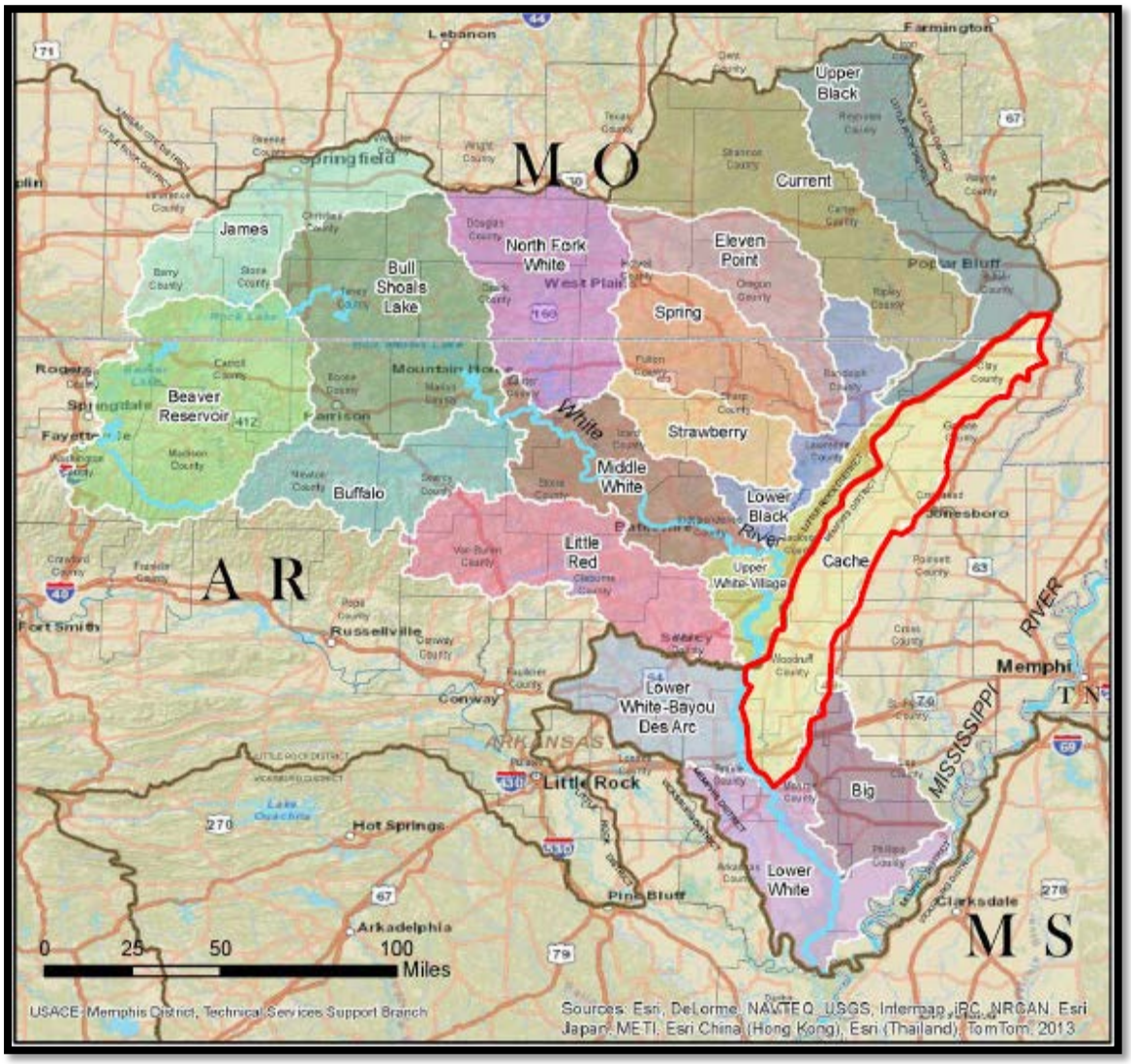


Figure 2. White River Watershed and Basin Names

Mountain streams dominate the upland area. Some of these are impounded and others are free flowing. Hydropower production, agriculture, fisheries, scenic rivers, water supply, flood risks, endangered and threatened species, and recreational opportunities are important considerations in the basin. The delta area contains meandering streams and is valuable for agriculture, navigation, commercial and recreational fishing, and water supply. The area is ecologically important, with hundreds of square miles of internationally significant BLH forests. These forests are home to bald eagles and many other threatened and endangered fish and wildlife species.

Background and Significance of the Cache River Basin

The Cache River basin is in the lower east-central area of the White River watershed. The basin covers about 2,018 square miles in portions of 12 counties in northeast Arkansas and 1 county in southeast Missouri (Figures 4, 5, and 6). The basin is approximately 143 miles in length and at the widest point 18 miles across. All but 260 square miles of the basin (headwater areas along the western slope of Crowley's Ridge) are located in the Western Lowlands geological division of the MAV. The Black/White River watershed lies to the west and north of the Cache basin, the Grand Prairie terrace is to the south along its western boundary, and Crowley's Ridge is on the east side. A very small portion of the basin (about 5 miles of the overall 143 mile channel length) extends into Butler County Missouri. At this upstream extent the Cache River is named the Catch River Ditch. While not specifically addressed, recommendations made in this Watershed Management Plan include this Missouri portion of the basin. A Corps of Engineers flood control project channelized the lower ten miles of the Cache River in the 1970's, creating a 7-mile long flood control channel from the Cache River's mouth near Clarendon, Arkansas, upstream to the mouth of Bayou DeView.

Bayou DeView, a major tributary, parallels the Cache River for about 90 miles. It joins the Cache River at about mile 7 immediately upstream of the channelized portion of the Cache.

The project area lies within a Wetland of International Importance. The Cache-Lower White River site is listed in the North American portion of the Ramsar[4] Convention list. It is so designated because it is the longest continuous expanse of BLH (forested, periodically flooded wetlands) in the Lower Mississippi Valley. The area is internationally important for numerous species of wintering waterfowl, especially Mallard Ducks. Up to 100 bald eagles also winter in the area. The lower White River basin contains three national wildlife refuges (White River, Cache River, and Bald Knob). The lower basin also contains numerous state wildlife management areas and natural areas.

The Cache River basin remains one of the most important BLH ecosystems in North America and many national and international conservation entities cite it for its ecological significance and as a priority region for future protection and restoration (USFWS 2009). In particular, the basin is a major wintering and stopover point in the Mississippi River Flyway for waterfowl. The basin's losses of BLH have been extensive due to agricultural clearing and other drainage efforts. The estimated total loss between 1935 (167,897 hectares) to 1975 (60,749 hectares) indicates about a 65% reduction in this historic habitat. Overall, in the lower MAV, about 75% of the BLH habitat has been lost. (Heitmeyer, 2010)

BLH forests supply critical benefits that are fundamental to ecosystem health at multiple scales and they can protect freshwater resources and habitat for terrestrial and aquatic fauna of national and international significance. Federally list threatened or endangered species are provided in the Existing Conditions discussion under Ecological resources (page 13).

Streams and associated riparian ecosystems of the southeastern United States provide important habitats for the most diverse terrestrial and aquatic fauna on the continent. Forested watersheds in the region often serve

[4] The Convention on Wetlands, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. Ramsar is the oldest of the modern global intergovernmental environmental agreements. The treaty was negotiated through the 1960s by countries and non-governmental organizations concerned about the increasing loss and degradation of wetland habitat for migratory waterbirds. It was adopted in the Iranian city of Ramsar in 1971 and came into force in 1975.

as the last refugia for many sensitive species of birds, non-game fishes, mussels, crayfishes and other riparian-dependent wildlife. At the landscape scale regional hydrologic cycles and floodplains are influenced by the ways in which upland, bottomland, and wetland forests are managed and/or restored.

The Cache River basin is important to the nation's agriculture. Crops grown in the basin include soybeans, cotton, rice, and grains for ethanol production and feed (corn, milo, giant miscanthus). Poultry production is increasing in the northern portion of the basin in Clay, Greene, and Lawrence Counties. Eight of the 18 most productive rice-producing counties in the United States fall partially or wholly in the Cache River Basin. Few areas in the United States are conducive to growing rice. Areas must have abundant irrigation water and soils must be able to retain and hold shallow water. Additionally, rice requires warm temperatures during critical growing stages to produce viable seeds. Only regions of California, Texas, Louisiana, Mississippi, Missouri, and Arkansas meet the necessary requirements for crop production (Baldwin, 2010). See Figure 3 for rice growing counties in the United States. Since 2000, Arkansas has produced more rice than any other state, producing nearly as much as all of the other states combined. (Economic Research Service 2014, Table 6, State and Rice production by class)

The U. S. exports about half of its rice (Economic Research Service, 2014). Since 2001, the U.S. has exported over 3 million metric tons of rice per year, and in four of these years exported more than 4 million metric tons. The U.S. crop is consistent and high quality. Exports have accounted for slightly more than $2 billion in each of the last three years.

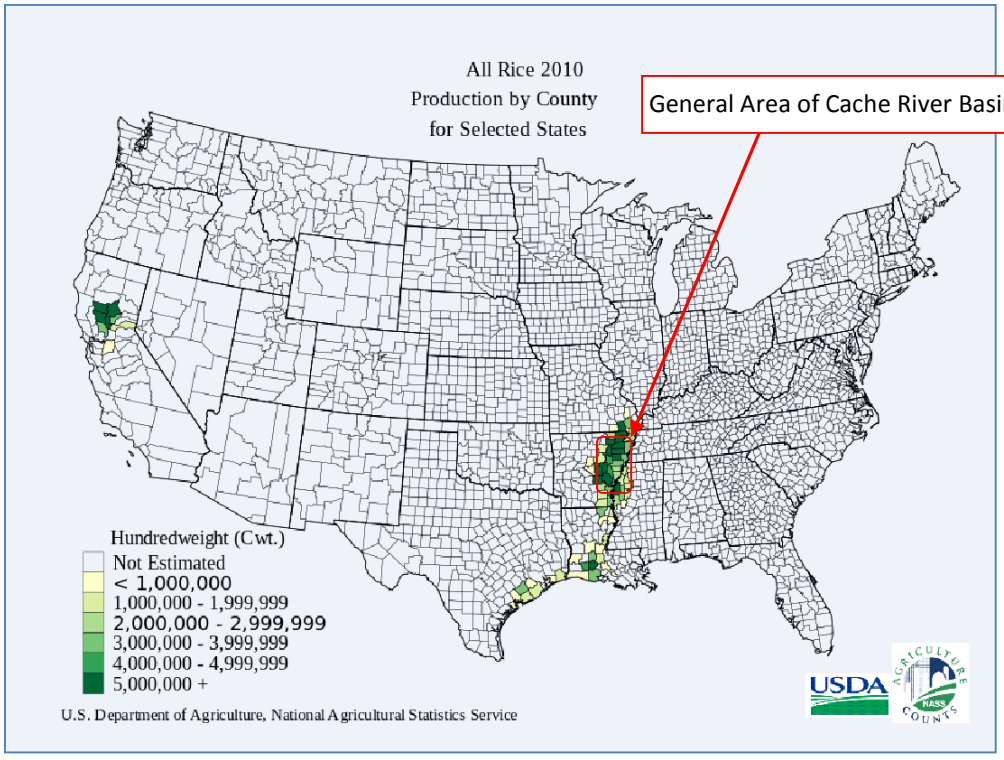


Figure 3. USDA: Rice Production by County, 2010

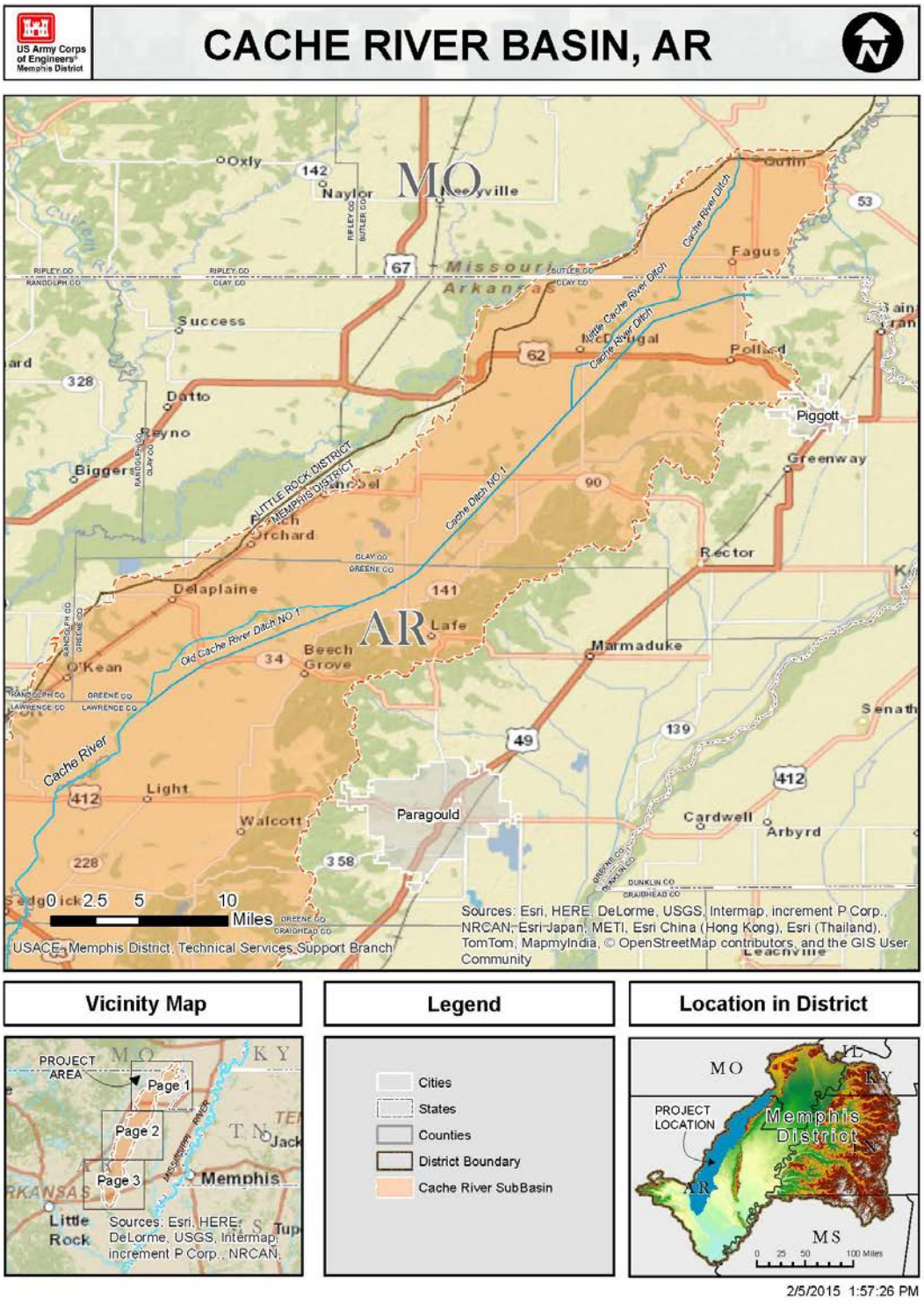


Figure 4. Upper Cache River Basin

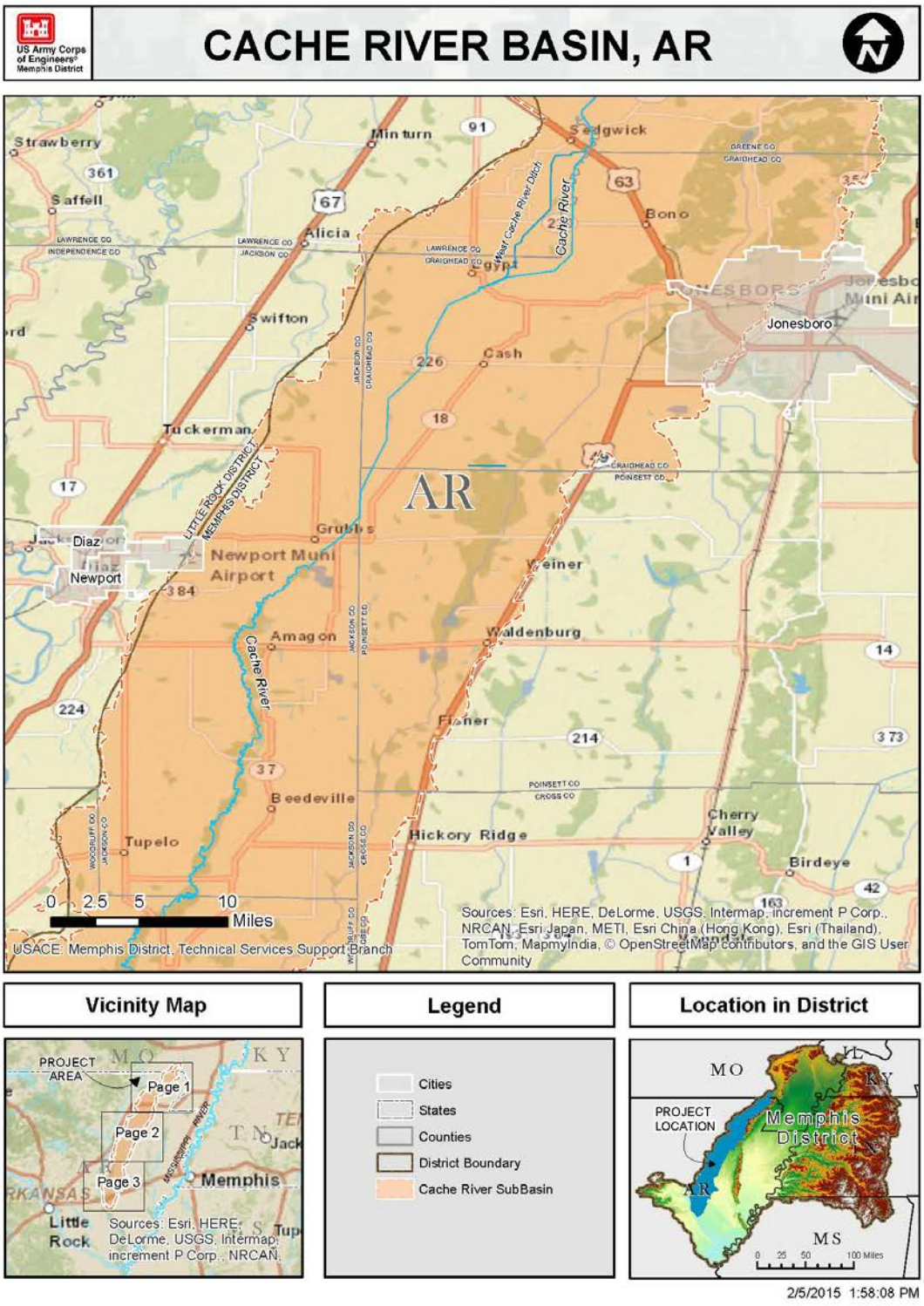


Figure 5. Middle Cache River Basin

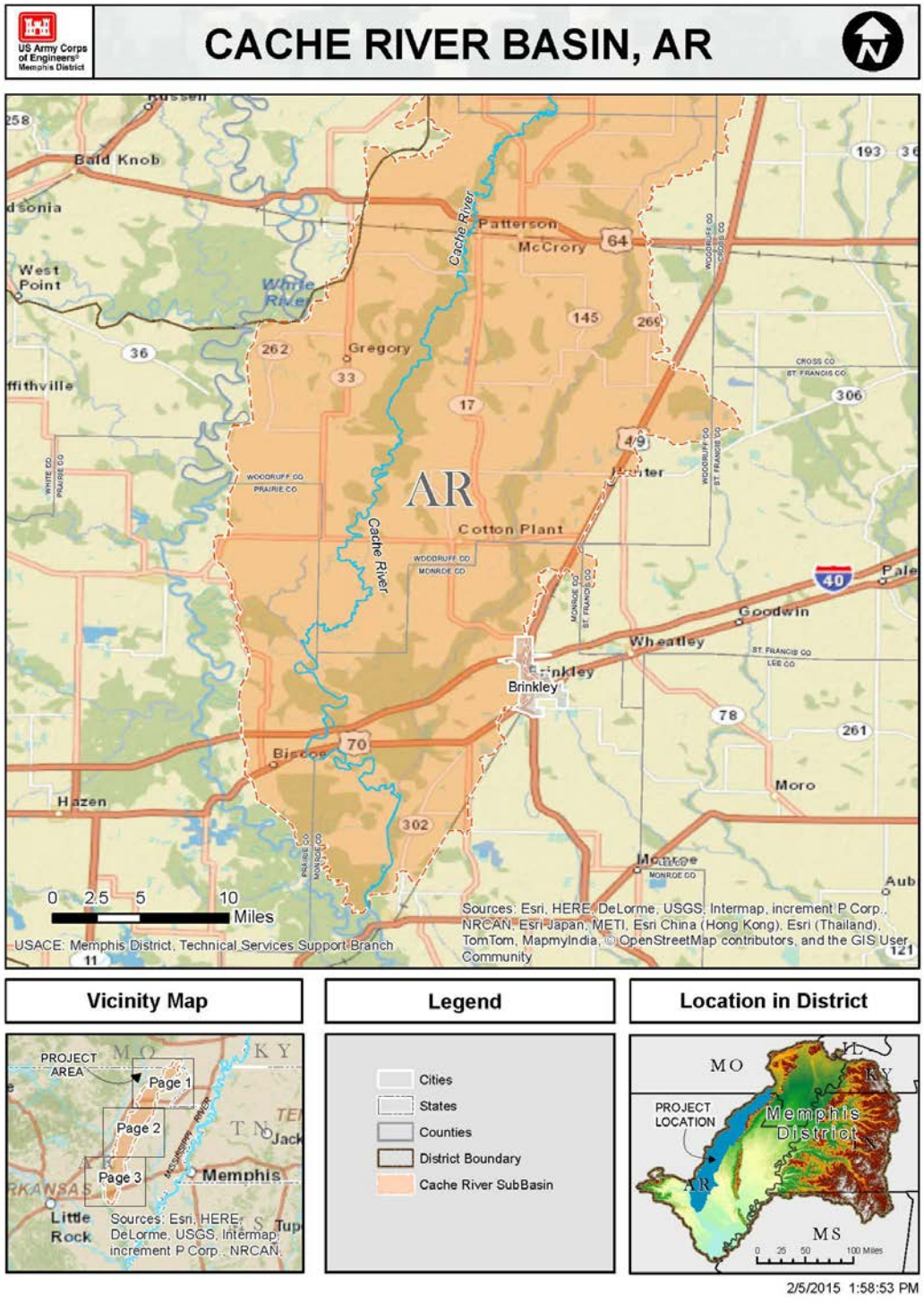


Figure 6. Lower Cache River Basin

Existing Conditions

Ecological

The Cache River basin is one of the tributaries of the lower White River watershed. Historically, the Cache River one-percent chance exceedance floodplain[5], contained one of the largest BLH landscape and hydrologic "corridors" in the MAV (Holder 1970, MacDonald et al. 1979). Communities and landforms in this region provided critical regional ecological functions that sustained the integrity and high productivity of the MAV. They also contributed many continental ecosystem services (e.g., Gosselink and Lee 1989, Fredrickson et al. 2005). Today, the Cache River ecosystem is highly altered and degraded. BLH was converted to agricultural cropland, physical topography and water flow corridors were altered, hydrodynamics of the Cache River and Bayou DeView floodplains have changed, water quality is degraded throughout the system, the composition and distribution of remnant BLH and aquatic communities were altered, and there is little connectivity between remaining BLH tracts and nutrient/energy flow. The remnant BLH in the middle and southern Cache River basin and the lower White River floodplain is the largest expanse of BLH remaining in the MAV (Twedt and Loesch 1999). These remnant areas of floodplain habitat provide habitat for many avian, terrestrial, and aquatic species.

Primary ecological processes within the Cache River basin include (Heitmeyer, 2010):

1) seasonal hydrologic regimes and regular overbank flooding
    a. Spring flooding and overbank flooding is an important dynamic to the flora and fauna of the basin for life cycle processes, such as fish spawning and rearing, wetlands, etc
2) nutrient and sediment dynamics of braided-stream water flow pathways and extensive stands of BLH
    a. Braided streams, islands, sediment laden with nutrients, long duration flooding, flat topography, and other aspects of delta bottom lands enhance the production of BLH
3) multi-trophic detrital-based energy flow and food webs
    a. From algae and macro-invertebrates upward to the top of the food chain (e.g., functional feeding groups), life has developed to thrive in these types of delta streams and channels
4) punctuated long-term community dynamics and regenerating mechanisms
    a. Disturbance patterns must have some resemblance to natural patterns in order for the flora and fauna accustomed to surviving in the local ecology can thrive.

Restoration in the basin will depend on establishing more natural patterns in each of these four areas. The typical period of high flow starts in December and January through April or May of each year, while the June through November timeframe is the low water period.

Currently, water flow dynamics in the Cache River basin are highly altered from historic conditions because of changed land use, deforestation, channelization, and many other systemic factors (Walton et al. 1996a, 1996b; Long and Nestler 1996). These changes have accelerated water flows through the northern part of the basin. In contrast, water drainage through the southern part of the basin is now slower, and causes more

[5] The 1 percent annual chance of exceedance floodplain refers to the hydrologic stage that one would expect based on a statistical analysis of a period of record of river stage data to have a 1% chance of occurrence in any one year. It is merely a calculation for planning purposes. Under traditional nomenclature, this was referred to as the 100-year flood. That nomenclature built some expectation that a 100-year flood would occur once every hundred years, which is not true. A 100-year event likely occurs more or less frequently than exactly every hundred years.

extensive and prolonged growing season flooding. Channel blockages, like the one near Grubbs, AR, also exacerbate flooding. This channel blockage is discussed further in the Physical site description below.

According to USFWS, several federally listed species[6] may occur within the counties of the Cache River basin. They are: Ozark hellbender (*Cryptobranchus alleganiensis bishopi*), pink mucket (*Lampsillis abrupta*), rabbitsfoot (*Quadrula cylindrica*), Curtis pearly mussel (*Epioblasma florentina curtisii*), scaleshell (*Leptodea leptodon*), fat pocketbook (*Potamilus capax*), gray bat (*Myotis griescens*), pondberry (*Lindera melissifolia*), red-cockaded woodpecker (*Picoides borealis*), the Indiana Bat (*Myotis sodalis*), Northern Long-eared Bat (*Myotis septentrionalis*), and ivory-billed woodpecker (*Campephilus principalis*). Some of these may occur outside the actual Cache River Basin and may occur in the adjacent Black River Basin, which is also part of the larger White River Basin. The lower seven miles of the Cache River was surveyed for mussels prior to the Lower Cache Section CAP Section 1135 of the Water Resources Development Act (WRDA) of 1986 project, and none of the species listed were found. Red-cockaded woodpecker is only likely to occur in the pine forests of Monroe County. The ivory-billed woodpecker is extremely rare and was commonly accepted to be extirpated from its known range in the United States, although it remained on the list of endangered species. A potential sighting in 2004 caused renewed interest in the species and led to a statement on April 28, 2005 by USFWS that the species was not extinct. The BLH habitat in the Cache River basin is habitat for many species of migratory birds for wintering, year-round, and breeding periods. Prior to implementing any construction project, the Corps would coordinate with the USFWS to ensure the proposed site-specific activities would not jeopardize any listed species.

Climate Change

The ability to predict the impacts of climate change specific to the Cache River has limitations. Ultimately, it would be desirable to integrate climate change studies and water resource evaluations to the point where we are able to predict changes in river discharges and attribute those changes to either climate variability or change. However, at this point in time, our efforts remain rudimentary and integration of the multitude of driving variables that influence discharge has not led to conclusive predictions of change. For instance, a recent paper by Caldwell et al. (2012) discussed that increases in impervious cover by 2060 may offset the impact of climate change during the growing season in some watersheds, while in other areas, increased water withdrawals for human consumptions, industrial utilization and irrigation could either offset or exacerbate climate change impacts. Hirsch and Ryberg (2012) concluded that there was not strong statistical evidence relating historic flood magnitudes to changes in global mean CO_2 levels. Additionally, the Mississippi River basin has had significant annual and inter-annual variability throughout the period of historical record. As a recent example, between the flood of the spring of 2011 and the drought of 2012, water levels at the gage in Memphis, Tennessee varied by 59 feet. Natural inter-annual and inter-decadal variability make it difficult to detect potential climate changes due to anthropogenic or other sources.

Despite these constraints, climate scientists have suggested a few trends for the watershed that may be useful to consider. Bonnin et al. (2011) have presented evidence that there will be an increase in heavy, flood-inducing precipitation events, particularly in the Ohio Basin that would have a direct influence in the Lower Mississippi River. Raff et al. (2009) also found that for the James River in the Missouri River Basin climate projections result in an increased simulated annual maximum flood potential through time. Also, Kunkel et al. (2013) report that although there is also large inter-annual variability in regional temperatures, historical

[6] The northern long-eared bat may be added to this list based on the consultation area map from the USFWS.

tendencies for the Midwest U.S. as a whole are towards increased annual temperatures. Easterling (1993) used the climate scenario of the 1930's as a baseline to describe the response in the Missouri, Iowa, Nebraska, and Kansas (MINK) region as a consequence of global climate change. Conclusions from the study indicated that farm level adjustments plus new technological advancements, when combined with CO_2 enrichment, would limit the negative impact of climate change. In addition, the panel agreed that accurate quantitative predictions of changes in future stream flow characteristics would be extremely difficult, if not impossible, to accomplish. According to the United States Global Research Program, agriculture is considered to be one of the most adaptable sectors to changes in climate. One example of adapting to climate change would be to adjust the planting dates to avoid late season heat stress. Another key effect of climate change is the potential for increased storms. "Precipitation has become less frequent but more intense, and this pattern is projected to continue across the United States." (Karl et al 2009). Therefore, the need for flood risk reduction and water management options would continue to be a necessity in the future for farmers to grow and harvest their crops. In addition, limiting the social costs of high water events by flood damage reduction measures is a goal of national importance.

Physical

The basin has several different regions based upon drainage, natural geologic processes, and anthropogenic influences. At the eastern boundary, the watershed begins at Crowley's Ridge. The Black River watershed lies to the west, and the watershed divide is lower. The northern end of the basin extends into Butler County, Missouri, where the Cache River originates. The Cache River joins the White River about one mile upstream from Clarendon, Arkansas. The basin has three distinct regions - upper, middle, and lower. A land use map of the Arkansas portion of the basin is provided in Figure 7.

Most of the upper portion of the Cache River above US Highway 63 was channelized for agricultural production (See Drainage and Irrigation Districts, Page 34). Crowley's Ridge influences the upper Cache River in this northern end of the basin in Clay and Greene Counties east of the river. Lawrence County is in the upper portion of the basin on the western side of the river. The ditches draining the western side of Crowley's Ridge contribute sand that increases channel maintenance costs in this area. Additional information regarding the upper portion of the Cache River and sediment issues is discussed in the Previous Studies Section below.

The middle portion of the basin starts at US Highway 63 near Sedgwick, Arkansas and extends past Arkansas Highway 18 to Arkansas Highway 14 near Amagon, Arkansas. This portion of the river is channelized in some sections, but is sinuous and has a BLH corridor in other areas. There are two unique features of the middle portion of the basin; the West Cache River Ditch and channel blockages at Grubbs. The West Cache River Ditch begins downstream of US Highway 63. It flows parallel to the main Cache River channel. The ditch rejoins the Cache River at Arkansas Highway 91 (Kings Highway) near Egypt, Arkansas.

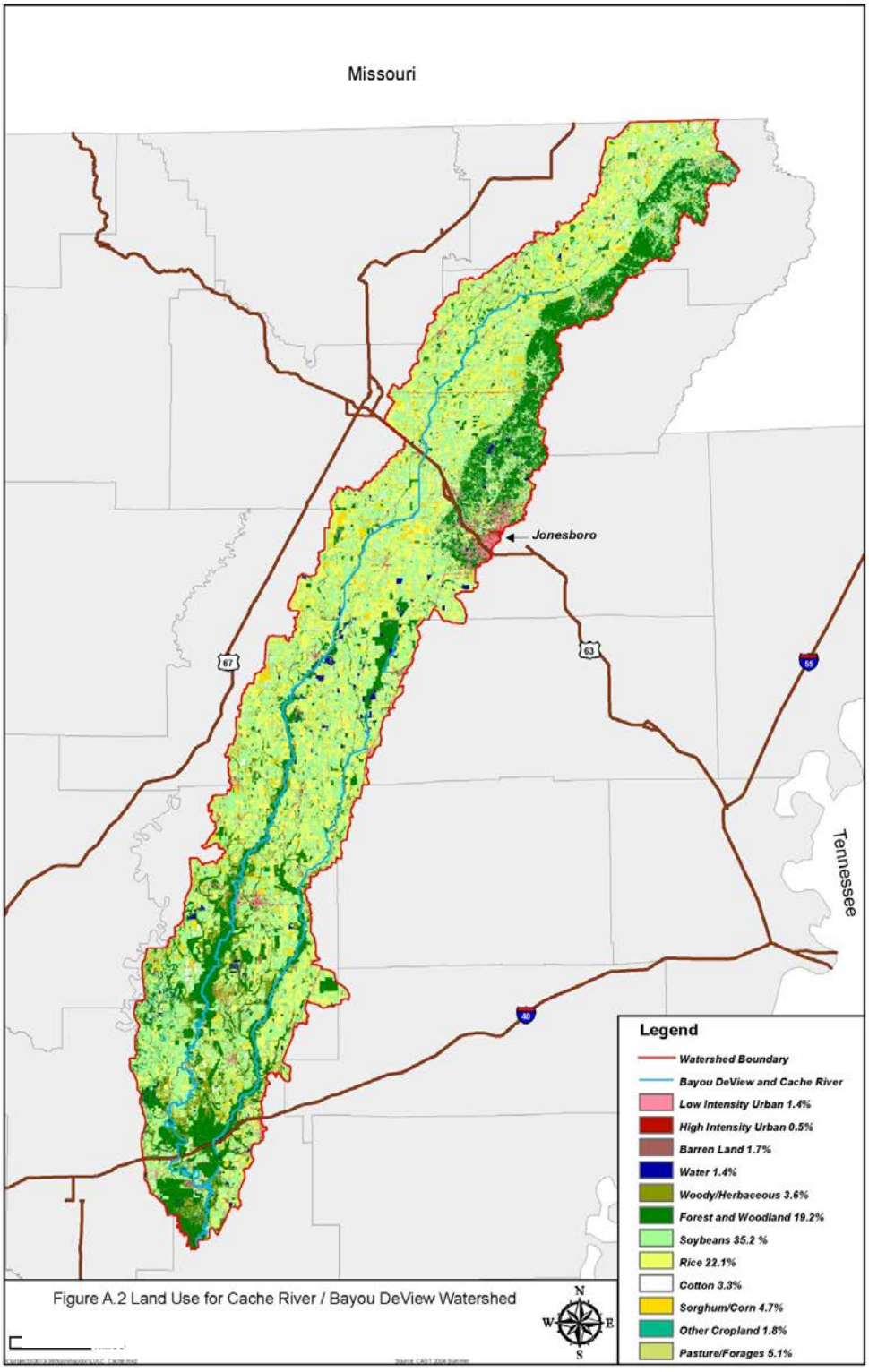


Figure 7. Cache River Basin Land Use

Four channel blockages existed in the Cache River downstream of Arkansas Highway 18 near Grubbs, Arkansas. The log and debris blockages at Grubbs lie at the point where the channel reverts from the channelized upper section to a meandering river. These blockages are massive blockages that span the entire channel and formerly totaled about five miles in length. The blockages impede river flow and induce sediment deposition. These channel blockages cause higher river stages and exacerbates flooding of Grubbs and nearby agricultural lands (Heitmeyer, 2010).

In 2013, the Cache River Non-Profit Association removed the two uppermost channel blockages. In October of 2014, (See Figures 13 and 17) the area was a functioning river. Sand deposition remains an issue, and debris continues to litter the streambank in this area. More intense channel maintenance will be required in this area unless the overall Cache River system is restored and stabilized. The two downstream channel blockages remain. The removal of the two uppermost blockages provided relief from issues cited above.

Except for the existing lowest seven channelized miles (ten miles prior to channelization in the 1970's), the lower portion of the Cache River meanders. These meanders start at the downstream of channelized sections. This portion of the river is braided and there is BLH adjacent to the channel. This portion of the Cache River floods frequently from both headwaters and White River backwater. The dominant hydrologic driver in this lower portion of the Cache is the White River. This is the natural condition of this lower portion of the Cache River, and generally does not require correction. There is the potential to enhance flood risk reduction through measures that may include reconnecting off-channel storage areas or enlargement of the National Wildlife Refuge through purchase of conservation easements or fee title acquisition (from willing sellers only) in this lower portion of the river.

Bayou DeView is the major tributary to the Cache River and runs parallel to it. Big Creek drains the west side of Jonesboro from Lake Frierson to the Bayou DeView State Wildlife Management Area, where it becomes Bayou DeView. Bayou DeView has been channelized in many areas, including adjacent to the Bayou DeView Wildlife Management Area. There is an intact riparian corridor along most of the channel downstream to US Highway 64. The corridor varies from very narrow to over a thousand feet wide (where Threemile Creek joins the Bayou). Several historic meanders and oxbows remain along this middle stretch of Bayou DeView. Starting at Highway 64 and continuing downstream to its confluence with the Cache River, Bayou DeView transitions to a braided meandering watercourse with an extensive BLH forest in its floodplain.

Agriculture Production

The importance of the basin to the nation's agriculture was discussed in the basin description above. Rice requires a lot of water, soils that can retain water, relatively flat land to aid in the process of irrigation, and temperatures that do not fall below 60° F during the growing season. Rice generally will not germinate at temperatures below 60° F. Additionally, floodplain areas that accumulate sediment provide fertile areas for crop production. Historic overbank flooding and the fluvial deposits that exist due to the flooding contributed to the agricultural productivity. The Cache River basin meets the requirements for rice production. Water for irrigation will be critical for the future of rice production in the basin.

Many factors have altered the natural topography and flow of water within the Cache River basin, especially in higher elevations outside of the 10 percent annual chance of exceedence floodplain[7]. BLH has been cleared and converted to agriculture. Surface water is drained and diverted to reduce flooding and provide irrigation. Most cleared and farmed areas in the basin have some combination of ditches, levees, berms, and land leveling. Although the recent trend has been an increase of BLH acreage due to several conservation and restoration efforts by NRCS and USFWS, the predominant land use in the basin is projected to remain agricultural. See Figure 7 for the existing land use in the Cache River Basin.

Socio-Economic and Infrastructure

The area is rural and predominantly dependent upon agriculture for economic stability. Agriculture is likely to remain dominant in the future.

Population. The population of the study area has increased slightly since 1980 (see Table 1). Craighead and Greene counties have grown and all of the other Counties within the study area have declined. The City of Jonesboro, in Craighead County, increased from 31,500 in 1980 to 67,300 in 2010. Paragould, in Greene County, increased from 15,200 in 1980 to 26,100 in 2010. The population for the remaining 6 counties decreased by 21,300 from 112,900 to 91,600 between 1980 and 2010.

Projected population figures for selected years are in Table 1. These estimates were obtained from the University of Arkansas Little Rock, Institute for Economic Advancement projections. Total population is expected to increase to 246,000 by 2030 with most of the increase occurring in Craighead and Greene Counties.

Table 1

Historical and Projected Population

County	1980 a/	1990 a/	2000 a/	2010 a/	2013 a/	2020 b/	2030 b/
Clay	20,600	18,100	17,500	16,100	15,400	14,500	12,800
Craighead	63,200	69,400	82,500	96,400	101,500	115,500	117,400
Greene	30,700	31,900	37,500	42,100	43,100	48,200	51,200
Jackson	21,600	19,000	18,400	18,000	17,600	17,500	13,200
Lawrence	18,400	17,400	17,700	17,400	17,000	17,000	17,400
Monroe	14,100	11,300	10,200	8,200	7,700	6,300	4,800
Poinsett	27,000	24,600	25,600	24,600	24,100	23,500	24,200
Woodruff	11,200	9,500	8,700	7,300	7,100	5,900	5,000
Total	206,800	201,200	218,100	230,100	233,500	248,400	246,000

a/ US Census Bureau.

b/ University of Arkansas Little Rock, Institute for Economic Advancement website;
http://iea.ualr.edu/population-estimates-a-projections.html

[7] See footnote 4 for a description of this nomenclature. Traditionally, the flood stage that statistically was referred to as a 10-year flood stage is more appropriately called the 10% annual chance of exceedence floodplain.

Employment. Employment within the study area has remained relatively constant. However, jobs in rural counties have decreased while those in urban counties have increased

Table 2

Employment

	2000	2014						
County	**Total**	**Total**	**Services**	**Agriculture**	**Construction**	**Manufacturing**	**Government**	**Unemployment**
Clay	6,188	3,488	1,924	227	119	331	887	8.0%
Craighead	39,366	44,949	30,232	247	1,742	5,731	6,997	4.7%
Greene	14,928	14,841	7,129	234	211	5,160	2,107	5.9%
Jackson	5,886	5,098	2,489	210	121	900	1,378	7.5%
Lawrence	4,889	4,040	1,984	189	113	459	1,295	6.1%
Monroe	2,973	2,250	1,465	126	56	136	467	5.9%
Poinsett	6,641	4,962	2,717	308	81	648	1,208	5.4%
Woodruff	2,524	1,845	893	129	32	224	567	7.4%
Total	83,395	81,473	48,833	1,670	2,475	13,589	14,906	
US Department of Labor, Bureau of Labor Statistics								

Income. Total personal income is income of individuals received through wages, salaries, profits, property income, and/or transfer payments. See Table 3 for basin income data. Per capita income (PCI) is a measure of the relative support the economy provides for the population.

Table 3

Personal Income

		Constant 2010 $			
	Current $			**Per Capita**	
County	**1994**	**1994**	**2010**	**1994**	**2010**
Clay	266,000,000	391,000,000	467,000,000	21,900	29,000
Craighead	1,264,000,000	1,860,000,000	3,082,000,000	24,900	32,000
Greene	517,000,000	760,000,000	1,185,000,000	22,300	28,100
Jackson	287,000,000	423,000,000	581,000,000	22,500	32,300
Lawrence	248,000,000	364,000,000	468,000,000	20,800	26,900
Monroe	150,000,000	221,000,000	250,000,000	20,300	30,500
Poinsett	376,000,000	554,000,000	716,000,000	22,200	29,100
Woodruff	131,000,000	193,000,000	214,000,000	21,000	29,300
Total	3,239,000,000	4,766,000,000	6,963,000,000	22,900	30,300
University of Arkansas, Division of Agriculture, Research & Extension.					

Social Effects: There are several small towns near the river. Flooding is common. In December 1990 and January 1991, flooding in Grubbs reportedly caused $500,000 in damage (U.S. Army Corps of Engineers. 1994). These damages today would be roughly $1 million in this town of 386 people (2010 Census). McCrory, Fisher, Patterson, Amagon, and Egypt also flood. Additionally, many road crossings are overtopped during floods, isolating homes and communities.

Cache River Basin Vision & Goals

Watershed planning is an approach for managing water resources within specified drainage areas or watersheds and addresses problems in a holistic manner that reflects the interdependency of water uses, competing demands, and the desires of a wide range of stakeholders in addressing watershed problems and opportunities.[8] USACE held public meetings and meetings with project sponsors and stakeholders, from the initiation of the White River Basin Comprehensive Study in 2002 and continuing through 2014. The vision for the White River basin and the Cache River basin, has been discussed at these meetings.

An interagency partnership developed a unified vision statement[9] for the Cache River Basin that defines goals and objectives for the future. The vision combines land management, farm practices and water conservation to maintain and restore the unique resources of the Cache-White River system. Agriculture and water management are as much a part of this watershed as the natural components of the ecosystem.

Vision Statement:

Maintain and enhance the globally significant Cache River BLH ecosystem within a sustainable agriculture-based landscape to balance ecological, economic and social interests

The vision provides the framework for a multi-level strategy which addresses five component goals:

- Promote voluntary, sustainable agricultural and forestry practices that improve water quality and enhance wildlife (agriculture)
- Improve ecological health of the Cache River system (habitat)
- Effectively manage surface and ground water resources to support all users (hydrology)
- Increase outdoor recreational opportunities and access (recreation)
- Increase public awareness of the link between economic and conservation goals (outreach)

[8] USACE Engineering Circular 1105-2-411, Watershed Plans, 15 January 2012

[9] This occurred mainly during a stakeholder workgroup meeting held in The Nature Conservancy's Little Rock AR office on 25 July 2012. In addition to the Assistant of the Secretary of the Army for Civil Works Office, the NRCS, USFWS, several Arkansas Commissions (Natural Resources, Game and Fish, Waterways, Forestry, Natural Heritage, and Parks & Tourism), National Wildlife Refuge Association, Ducks Unlimited, Audubon, and Arkansas Chapter of TNC participated.

Stakeholders and Sponsors

Federal water resource policy is to develop comprehensive watershed solutions that address multiple issues. The long-term recommendations to address the Cache River basin require collaboration amongst federal, state, and local agencies to leverage knowledge, experience, and resources. The White River Basin Comprehensive Study and meetings conducted in 2012 through 2014 led to an interagency partnership to achieve these goals. The partnership includes:

Local and Regional Federal Offices

- U.S. Natural Resources Conservation Service (NRCS)
- U.S. Fish and Wildlife Service (USFWS)
- U.S. Army Corps of Engineers (Corps of Engineers)
- Lower Mississippi Valley Joint Venture (LMVJV)
- Environmental Protection Agency (EPA)

State and Local Government

- Arkansas Game and Fish Commission (AFGC)[10]*
- Arkansas Natural Heritage Commission (ANHC)*
- Arkansas Forestry Commission (AFC)
- Arkansas Department of Parks and Tourism (ADPT)
- Arkansas Natural Resources Commission (ANRC)*
- Arkansas Waterways Commission (AWC)*
- Missouri Department of Conservation (MDC)*
- Missouri Department of Natural Resources (MDNR)*

Non-Governmental Organizations

- Audubon Arkansas (AA)
- Ducks Unlimited (DU)
- Cache River Watershed Non-profit Association (CRWNA)
- National Wildlife Refuge Association (NWRA)
- The Nature Conservancy of Arkansas (TNC)*

Several agencies, counties, and local drainage and irrigation districts participated in the development of this watershed management plan. They were involved in all aspects of plan development, including editorial reviews and participation in tours and local and public meetings. The EPA provided information about Arkansas's Clean Water Act (CWA) Section 319 grant package.

[10] * These are official White River Basin Comprehensive Study Project Sponsors.

Sources of Information

The team used existing information for this watershed assessment. Information included previous studies, management programs, approved plans, agency records, personal communication, and other references. Public meetings, stakeholder meetings, and site visits occurred. Geographic information systems provided landscape and land-use information. This information came from the public, federal, state, and local agencies, non-governmental organizations, and local drainage and irrigation districts. These information sources are summarized below:

Existing/Past Studies and Management Programs

Corps of Engineers

The Corps of Engineers has a considerable history of work in the basin going back to four specific authorizations or programs, and a general authority for delegated projects:

Cache River Basin Project:

The Cache River and Bayou DeView General Design Memorandum No 101 (June 1969) recommended the need and justification of providing flood control alternatives in the basin. The Cache River flood control project was started in July 1972 and construction was stopped in March 1973 after the lowest seven miles of river were channelized due to an injunction, which was subsequently lifted. Funding on this initial project trended downward and the last year funds were provided was 1978. In 1987, funds were again provided to re-evaluate a federal project in the area. A General Re-Evaluation Report (GRR) was completed in September 1994. The GRR determined flood damages on 788,000 acres of cropland, and indirect damages to other public infrastructure and quality of life. The GRR recommended: One-sided channel enlargement in the upper portion of the basin to tie into the unchannelized lower portion of the basin; installation of a sediment trap and removal of a plug at the north end of Hale Lake; installation of a rock weir to form the sediment trap between river miles 122.4 and 124.7 (2.3 miles long); channel enlargement for 4.9 miles downstream of Highway 18; bridge protection at two road bridges; construction of an earthen sediment trap from mile 127.62 to 127.90 (about 1,500 feet). Sediment management was an identified issue. The GRR discusses the December 1990-January 1991 event that flooded 50 businesses and homes in Grubbs. The sponsor did not support the recommended plan due to the estimated maintenance costs for the sediment traps. The project was not constructed and remains as an uncompleted project. The likelihood that the project will ever resume construction is very low.

Eastern Arkansas Region Comprehensive Study

The Eastern Arkansas Area Comprehensive Draft Study was completed in 1990. It identified water supply needs for several areas including the southern portion of the Cache River basin. Bayou Meto and Grand Prairie were the priority areas and GRRs for these two areas were completed and construction is underway for both these flood risk management, water supply and distribution projects. An area between the Black River and Crowley's Ridge, including portions of Craighead, Jackson, Poinsett, Cross, Woodruff, and Monroe counties were identified as a area of significant aquifer depletion.

White River Basin Comprehensive Study:

Several scientific studies have been completed or are underway for the White River Basin Comprehensive Study effort and are applicable to the Cache River assessment. These are as follows:

Cache River/Big Creek Sedimentation White River Basin Comprehensive Study (Joint report between Memphis District, Corps of Engineers and the National Sedimentation Laboratory-Agricultural Research Service, U.S. Department of Agriculture, 2010). This study applied USDA-ARS sedimentation models to the Cache River watershed. It identified gully erosion as the most significant contributor of sediment within the basin and found that chronic sediment deposition exacerbates flooding in the basin. The modeling showed the majority of these gullies were on the eastern side of the basin and originated on the western flank of Crowley's Ridge. It also identified one particular basin - the Big Creek basin to the northwest of Rector, Arkansas, as a primary source. The report suggests controlling sediment from this area would reduce flood risks and enhance or improve ecological quality. Simulations estimated 50% reductions in the sediment loading are possible with continued use of Best Management Practices and introduction of gully control; but without gully control at the source of the sediment, only a 10% reduction in sediment loading is likely. Farmers (producers) efforts and NRCS conservation programs have reduced the amount of sediment coming from agricultural land. These projects are discussed in the NRCS Conservation Programs section below.

An Evaluation of Ecosystem Restoration Options for the One-Percent Chance Exceedance Floodplain of the Cache River Basin in Arkansas and Missouri with Special Reference to Channel Blockage Near Grubbs, Arkansas and Sediment Management in the Big Creek Watershed, Heitmeyer, 2010. The objectives of this study were to identify restoration options and necessary ecological attributes for specific habitats in the Cache River floodplain; identify the current ecological condition at the blockage near Grubbs and identify possible remedies; and determine ecological benefits of reducing the sediment loading to the Cache River. The document provides broad conceptual guidance for developing ecosystem restoration and management options that work with existing conservation efforts and do not significantly impact the agricultural productivity of the basin. The report recommends restoration and stabilization of the ecosystem in some general ways: restore key ecological floodplain functions; restore to the extent practicable physical geological features of the basin; identify and evaluate specific measures to remediate the blockage at Grubbs; and reduce the sediment from the Big Creek basin and the slopes areas on the western side of Crowley's Ridge. Specific measures are discussed in the Recommendations section of this report.

Hydrogeomorphic Bottomland Hardwood Study of the Lower White River and Lower Cache River, Dr. Sammy King, under development in 2015. This study is underway and is scheduled to be complete in late 2015. The study will assist in the development of the larger White River Basin Comprehensive Study.

Lower Cache River Section 1135 Meander Restoration Project:

Major construction for this project was completed in 2013. This CAP ecosystem restoration study analyzed the channelized section of the lower Cache River and proposed re-establishing flow to six meanders. Two meanders were constructed to date and they have been very successful. While the City of Clarendon was the official sponsor of this project, the Arkansas Game and Fish Commission and The Nature Conservancy were important partners in the project. The restoration will be monitored to assess the ecological response. Efforts to restore the remaining meanders are discussed in Recommendation 4.

Continuing Authorities Program:

The Corps of Engineers is granted a delegated authority from Congress to perform several types of smaller scale projects that are typical of the Corps of Engineers primary mission areas. This program is called the CAP and the types of projects that are covered and may be of use in the Cache River basin are ecosystem restoration (Section 1135 of WRDA 1986 and Section 206 of WRDA 1996), flood risk management (Section 205 of the Flood Control Act (FCA) of 1948), and infrastructure protection (Section 14 of the FCA of 1946). These are hereinafter referred to by their Section number.

U. S. Fish and Wildlife Service

National Refuge System - Central Arkansas Complex: The USFWS operates six refuges in this complex, of which four either fall partially or wholly in the Cache River basin, or lie in adjacent basins (Weaver, pers comm. 2015). These are the Bald Knob National Wildlife Refuge (NWR) in the White River basin, Big Lake, and Wapanocca refuges in the St. Francis River basin, and Cache River NWR. The Cache River NWR lies in Jackson, Monroe, Prairie, and Woodruff Counties in Arkansas. It covers about 70,000 acres and had an acquisition boundary of nearly 186,000 acres, but it was expanded to around 287,000 acres in 2012. It is important to note that any USFWS acquisition of lands for the refuge is limited to willing sellers only.

The comprehensive conservation plan for the Central Arkansas National Wildlife Refuge Complex directs the USFWS to actively manage forest, moist soil, scrub-shrub, grassland, and aquatic habitats for wildlife. The plan also provides greater opportunity for wildlife-dependent public recreation, including better facilities (including roads, ATV trails, boat ramps, visitor contact stations, observation decks, fishing piers, hiking trails, boardwalks, and photo blinds to allow access) and public education programs. Refuge management also includes expanding restoration project efforts.

Ecological Services Field Office - The USFWS has responsibilities under the Fish and Wildlife Coordination Act to participate in the planning of federal projects. The Arkansas Ecological Services Field Office consults with federal agencies in accordance with Section 7 of the Endangered Species Act to avoid or reduce negative impacts to federally listed species. They also work with state, and private partners to implement actions consistent with the recovery of listed species. The USFWS has an Arkansas Delta Sub-Office co-located with the Cache River National Wildlife Refuge office near Augusta. This office takes an active role in reviewing and participating in Corps of Engineers and other federal projects in the basin, including mitigation for any projects which cause unavoidable impacts to the environment.

Environmental Protection Agency

The EPA has responsibility for administering and enforcing parts of several environmental laws including the CWA. They are focused on non-point source pollution in rural and agricultural areas. The EPA administers Section 319 of the CWA, which is a grant program to help state and local agencies address non-point source pollution issues on streams listed under Section 303(d), Impaired Waters Program. Several sections of both Cache River and Bayou DeView are listed as 303(d) impaired waters from total dissolved solids and lead, with agricultural runoff cited as the source, and Lake Frierson is listed as impaired due to copper and siltation. The primary impairment categories are: 1) Fish, Shellfish, and Wildlife Protection and Propagation, 2)

Agricultural Water Supply, 3) Industrial Water Supply, and 4) Primary Contact Recreation. Fish and wildlife protection is the most common concern in the Cache River.

The EPA can participate in restoration, conservation, and regulation of water resources in any comprehensive basin-wide feasibility study or resulting actions. If EPA approves the ANRC's Section 319 application (discussed below), the EPA will serve as a contributory federal agency for specific conservation efforts covered under the Section 319 program.

Farm Service Agency

The Farm Service Agency administers the Conservation Reserve Program (CRP). This program is a cost share, land rental program wherein the government enters into contractual agreements with individual producers to install conservation measures on erodible soils. Measures can include land treatments such as establishment of riparian wooded buffer strips, grassed vegetation, or other erosion control methods. The contract periods are typically 15 to 30 years. There are CRP contracts in the basin.

Agricultural Research Service

The ARS Delta Water Management Research Unit in Jonesboro focuses on preserving the quality and availability of water resources used in agricultural environments, particularly in the small, rural farms that dominate the Lower Mississippi River Delta. This includes nutrient impact investigations in the basin's waterways. The specific objectives are to 1) Conduct hydrological system studies to measure, model and predict the impact of current and innovative farming practices and associated ground and surface water withdrawals on water availability and quality; and 2) Develop economical and environmentally sound irrigation and drainage management tools, practices, and technologies that conserve water and protect regional water resources and supplies.

The ARS also provides economic analyses on crop production in the United States including exports, forecasting, and production trends. The service produces annual crop reports for use in agriculture and academia.

Natural Resources Conservation Service

NRCS, formerly known as the Soil Conservation Service, is the Federal Government's expert on conservation of farmland and highly erodible lands, as well as conservation of irrigation water. NRCS works closely with individual landowners and is well known throughout the basin.

The NRCS administers several conservation programs to assist landowners. These programs were established decades ago and are used to build soil, water, and wildlife conservation measures on private lands. There are focus programs or initiatives that allow a local sponsor, such as a county, drainage district, or non-governmental organization, to work with the agency to implement projects with multiple landowners within a defined area. These programs can be very specific to types of land treatments on individual tracts to very broad in their capabilities. The programs are voluntary. These programs are:

Conservation Implementation Programs

- Public Law 566 Watershed Conservation Program (PL-566)
- Environmental Quality Incentives Program (EQIP)
- Conservation Stewardship Program (CSP)
- Wetland Reserve Easement (WRE)/Wetland Reserve Enhancement Partnership (WREP)
- Wildlife Habitat Improvement Program (WHIP)[11]

Regional or Focus Areas:

- Mississippi River Basin Initiative (MRBI)
- Regional Conservation Partnership Program (RCPP)

The PL-566 program was used in the 1980's in the Cache River basin for the Boydsville Watershed Plan and Environmental Assessment. This document recommended a resource protection plan to reduce erosion from within the basin. The Clay County Conservation District and the Soil Conservation Service agreed to the plan and the plans features were implemented in the basin.

The EQIP program is popular in the basin for water conservation, such as drop pipes, tailwater recovery systems for irrigation water, and on-farm detention reservoirs. The program also allows for features such as wildlife habitat restoration, establishment of riparian (wooded) buffer corridors along streams and ditches, floodplain restoration, and other features, but these have not been greatly used in the basin. A program requirement is an NRCS approved conservation plan.

The CSP is a contract between NRCS and individual landowners. The program enhances air quality, animals, energy, plant, soil quality, water quality, and water quantity and reduces soil erosion. Establishment of erosion reducing buffers or other measures and water quantity measures available for cost share under this program are of particular potential in the Cache River basin.

The WREP program is similar to the CRP program administered through the Farm Service Agency, but requires a long term or permanent conservation easement rather than a contract, typically in perpetuity. It is used on portions of the landowner's property that either have wetland characteristics or would exhibit wetland characteristics with hydrologic and vegetative restoration. The NRCS also works with the landowner on reforestation, hydrologic modification to enhance wetland function, or other measures to improve the wetland value of the land under contract. The landowner still owns the land and can receive income from hunting leases or other uses as long as the WREP conservation measures remain in place.

Regional programs or initiatives such as the MRBI or the RCPP require a local sponsoring entity that submits a proposal for a defined area to the NRCS. The sponsor facilitates cooperation between the NRCS and landowners for conservation project implementation. Once a sponsor proposal is approved, the specified area can receive priority funding under the other conservation programs (EQIP, WREP, CSP, etc). The

[11] The WHIP program was not reauthorized in the 2014 Farm Bill. Its use in the basin has been limited.

MRBI and RCPP do not implement or directly fund projects, but they do elevate the funding priority of the area.

The goal of MRBI is to reduce sediment and nutrient runoff and improve water quality in the Mississippi River and the Gulf of Mexico. The MRBI projects implemented in the Cache River watershed were WREP and the former Cooperative Conservation Partnership Initiative (CCPI), which is similar to the RCPP. See Figure 8 for the use of MRBI sponsored areas in Arkansas. Project areas 6, 7, 19 and 24 fall partially or wholly in the Cache River basin. Project sponsors were the Arkansas Association of Resource Conservation and Development Councils Inc, The Nature Conservancy (with several partners), and Jackson County Conservation District. NRCS updated the focus of the MRBI was following passage of the 2014 Farm Bill. For 2015, the focus for MRBI in Arkansas is the Arkansas's Nutrient Reduction Strategy Plan and includes the Cache River watershed.

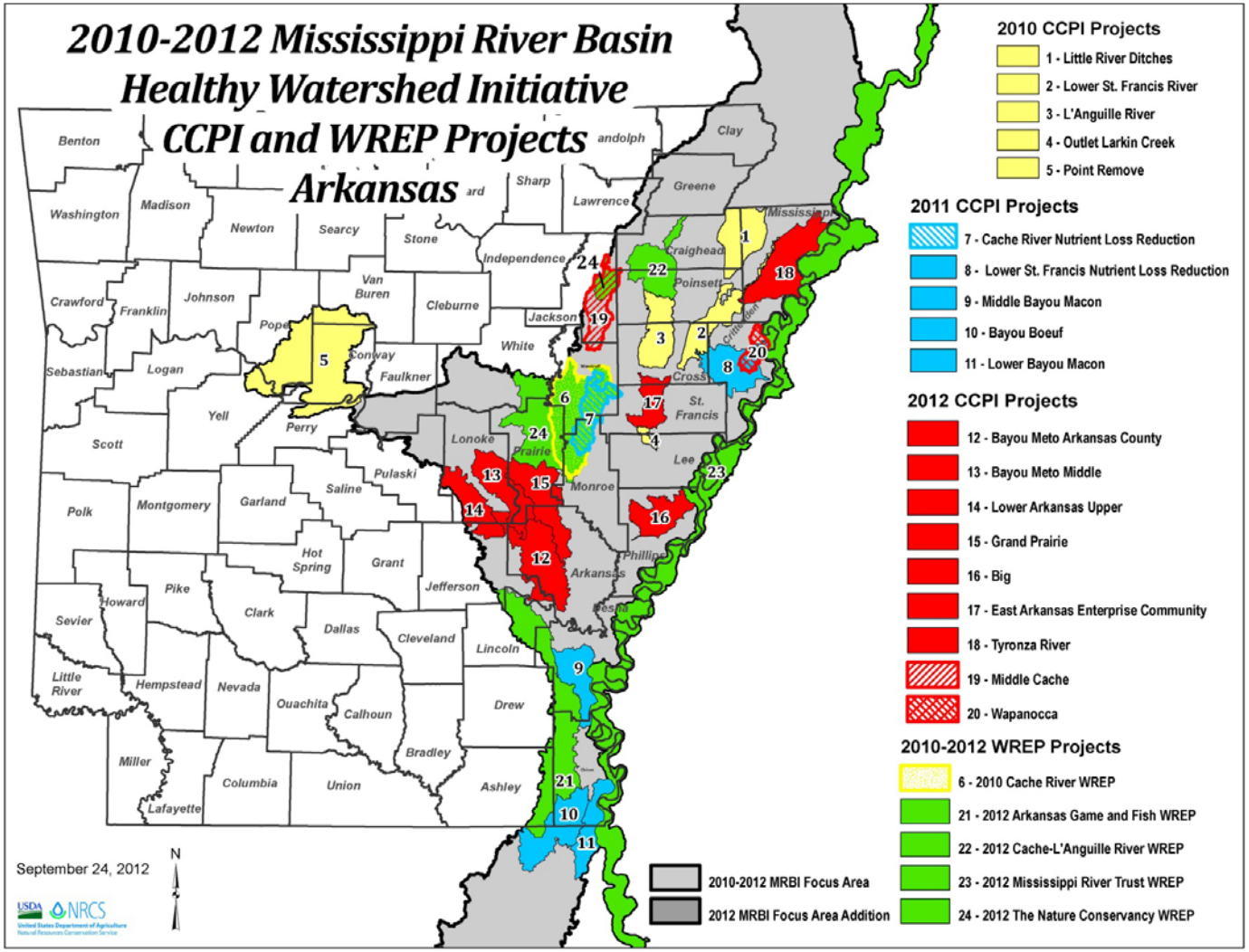


Figure 8: NRCS Conservation Initiatives

Arkansas Game and Fish Commission (AGFC)

The AGFC is a cost sharing sponsor of the White River Basin Comprehensive Study, the parent study of this Cache River Watershed Assessment. AGFC operates and maintains several Wildlife Management Areas (WMA's) in the basin along with employing Private Lands Biologists that assist landowners in the basin to improve wildlife habitat along with water quality. AGFC participates in the federal planning process for water resource projects, representing the state's interests in natural resources indigenous to the state. This includes in some cases taking the responsibility for ownership and management of mitigation lands. The agency manages hunting and fishing.

In all, the AGFC manages about 27,000 acres within the Cache River Basin. WMA's in the basin include:

- Clay County - Ring Slough WMA (86 acres) and a small portion of Dave Donaldson Black River WMA (5 acres)
- Greene County - Cattail Marsh WMA (76 acres), a large portion of W.E. Brewer Scatter Creek WMA (4,076 acres in Cache Basin), Frierson WMA and Lake (930 acres), and Crowley's Ridge State Park (291 acres operated by Arkansas Park Commission - APC)
- Poinsett County - Earl Buss Bayou DeView WMA (4,501 acres)
- Woodruff County - Rex Hancock Black Swamp WMA (6,688 acres) and a small portion of Benson Creek Natural Area WMA
- Monroe County - Benson Creek WMA (1,464 acres cooperatively with ANHC) and Sheffield-Nelson Dagmar WMA (9,720 acres)

AGFC has two WMA's in Woodruff and Monroe County that are directly impacted by the Cache River and associated drainages. Black Swamp borders the Cache and there is opportunity on this WMA to put in some additional infrastructure to stop bank erosion, land acquisition to increase riparian buffer widths and some opportunity to purchase key tracts to improve public access. Dagmar WMA is directly affected by flows on the Cache River and Bayou DeView (flood frequency and duration). The comprehensive plan is needed for this valuable natural resource that is the life blood for providing critical habitat for many species in eastern AR; especially those wintering/migrating down this habitat corridor.

AGFC provides public access to state hunting and fishing grounds and lakes. AGFC manages many boat ramps and public duck hunting areas in these WMA's. Some facilities are managed by Arkansas Natural Heritage Commission (ANHC) and Arkansas Department of Parks and Tourism (ADPT). AGFC has determined there is a need for additional public access in the basin. The existing facilities are:

- 26 State operated Boating Access Areas – 25 AGFC Owned & 1 ANHC Owned
- 3 Fishing Piers (Mobility Impaired Access) – 2 owned by ADPT,
  1 AGFC
- 2 Courtesy Docks – 1 owned by AGFC, 1 owned by ADPT

AGFC recognizes that sedimentation, sediment management, and erosion are priority issues in the basin. Sedimentation impairs water quality and habitat. Improved sediment and erosion control management would benefit the area.

The AGFC works directly with private landowners to improve, restore, and manage land for healthy wildlife populations in the watershed. The agency has a staff of Private Lands Biologists that work in the watershed and have the opportunity to influence land management decisions in positive ways to improve not only wildlife habitat but soil and water resources as well. These biologists can conduct numerous outreach activities to include workshops and field days to reach farm producers in the watershed to increase the delivery of conservation practices on the landscape.

Arkansas Natural Resources Commission (ANRC)

The ANRC is a cost sharing sponsor of the White River Basin Comprehensive Study. The ANRC, formerly the Arkansas Soil and Water Conservation Commission, is the state agency responsible for soil conservation, water rights (ground and surface), dam safety, flood control, the Water Plan, interstate water compacts, and non-point source pollution prevention. The ANRC is organized with three divisions - Water Resources Development, Water Resources Management, and Conservation. The commission provides financial assistance for the development of water, wastewater, and solid waste projects within Arkansas. Their main involvement in this watershed is:

- Regulating and permitting dam construction and operation.
- Tracking water use
- Administering several federal water resources funding programs.
- Preparing water resources and nonpoint source pollution management plans.
- Developing and administering mitigation banking and conservation and restoration incentive programs for aquatic resources.
- Supporting conservation districts.
- Promoting public health and safety and minimizing flood losses through:
    - Training, technical assistance in floodplain management, and accrediting floodplain administrators.
- Administering state nonpoint source pollution management program and federal grants.
- Measuring, modeling, and forecasting groundwater conditions and designates critical groundwater areas.
- Administering tax credit programs for agricultural and industrial water conservation and riparian and wetland zone restoration.

ANRC has more than 30 years of water use and availability data and information (http://ar.water.usgs.gov/PROJECTS/WUData.html). The recently completed Water Plan Update (http://arkansaswaterplan.org) holds specific recommendations that augment the tasks and information needed to complete a comprehensive, basin-wide study for the optimum use and management plan of the water resources in the basin. Many of these recommendations will have applicability to the rest of the White River Basin. The Water Plan Update projects water demand and water availability to the year 2050.

A major recommendation related to the Cache River watershed involves the use of surface water to augment groundwater use for crop irrigation with a goal of reaching sustainable groundwater yield levels and reducing sediment and nutrient runoff from non-point sources. The Water Plan Update also includes groundwater information for Arkansas (http://pubs.usgs.gov/sir/2014/5149/). ANRC has a unique role as the custodian

of the waters of Arkansas that does not fall specifically within any of the federal agencies' missions, and as such many of the Water Plan Update recommendations would require the leadership and participation of ANRC to perform.

The Water Plan Update (ARNC, December 2014) was developed with initial public meetings/involvement during its scoping in November 2012 through June 2013. More public meetings were held in 2013 and 2014 to determine water demand and supply, to identify information gaps, and to formulate issues and recommendations. ANRC seeks cooperation and collaboration of all water resources users; focuses on sustainable use to support local and state economies; protection of public health and natural resources; and enhancement of the quality of life for the residents of Arkansas.

Key findings of the Water Plan Update are: water demand into the future will increase nearly 15% by 2050 compared to the current demand; increases are largely due to crop irrigation; and the Cache River basin is one of the three priority water use regions where groundwater levels will reach critical levels. The aquifer is being depleted in the Cache River basin. Depletion began in the 1980s when irrigation practices focused on the aquifer as the water source. The basin has a net annual surplus of surface water for the wide range of users, including in-stream plants and animals, riparian plants and animals, and people. ANRC estimates that there is an average 161,000 acre-feet of surface water available to the basin annually. Water moves through the basin more quickly than it did historically, and there is little detention for human or ecologic use. Figure 9 from the ANRC Water Plan Update illustrates a potential way forward with a hypothetical system to retain high water and redistribute it when needed.

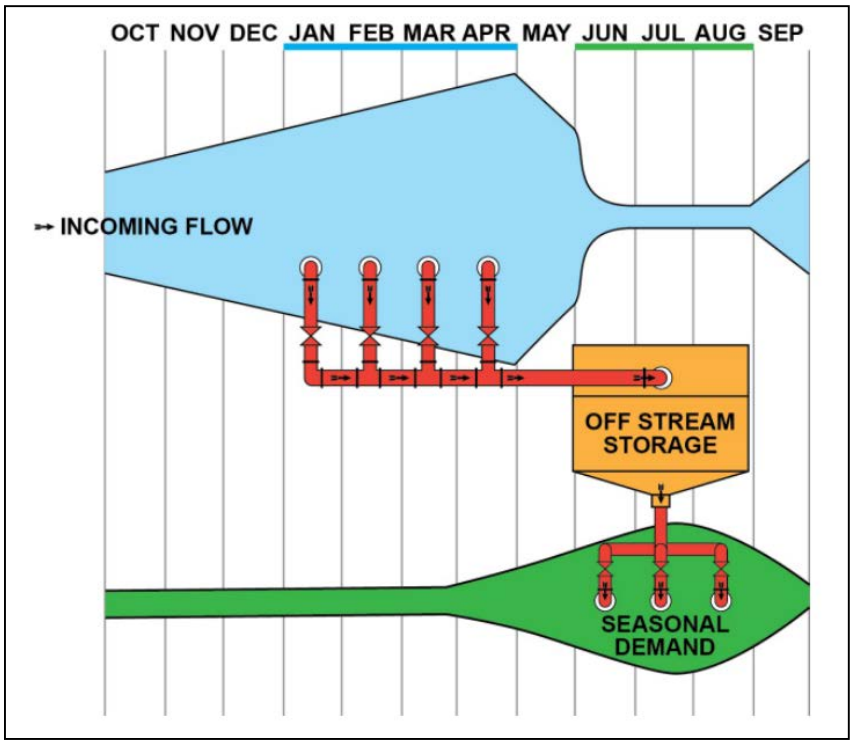


Figure 9: Operational Example of Conjunctive Water Management (Courtesy of ANRC)

Agriculture is critical to the area's economy and the importance of future water supply cannot be overstated. According to the Water Plan Update, only about 20% of the projected 2050 groundwater demand would be sustainable. Figure 10 shows the areas of most critical depletion, including Clay, Greene, Jackson, Craighead, Poinsett, Prairie, and Monroe counties. The farmers in the basin will have to identify alternative sources of irrigation water, or they may not be able to adequately irrigate their crops. ANRC conducted a gap analysis of the difference between groundwater demand and the supply for the year 2050. In the eastern Arkansas Region, including basins in southeast, east central, and northeast Arkansas, the estimated 2050 groundwater gap is 17 million acre feet per year. The Plan Update recommends: off-channel storage (See figure 9), tail water recovery, soil moisture content monitoring to prevent unnecessary irrigation, precision leveling, other conservation techniques, or a combination of these methods. Additionally, using excess springtime in-stream flow to recharge the alluvial aquifer in an enhanced manner would be an approach worth considering (e.g, using the aquifer as the off-channel storage to reduce the groundwater use deficit) (Reba, 2015). USGS performed an assessment for this very potential that is referenced in the August 1990 Eastern Arkansas Region Comprehensive Study (page 67). Any potential for artificial recharge would require significant examination to determine the feasibility of the measure.

ANRC administers federally funded water resource programs that may be appropriate within the Cache River basin. One such program is the EPA funded CWA Section 319 grant program designed to reduce non-point source pollution. The Section 319 program requires a nine-element plan. The nine elements are:

1. Identification of Pollutants Causes and Sources
2. Pollutant Load Reduction Estimates
3. Best Management Practices
4. Financial and Technical Assistance
5. Education and Outreach
6. Implementation Schedule
7. Interim Milestones
8. Monitoring and Assessment
9. Plan Implementation Effectiveness

In January 2015, ANRC engaged an engineering firm to complete a nine-element watershed management plan for the Cache River watershed. The Plan should be complete by early 2016 and will make projects in the basin eligible for EPA financing to reduce non-point source sediment and nutrient runoff. In smaller reaches of the basin, there may be municipalities or cooperative organizations that have runoff issues that Section 319 can address.

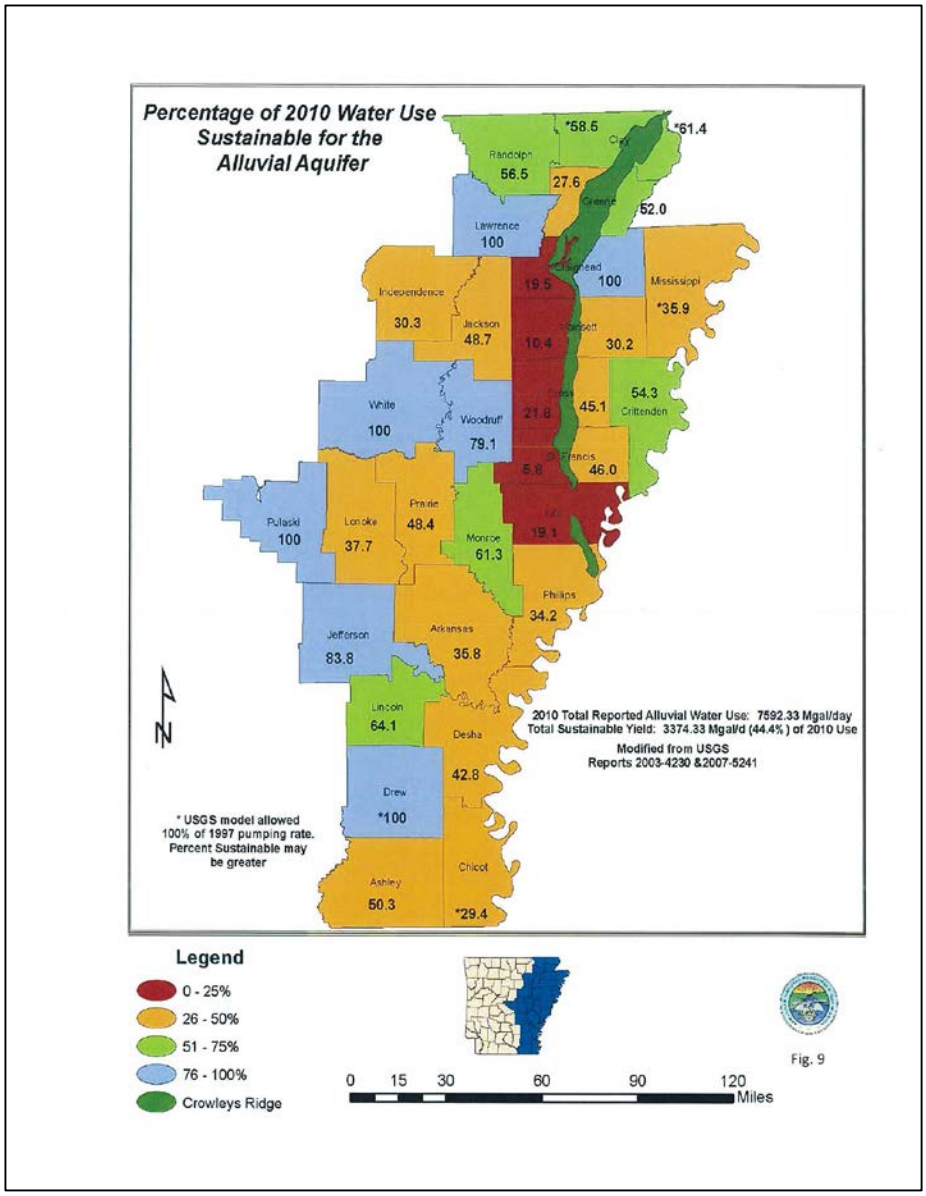


Figure 10: Regions of Sustainable Aquifer Production (Courtesy of ANRC)

Arkansas Natural Heritage Commission (ANHC)

The ANHC is a cost sharing sponsor of the White River Basin Comprehensive Study, the parent study of this Cache River Watershed Assessment. ANHC also provided some in-kind monitoring and sampling during the Lower Cache River Section 1135 Ecosystem Restoration Project. The ANHC's mission is to preserve natural diversity, to promote choice among beneficial uses of the environment, and to promote a balance between development and environmental protection in the State of Arkansas for this and succeeding generations. The ANHC identifies and protects some of Arkansas's important natural places. It does this through research, collaboration, formal land protection, and environmental review and data sharing. The agency maintains a database of information on known locations of rare species and high quality examples of natural communities.

This database is used to help identify important natural areas and is made available to outside users to assist in land management and development. The ANHC currently manages 20 Natural Areas in the Delta Region. Some of these are co- located with and adjacent to AGFC's WMA's. Two of these areas fall within the Cache River basin. ANHC and The Nature Conservancy jointly own the 302 -acre Benson Creek Natural Area. The area is adjacent to both the Cache River National Wildlife Refuge and Dagmar WMA. This area falls mainly in Monroe County with a small tract in Woodruff County. The Cache River Natural Area is 937 acres and falls within the boundaries of the Black Swamp WMA in Woodruff County.

Cache River Non-Profit Association and Nine Counties

This association of the nine Arkansas counties in the basin includes the county judges from Clay, Greene, Lawrence, Craighead, Poinsett, Jackson, Woodruff, Prairie, and Monroe counties. This group has met since the 2011 flood. U. S. Congressman Rick Crawford initiated the Cache River Task Force, which included the drainage districts from Willow Slough and Craighead County. The county judges formed the Cache River Non-Profit Association shortly thereafter to address all water resource issues in the basin. Their first major accomplishment was the 2013 removal of the upper two blockages of the Cache River near Grubbs. Other groups and agencies assisted with this project. The association meets frequently and desires the removal of the remaining blockages, recognizes the need for ongoing maintenance of that portion of the Cache, and looks forward to addressing other water issues in the basin. They aided with the two public meetings and three site visits for this watershed assessment.

County Conservation Districts

Conservation districts are political subdivisions of the State of Arkansas. Their purpose is conserving land and water resources as authorized by Arkansas law in 1937. A conservation district's specific responsibility is management of soil and water resources. These districts make decisions on soil and water conservation matters at the local level. District boards have five members, two of whom are ARNC appointed and three are elected district landowners. Each District works with the NRCS County Conservationists. These boards are important stakeholders for water resource management within the Cache River basin.

Drainage or Irrigation Districts

Drainage Districts are state recognized, chartered organizations with taxing authority and are important stakeholders in the basin. They provide levees, channel improvements and maintenance, and other local features for agricultural land flood protection. Drainage districts are very active throughout the basin. For example, the Cache River Drainage District of Clay County and Cache River Drainage District of Greene County have worked since the 1960's to channelize the upper portions of the Cache River and its tributaries for agricultural purposes. The main stem of the Cache River north of Highway 18 near Grubbs has been fully channelized, as well as many tributaries. Most productive acres have already been placed into agricultural production. However, ongoing maintenance of those channel improvements is a major responsibility and expense to those two drainage districts. These channel improvements facilitate the

transport of sediment from Crowley's Ridge downstream to the middle portion of the Cache River near Grubbs.

The Nature Conservancy (TNC)

The Nature Conservancy is a cost sharing sponsor of the White River Basin Comprehensive Study. TNC and NRCS have a WREP project along the Cache River initiated in 2010, and expanded in 2012. This was the second agreement that TNC has entered into with NRCS in Arkansas, and both are in the delta portion of the state. Additionally, TNC is also a partner starting in 2015 for an EQIP focused MRBI project in the upper portion of the Cache River basin. TNC was involved in the study and a significant contributor to the construction of the Lower Cache River Ecosystem Restoration Project. TNC, AGFC, ANHC, the City of Clarendon, and the Corps completed evaluation and restoration of two of the six meanders in the lower 10 miles of the Cache River immediately north of Clarendon, Arkansas, in 2014.

TNC has been a part of several meetings with many stakeholders in the basin, and worked with NRCS, AGFC, ANRC, the USFWS, the Corps of Engineers, Ducks Unlimited, Audubon Arkansas, and others to generate a vision for a long-term, sustainable, agricultural-based economy, with enhanced wildlife habitat in the basin. TNC worked with ANRC through an EPA-funded 319 grant analyze sediment transport through the Cache River. The data will be useful to restoration of a sustainable Cache River channel through its headwaters above Clay County. TNC has focused on the Big Woods, the area noted as the Ramsar Wetland of International Importance previously described in this document, but recognizes the potential throughout the entire basin for enhancement and increased sustainability.

The Lower Mississippi Valley Joint Venture - The Arkansas Mississippi Alluvial Valley Conservation Delivery Network (Arkansas MAV CDN)

While not a specifically involved stakeholder in the Cache River Watershed Management Plan, many members of the Arkansas MAV CDN are direct stakeholders in the basin. An introduction to this group can be found on the LMVJV website and is reproduced here (Lower MAV Arkansas MAV Conservation Delivery Network, 2015)[12](See Figure 11):

> *'The AR MAV CDN represents the very first effort of the LMVJV partnership toward establishing unique, regionally based Conservation Delivery Networks. The AR Game and Fish Commission accepted initial responsibility for establishing the new Network and appointed the first CDN Chair from among its staff. Other JV partners within the CDN area (as defined in green, in the adjacent) including the U.S. Fish & Wildlife Service, The Nature Conservancy, USDA Natural Resource Conservation Service, and Ducks Unlimited also agreed to support establishment of the new forum. The Network met formally for the first time in January 2011 with the hosting of its full membership meeting in Brinkley, AR. Since its establishment, other key conservation partners within the region*

[12] http://www.lmvjv.org/pages/CDNs/AR-MAV_CDN.htm

have also become members including Audubon, AR Natural Heritage Program, Bayou Bartholomew Alliance, National Wild Turkey Federation, and the AR Forestry Commission.'

Figure 11 - The Arkansas Mississippi Alluvial Valley Conservation Delivery Network Area

In Figure 11, the Cache River basin lies in the upper left portion of the green area, with the eastern boundary being Crowley's Ridge, which is in white.

Several projects identified in the Arkansas MAV CDN priority list are in the Cache River basin (e.g., the Phase Two Cache River Meander Restoration Project). There are also priority areas in the adjacent Black River basin. The Joint Ventures were established to implement the North American Waterfowl Management Plan. LMVJV is a non-regulatory, self-directed effort with private, state, and federal members dedicated to conservation of waterfowl and waterfowl habitat. The USFWS facilitates the group and provides logistical support. LMVJV demonstrates the importance and potential support of conservation efforts that may be possible in the Cache River basin.

Stakeholder Meetings

Two meetings for the Cache River Watershed Management Plan were held with county judges[13] - Newport, AR (2 June 2014, four county judges) and Jonesboro (4 June 2014, three county judges, and two elected officials of the Cache River Drainage District of Clay County). Some of the county highway supervisors also attended these meetings. The purpose of these two meetings was to identify specific water resource issues. Flooding around infrastructure was identified in several locations. Channel maintenance costs are an issue for the drainage districts in the basin. The stakeholders discussed the Boydsville Lake concept, which is discussed following the Newport Arkansas meeting of 27 August 2014 below.

Public Meetings

Two public meetings were held to identify water resource issues and concerns. The first public meeting was held on 27 August 2014 at the Newport Campus of Arkansas State University. There were 22 attendees including landowners, county judges, state and federal agency employees (other than Corps employees), and representatives of both Senator John Boozman and Representative Rick Crawford's offices. The following issues were raised during the meeting:

- Boydsville Lake concept to control erosion on the western side of Crowley's Ridge
- A local drainage problem in Woodruff County near Cache Bayou and County Road 874
- The lack of communication with local drainage districts by the Corps of Engineers
- A lack of funding for some of the NRCS conservation programs in the project area
- Water supply
- Flooding of fields was attributed by some local residents to the blockage removal cleanout near Grubbs or to the Corps of Engineers meander restoration project in the Lower Cache River near Clarendon [14]
- Flooding in the City of McCrory Arkansas

Regarding the Boydsville Lake concept, this was a potential impoundment (earthen dam) across some portion of a drainage basin on the western side of Crowley's Ridge to the west of Piggott Arkansas. Highway 90 runs through the middle of this area as it comes off the western side of the ridge. The plan was considered for years up through about 2000 when for unknown reasons further consideration of the project stopped. Documentation is sparse, but a very rough concept plan from 1992 by NRCS was provided by local interests to the Corps for this watershed plan. Apparently, three potential alignments were contemplated for a northern impoundment, southern impoundment, and one larger full impoundment which would create from 2,400 to 5,600 acres of surface area. Please see Figure 12 for the area indicated in the Boydsville Lake

[13] In Arkansas, County Judges are elected officials that serve as the executive managing official in the county government system, similar to a mayor. These officials do not have criminal nor civil court responsibilities.
[14] The Lower Cache River project was designed and constructed to not affect upstream river stages. In several recent years, there has been springtime high water associated with local rain events and in particular in 2011 during the Mississippi River Flood of 2011.

concept. In this figure, the drainage is toward the west and the impoundments would be uphill toward Crowley's Ridge on the east.

Subsequent to the meeting, the problem near County Road 874 was discussed further with residents and the Woodruff County Judge. The Corps and stakeholders made several site visits to clarify issues raised at the meeting.

The second public meeting was held on 17 September 2014 in the Paragould Community Center in Paragould Arkansas. It was attended by 17 people including citizens, county judges, and state and federal agency employees. There were six Corps employees in attendance. The following issues were raised during the meeting:

- Boydsville Lake Concept to control erosion on the western side of Crowley's Ridge
- A local scour issue on a landowner's property on the east bank of the Cache River south of Evening Starr Road/Greene County Road 229
- The lack of communication with local drainage districts by the Corps of Engineers voiced by the Cache River Drainage District of Clay County
- Water supply
- High channel maintenance costs due to sediment loading in the Cache River and major tributaries
- A local desire for federal funds without federal involvement was expressed
- A desire to perform cultural resource survey work on the entire Cache River basin as part of this watershed assessment effort was requested

Subsequent to the meeting, the Corps and stakeholders resolved the problem at Evening Starr Road to the satisfaction of the landowner. Information provided by the Cache River Drainage District of Clay County on Boydsville Lake indicated that the concept did not go beyond a planning phase. That information is discussed and considered in this watershed assessment within the *Long Term Recommendation* section. The Corps and stakeholders made several site visits to clarify issues raised at the meeting.

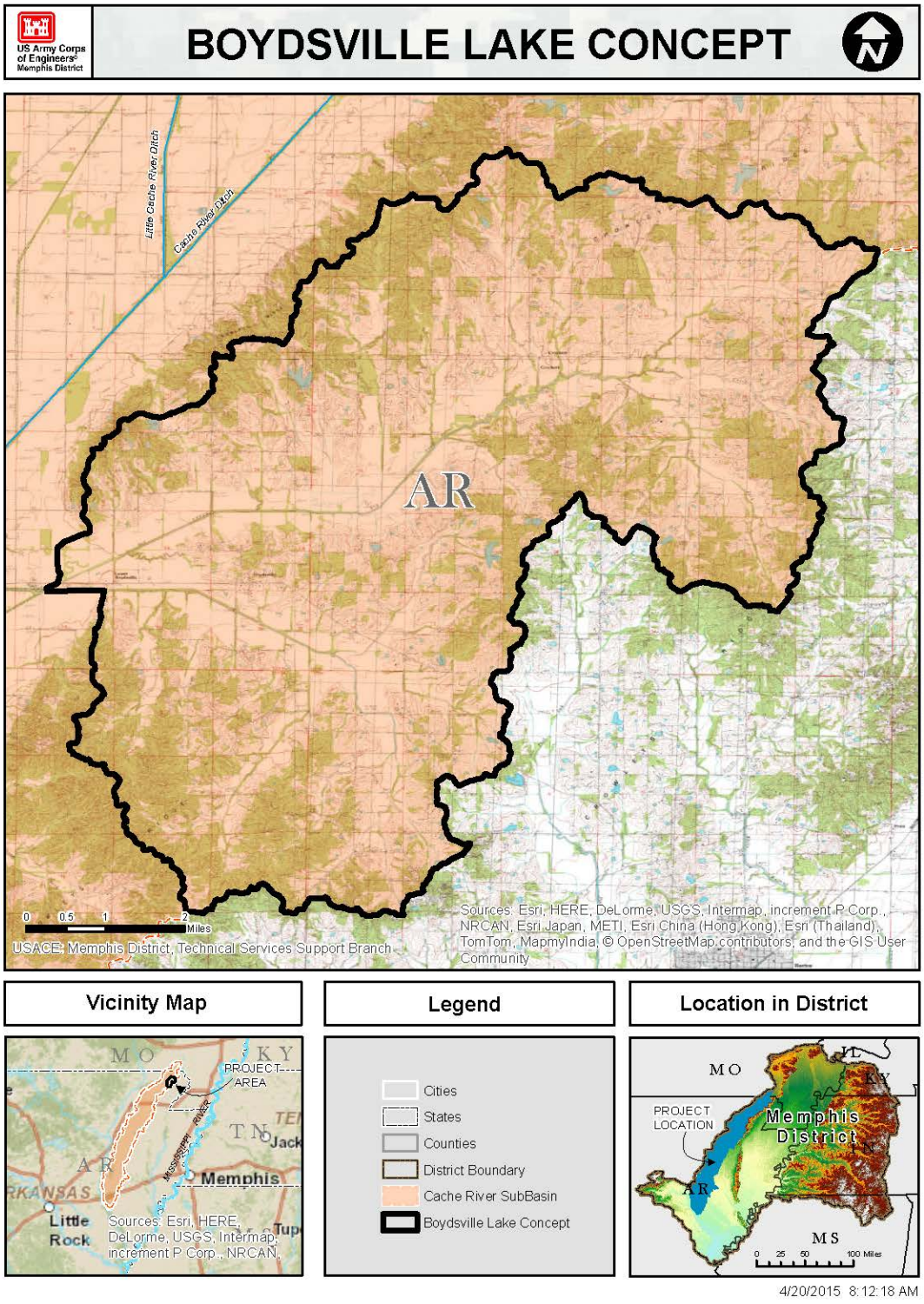


Figure 12. Boydsville sub-basin

Site Visits

Three site visits for the Cache River Watershed Management Plan were conducted in October and November 2014. The county judges hosted the site visits and the Corps, NRCS, drainage district, and local producer/landowners participated.

The first visit was to Clay and Greene counties. Sediment loading in the Cache River from North Big Creek, Ditch Number 10, and other major drainages coming into the Cache from the east and originating on Crowley's Ridge was observed. Sediment loading was not seen from any channel entering the Cache from the west; these tributaries are stable. The sediment in the eastern tributary ditches is predominantly sand, and the President of the Cache River Drainage District of Clay County stated the state highway department will use the sand that has been removed and stockpiled along the top bank of Big Creek for highway maintenance. Other issues observed in the eastern tributary ditches were debris buildup and downstream scour where: (1) a bridge or bridge pilings were not oriented squarely to the direction of flow in the Cache River; (2) there is very little riparian area; (3) a stream is channelized; and (4) a channel has varying top bank widths with most of the available floodplain between the top banks.

The second visit was to Lawrence, Craighead, and Poinsett counties. Sediment was observed coming from the eastern tributaries similar to Clay and Greene counties. At the Lawrence and Craighead county line on Arkansas US Highway 63 just east of Sedgwick, Arkansas, the West Cache River Slough diverts some flow off of the Cache River and roughly parallels the Cache River until it rejoins the Cache River at Kings Highway (AR Highway 91W). Figures 13a and 13b show how the two flows conjoin and that the eastern main stem of the Cache is moving sand downstream, while the western Cache River Slough has a clay bottom. Additional information provided during the public comment period indicates that a short portion of the West Cache River Slough starting at the Cache River downstream to Lawrence County Road 717 serves as a sediment detainment area. This may be due to a series of culverts at that County Road 717 location along that reach. It is reported that this area suffers from frequent out of bank flooding to crop fields.

Figure 13a. Cache River-West Cache River Slough Junction

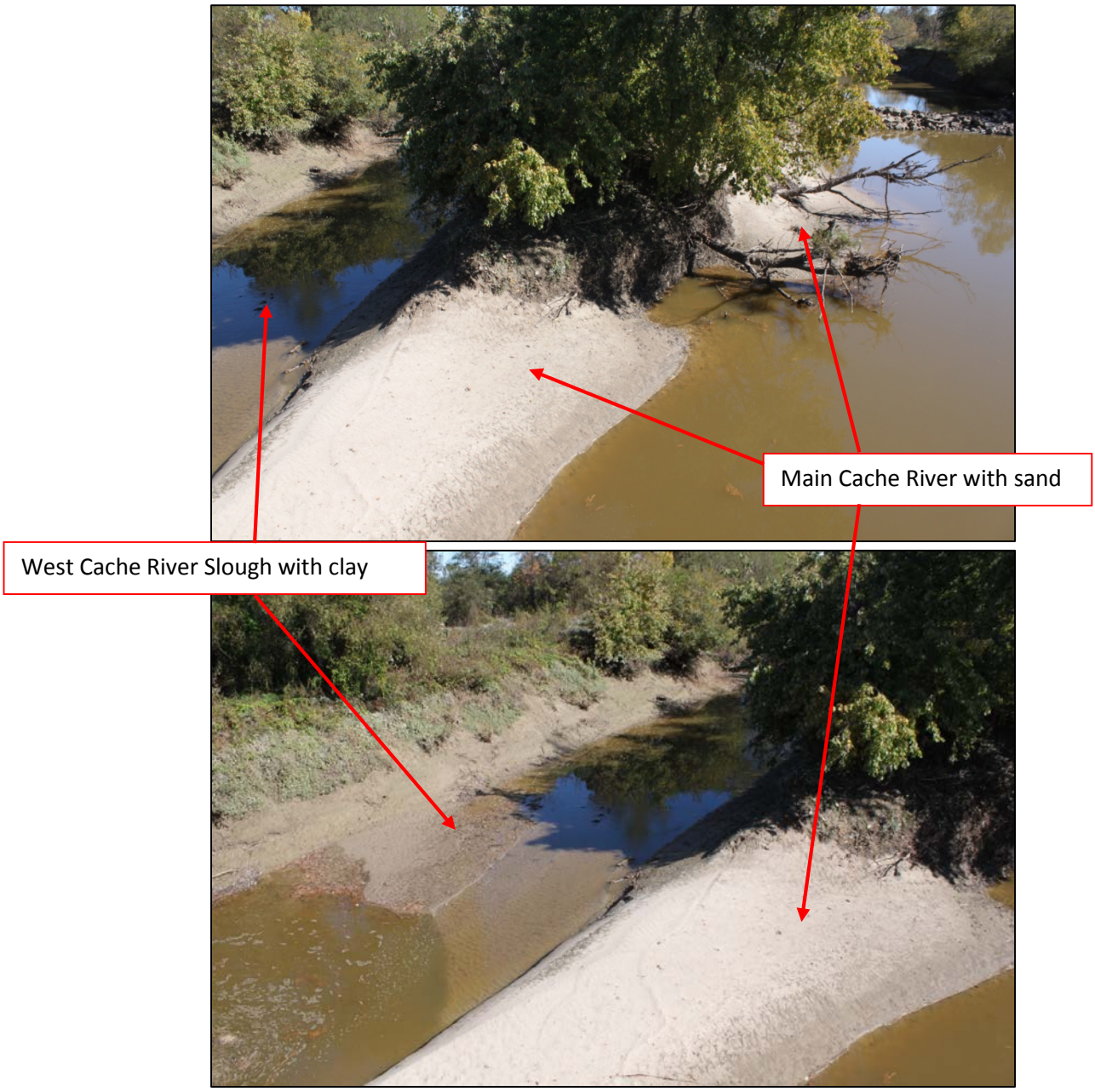


Figure 13b. Confluence of the Cache River and West Cache River Ditch

In Craighead County, several bridges that were constructed with adequate openings now have sand accumulations restricting flow. Craighead County is on the eastern side of the river where Crowley's Ridge is located. Craighead, Greene, and Clay counties had the most visible sediment accumulation. Local drainage interests and highway officials stated that frequent maintenance of these channels was necessary. Several check dam pools and water lift pumps were observed. In Lawrence and Craighead counties, the Cache River had some limited riparian areas.

The last site visit was to Jackson and Woodruff counties. Corps of Engineers personnel and the Jackson and Woodruff County Judges observed the Highway 18 Bridge and the uppermost former blockage of the Cache River south of Grubbs. Figure 14 was taken at the location where the Cache River Non-Profit Association removed the uppermost log jam in 2013. Additional sites visited included several areas that are flooded occasionally, including the town of Amagon in Jackson County and the City of McCrory in Woodruff County. The Mayor of McCrory and the Woodruff County Judge led the McCrory visit and indicated where flood damages are frequent. Additionally, the Woodruff County Judge took Corps representatives on a site visit to an active ditch channelization project immediately northwest of McCrory. This project is intended to divert local drainage around the west side of McCrory and into the Cache River.

Figure 14. Site of Upstream-most Log Jam Removed in 2013 - Sand in Channel Remains

Prairie and Monroe Counties were not visited. Federal or state administered public lands cover much of the Cache River Basin within these two counties.

Problems and Opportunities

The Principles and Requirements (March 2013) and the recently issued Interagency Guidelines (December 2014), collectively called the Principles, Requirements, and Guidelines (PR&G), require federal agencies to consider the following 6 topics in water resource project development:

1. Healthy and Resilient Ecosystems,
2. Sustainable Economic Development,
3. Floodplains,
4. Public Safety,
5. Environmental Justice, and
6. Watershed Approach.

Problems related to all six topics exist in the Cache River basin. Some of these are specific to one location, and others are systemic. Both types of problems are described in this section of the report.

The problems that follow are not limited to Corps of Engineers primary mission areas. They include problems within other federal and state agencies' missions. Also, the recommendations that follow in this watershed management plan are not limited to the Corps of Engineers.

Problems

Groundwater Decline

1. The groundwater withdrawals from the Alluvial Aquifer in the Cache River Basin, at the current rates, are not sustainable.

The USGS and ARNC projections in the Arkansas Water Plan Update indicate there could be catastrophic effects on the economy of the basin and for Arkansas if this is not addressed. The potential reduction in rice production in this basin is nationally significant. This issue is addressed in Recommendation 7.

The greatest impact associated with the depletion of the alluvial aquifer would be restricted to the Cache River Basin and the immediate surrounding area, which is also in agricultural production. Without adequate water supplies, agriculture in the basin may convert to crops less dependent on irrigation. Rice production in the Cache River basin would likely decrease or the increased pumping cost from deeper wells would raise production costs.

A potential alternative could be that as the alluvial aquifer is exhausted, irrigators would begin to use the deeper Sparta aquifer for irrigation, which could impact areas outside the Cache River Basin. This would be problematic for reasons related to agricultural production and other water uses. The cost of pumping water is directly related to the depth from which water must be pumped. Extracting deeper groundwater has a direct effect on the cost of the crop. Additionally, production from the Sparta Aquifer would not be possible at the same rates (in terms of gallons produced per hour) as the Alluvial Aquifer due to aquifer geology and the lack

of recharge capacity. Another alternative would be increased use of water conservation measures as previously discussed in the NRCS program description. Measures are used by some basin farmers, sometimes in conjunction with the NRCS and include tail water recovery and on-farm detention reservoirs. However, the use of these measures is limited.

There is concern that increased levels of extraction from the Sparta Aquifer would not be sustainable. The cities and towns in the Upper Mississippi Embayment nearly exclusively use the Sparta/Memphis Sands aquifers for municipal and industrial water supply. The Sparta aquifer is already recognized as having regional depletion concerns as noted by USGS (USGS, 2004). Estimated extraction from the Sparta aquifer has increased from 106 Mgal/day in 1965 to 265 Mgal/day in 2000. Additionally, modeling (Freeze and Cherry, 1979) indicated that excessive dewatering of the aquifer and overlying confining units can lead to irreversible compaction, reducing the aquifer's water yielding capacity permanently.

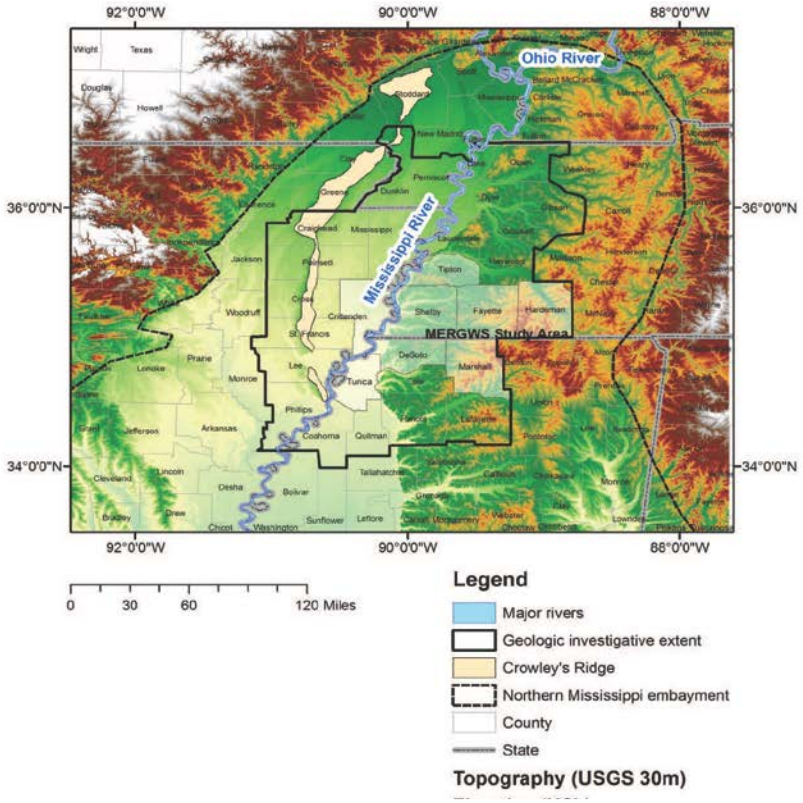
As recommended in the Water Plan, using the alluvial aquifer only to supplement irrigation from surface water, rather than as the primary source of irrigation water is necessary to sustain the aquifer. Managers will have to determine:

- How much excess surface water (either from precipitation runoff or out of the river) during the late winter through spring time could be captured and held until it is needed for irrigation purposes?
- Would this cause any impacts to the in-stream resource users?
- How would users who do not have riparian access or rights to in-stream water be affected?
- Is it possible to use some of the excess water during the springtime to more efficiently recharge the aquifer?
- Is the demand such that water would have to be imported from an adjacent basin to make sustainable groundwater use possible? (The Water Plan provides some estimates of some of these quantities, and preliminary answers indicate water from a new source is likely needed)
- What would farmers in the basin do if no long term solution to the groundwater deficit is implemented?
    - What would be the alternative crop grown or land use?
    - What would this do for the economy of the region and state?
- How would continued depletion of the alluvial and Sparta aquifers affect other water users?

This issue exists for all farmers in the basin who participate in the growing of high water demand crops. The only spatial effect that exists for this issue is the distance individual producers/farmers are to a reliable water source and whether they have the (riparian) right to take that water.

In a related issue, the region's deeper confined aquifer, the Sparta Aquifer is recharged through the Mississippi Embayment zone. This large area covers several states (Figure 15). Included along the embayment's northwestern side is the area to the east of the Ozark Plateau and west of Crowley's Ridge which is the entire Cache River and Bayou DeView basin. The area within the dashed line indicates recharge regions for the Sparta Aquifer. Section 5137 of WRDA 2007 gave the Corps the authority to participate in studies related to address issues concerning managing groundwater as a sustainable resource in Tennessee, Arkansas, and Mississippi, and to coordinate the protection of groundwater supply and groundwater quality of the Embayment with local surface water protection programs. This is an unfunded authority and not a primary Corps mission area. If this situation ever changes and the Corps is directed to perform work on the

Mississippi Embayment for the purposes stated in the WRDA 2007 Section 5137 authority, the Cache River and Bayou DeView areas should be included in the effort.



Upper Mississippi Embayment for the recharge area of the Sparta/Memphis Sands Aquifer

Figure 1. *MERGWS study area (counties in opaque white), geologic investigative boundary and digital elevation model (elevation in feet) of the northern Mississippi embayment.*

2

Figure 15. Upper Mississippi Embayment

Sedimentation and Erosion Processes and Nutrient Loading

2. Sediment loading in the Cache River is excessive resulting in:

- *greatly increased channel maintenance costs,*
- *poor hydraulic performance and channel instability,*
- *increased nutrient loading in the surface water, and*
- *poor aquatic habitat.*

Erosion due to multiple sources (lack of conservation practices, gullies, construction, tree clearing, etc), including active head cutting of stream channels, has increased and is likely the major source of sediment entering the Cache River system (Bingner et al., 2010). The majority of these sediment sources are on the western flank of Crowley's Ridge. The Big Creek watershed in the northeastern portion (Clay County) of the basin has been recognized as a potential high contributor to the sediment loading in the Cache River (Carmen 2008). Site visits in 2014 and inspection of aerial photography (Google Earth, Google Maps, Bing Maps) further illustrate and confirm that land clearing activities and gulley erosion are the source of a large amount of sediment that moves into the Cache River.

Gullies are the major source of sediment coming off the western slopes and the western base of Crowley's Ridge. Bingner (Bingner et al, 2010) estimates through the use of the Agricultural Non-Point Source Pollution Model that nearly 60% of the annual sediment loading in the Cache River comes from only 10% of the area of the basin (Figure 16). These areas lie on the western side of Crowley's Ridge. Figures 17a through 17e illustrate the erosion problems. Several references (Heitmeyer, 2010; Bingner et al., 2010) have noted these types of areas as being likely sources of the sand that migrates into the Cache River from the eastern side of the river.

Resolving this source of sediment in its entirety is a significant challenge. Some positive effects may be achieved by arresting channel incision and providing channel stability on isolated tributaries to the Cache coming off the western flank of Crowley's Ridge. However, treating individual tributaries vice treating the entire system as a whole would reduce but not eliminate the sediment loads into the main stem of the Cache River. The general types of sediment reduction techniques are grade control structures, in-channel or off-channel sediment traps, meander restoration, floodplain restoration (e.g. wetland and BLH riparian restoration and floodplain enlargement), etc. The capability to address individual channels is possible through existing programs that are discussed in the Sources of Information portion of this document, and are captured in Recommendations 3 and 5. However, the comprehensive approach in addressing this issue is discussed in Recommendation 6.

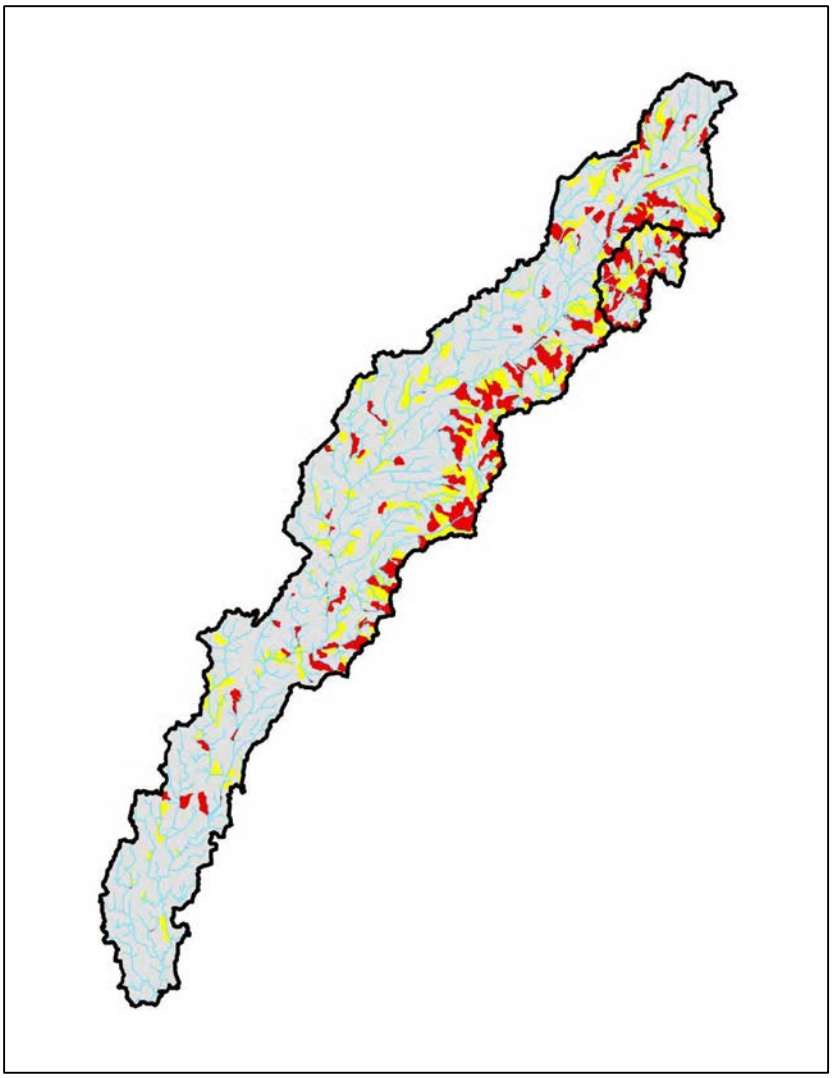


Figure 16: Cache River Watershed top 10% sediment load producing areas (red) and areas that produce sediment higher than the watershed average (yellow) under existing conditions with no gully control

Figure 17a: Typical Gully Sediment Sources: Larger Stream Cut-Bank

Figure 17b: Typical Gully Sediment Sources: Construction Site

Figure 17c: Typical Gully Sediment Sources: Incising Pasture Creek

Figure 17d: Typical Gully Sediment Sources: Farm Pond Outlet

Figure 17e: Typical Gully Sediment Sources: Industrial Source Site (Gravel Mine)

3. Gully erosion and headcutting, cause damages to infrastructure resulting in:

- *advance replacement and repair of public roads and other utilities, and*
- *property loss and damages*

The photographs in figure 18 demonstrate an example of where this has occurred. The bridge shown in Figure 18 is at the western base of Crowley's Ridge where a stream comes off the ridge and enters the flat delta portion of its flow path. Both images are of the same problem site.

Resolving erosion and headcutting throughout the basin is a significant challenge. The most effective demonstrated way to address this issue in these highly erosive soils present in the Mississippi Alluvial Valley is through channel stabilization. Some positive effects may be achieved by addressing channel stability at isolated locations on the Cache River or on tributaries to the Cache. A general approach to arresting channel instability and headcutting is the use of in-channel grade control structures. The capability to address individual problem sites is possible through some existing programs that are discussed in the Sources of Information portion of this document, and are captured in Recommendations 3 and 5. Additionally, local highway departments do address these issues on an as needed basis. However, unless the repair is treated within the context of a hydrologic and hydraulic system, these local fixes typically either do not exhibit sustainability or they tend to move the erosion problem downstream.

Similar to the excessive sediment loading discussed in Problem 2, these isolated responses would improve the situation. However, Recommendation 6 would comprehensively address gully erosion and headcutting.

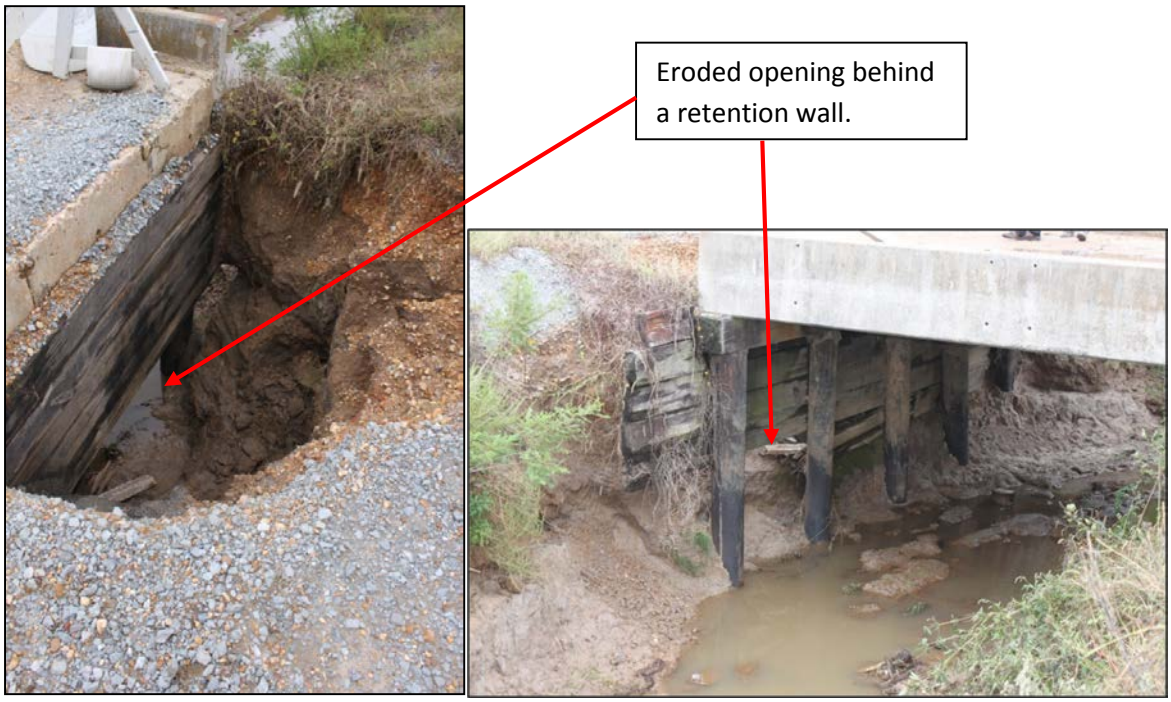


Figure 18: Infrastructure Damage from Channel Erosion

4. Sediment that moves from the upper channelized portion of the Cache River accretes and contributes to debris blockage near Grubbs.

Upstream channelization, land clearing, bank scouring, limited water flow capacity under the Highway 18 bridge, and increased sediment movement downstream caused debris and sediment to accumulate in a six mile long log jam from Cache River mile 123 to 129 where the widened, straightened Cache River channel from the north meets the meandering and narrower channel in the middle portion of the Cache River Basin (Heitmeyer, 2010). As previously discussed, the upper two most blockages were removed in 2013. As observed during the site visit in October 2014 (Figure 19), while the blockage removal certainly helped local and regional drainage through that reach of the Cache, the sediment bed was pronounced and excessive. This reach will require frequent maintenance unless the sediment load is reduced.

Similar to Problem 2, Sediment loading in the Cache River is excessive, resolving this source of sediment in its entirety is a significant challenge. Some positive effects may be achieved by arresting channel incision and providing channel stability on isolated tributaries to the Cache coming off the western flank of Crowley's Ridge. The general techniques used to reduce in-stream sediment loading are grade control structures, in-channel or off-channel sediment traps, meander restoration, floodplain restoration (e.g. wetland and BLH restoration and floodplain enlargement), etc. However, treating individual tributaries vice treating the entire system as a whole would not eliminate the sediment loads into the main stem of the Cache River. Nor would

these isolated treatments resolve the sedimentation issue once the upper channelized portion of the Cache meets the un-channelized portion near Grubbs, Arkansas. These isolated responses could improve the situation at Grubbs. The capability to address individual channels is possible through existing programs that are discussed in the Sources of Information portion of this document, and are captured in Recommendations 3 and 5. However, the comprehensive addressing of this issue, unless the smaller scale actions are universally implemented throughout the upper portion of the basin, is addressed in Recommendation 6.

Figure 19: Cache River Meander Looking Downstream: Site of recently removed debris blockage showing depositional sand area on inside bend of the meander

Habitat Degradation

5. Reduction in Bottomland hardwood habitat and hydrologic connectivity in the flood plain.
(Heitmeyer, 2010)

The Cache River is a designated Wetland of International Importance in this southern end of the basin. Many migratory waterfowl, mussels, Neotropical migratory songbirds, and other species dependant on large expanses of BLH areas rely on this region. Prior to European settlement, the Cache River floodplain was nearly entirely covered with BLH forests. Today, the floodplain is more than 75% cleared of BLH and is in agricultural production (See Figure 7 - Land Use Map). Portions of BLH forests have been reduced in size and segmented. A large portion of the upper part of the basin above highway 18 has essentially no floodplain

(due to loss in hydrologic connectivity) due to channelization and levees, and most BLH have been removed. In the lower part of the basin, much of the historic floodplain retains the BLH and wetland hydrology. However, the conversion from BLH to largely agrarian land use has resulted in a non-contiguous BLH forest.

There are several ways to address a loss in hydrology that has affected the presence and extent of wetlands. Examples of the types of techniques that have been used in this middle portion of the Mississippi River Valley are moist soil management units that collect and retain water, micro-topographic contouring, in-channel bench cuts, levee setbacks, reconnection of isolated or cutoff meanders, vegetative planting in conjunction with hydrologic adjustment, removal of field drains, conversion of land use to more conservation practices (wetland reserve, conservation reserve, and other land use changes), etc. Any of these techniques may be applicable in the Cache River basin. Recommendations 2, 5, and 6 address this problem.

6. Riparian habitat in the basin north of Highway 18 has been largely removed and is essentially non-existent. *(Heitmeyer, 2010)*

Channelization has effectively reduced agricultural flooding. However, channelization has eliminated long stretches of riparian habitat. This upper part of the basin is of limited value for wildlife, fish, mussels and recreation. Through large stretches, the river is disconnected from floodplain by levees rather than entrenchment. Also, historic meanders and the floodplain associated with each meander were also disconnected from the Cache River due to channelization activities.

There are several ways to address a loss in riparian habitat in the upper portion of the Basin in Lawrence, Green, Clay, and, to a lesser extent, Craighead Counties. The goal for this habitat restoration would be to open up some of the historic floodplain which would allow for wetlands, scrub/shrub herbaceous, and BLH habitat. Examples of the types of techniques that have been used in this middle portion of the Mississippi River Valley are moist soil management units that collect and retain water, micro-topographic contouring, in-channel bench cuts, levee setbacks, reconnection of isolated or cutoff meanders, vegetative planting in conjunction with hydrologic adjustment, removal of field drains, conversion of land use to more conservation practices (wetland reserve, conservation reserve, and other land use changes), etc. Any and all of these techniques may be applicable in the Cache River basin.

Previous channelization in the upper end of the basin has left many meanders that are cut off from the Cache River. A technique that may be appropriate there is the reconnection of meanders to the floodplain or the river. This on a small scale would be appropriate for a Continuing Authorities Program Section 206 effort. However, Recommendation 6 would address these problems holistically.

7. Degradation of aquatic habitat in the Cache River. *(Heitmeyer, 2010)*

From the area near Highway 18 in Grubbs downstream to the mouth, excess sediment deposition has degraded aquatic habitat. Sessile organisms have been buried under sediment from the upper portion of the basin. Sediment reduces spawning and rearing habitat for fish. Channelization north of this Highway 18 area has degraded aquatic habitat, reduced substrate heterogeneity, limited riparian shade, and degraded thermal

(high summer water temperatures) and chemical water quality. Another issue with aquatic habitat is a lack of flow or wetted perimeter in the channel. The source of degradation is varied, but the primary cause is sedimentation.

Similar to Problem 2, Sediment loading in the Cache River is excessive, resolving this source of sediment in its entirety is a significant challenge. Some positive effects may be achieved by arresting channel incision and providing channel stability on isolated tributaries to the Cache coming off the western flank of Crowley's Ridge. The potential techniques to address these issues are those listed in problem 2, and in particular the restoration of a vegetated (preferably through BLH) riparian corridor. However, treating individual tributaries vice treating the entire system as a whole would not eliminate the sediment loads into the main stem of the Cache River. Nor would these isolated treatments resolve the sedimentation issue once the upper channelized portion of the Cache reach the un-channelized portion near Grubbs, Arkansas. These isolated responses would improve the situation at Grubbs. The capability to address individual channels is possible through existing programs that are discussed in the Sources of Information portion of this document, and are captured in Recommendations 3 and 5. However, implementation of Recommendation 6 would be needed to identify a comprehensive solution.

Flooding

8. Flooding in the lower portion of the basin reduces agricultural profits and damages roads

Poor drainage frequently impacts field access and the timing of spring planting. Additionally, late season infrequent flooding can affect crop yields and the ability of the farmers to access their fields for harvesting. The extent of these impacts is not well defined. Arkansas Highway 18 to the east of Grubbs is often overtopped. As indicated during the October and November 2014 site visits, floods frequently damage and close numerous other publicly maintained roads.

The topography in the lower Cache River basin is typically flat Mississippi Alluvial Valley delta. Sediment accretion in the local laterals and ditches certainly causes some of the issues. Another significant cause is the backwater effect from the much larger White River and even further downstream the Mississippi River. When those rivers are flooded, Cache River flow is impeded. Without significant hydraulic modeling, it is premature to determine what particular measures would be feasible.

Some possible techniques that may be used to reduce flooding damages are both structural and non-structural in nature. Non-structural techniques could include landscape conservation practices (wetland reserve, conservation reserve, and other land use changes), and conversion to more flood tolerant crops. Structural techniques could include channelization, levees, setback of existing levees with batture floodplain restoration, storm water detention ponds (which could double as irrigation reservoirs), and improved field drainage. A feasibility study of the Cache River would be needed to determine the total economic damages from flooding and the potential for federal investment.

9. Increased flooding in the City of McCrory

Residential areas in McCrory, Arkansas flood frequently. The west side of town receives flow from a Cache River tributary ditch. The town receives overland flow from regional runoff and a small Bayou DeView tributary ditch to the east of town. The town has experienced interior flooding in 2002, 2003, 2008, 2009, 2010, and 2014 (Fowler, 2015).

The town has no underground storm sewer system. All drainage through the town is handled through surface ditches, including ditches through yards. The low elevation of the town makes a piped storm water management system impractical. The town's location between Bayou DeView and the Cache River contributes to the problem. Recently, Woodruff County installed a large diversion channel north of US Highway 64 and west of Arkansas Highway 17 to divert flood waters away from town, to the Cache River northwest of the city. This channel was completed in 2014. There are several smaller culverts to the east of town on US Highway 64 that may be too small to drain regional runoff to the southeast. There is also an inadequate outlet to the surface water drainage from the town to a Bayou DeView tributary slough to the southeast of town (Figure 20). Figure 21 shows recent flooding in McCrory.

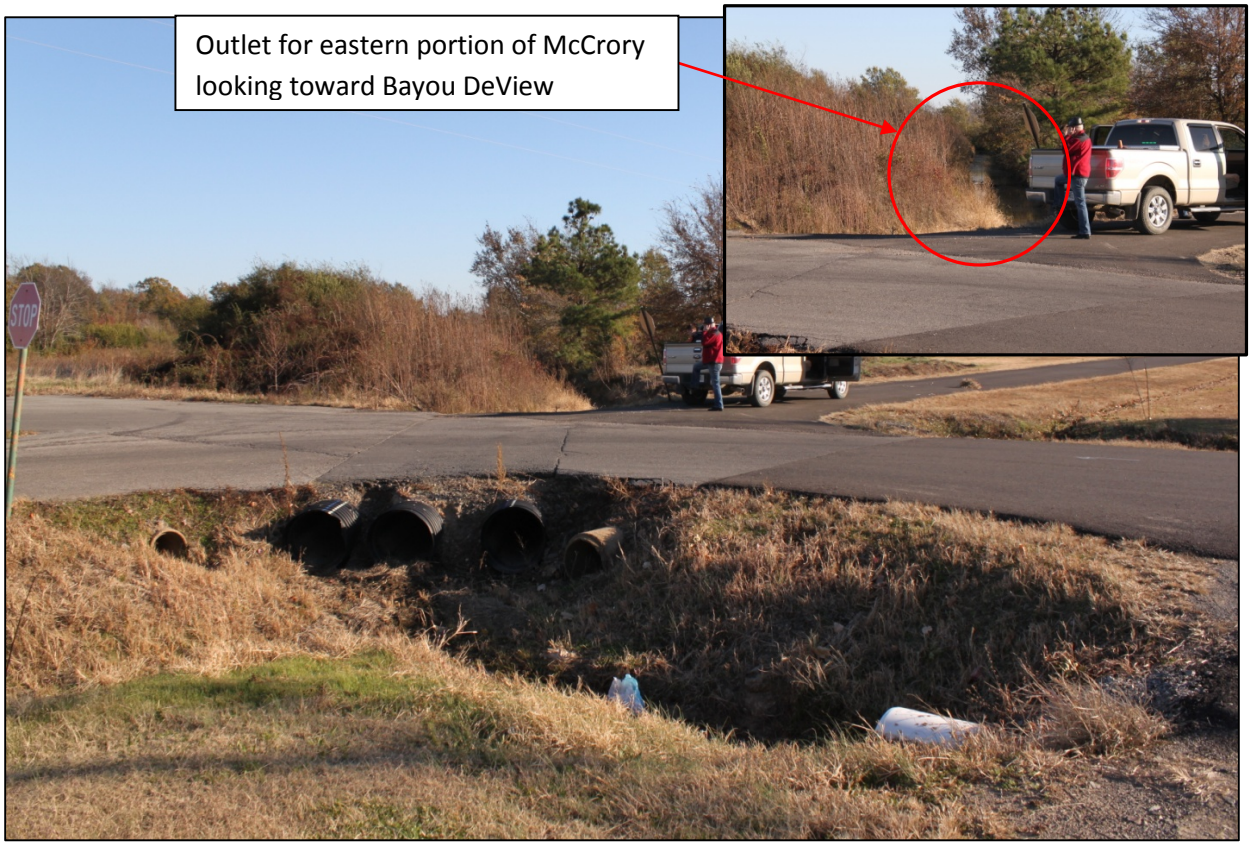


Figure 20. Drainage outlet - Southeast portion of City of McCrory - looking toward Bayou DeView

Flooding in the City of McCrory was stated as an issue by the mayor of McCrory during the Jackson public meeting. When Memphis District personnel toured Jackson and Woodruff Counties, the mayor gave a tour

of the city. The observations above are directly due to what information was provided by the mayor during the development of this water shed management plan. The techniques that may help resolve the flooding issues in McCrory are the same structural and non-structural techniques listed in problem 8 above. The most logical existing authority that any federal agency has to address the flooding issue in the city is the Corps CAP Section 205 project authority. Recommendation 1 addresses this problem.

Figure 21. Southeast portion of City of McCrory Industrial Area Flooding - June 2014

Public Access and Recreation Availability

10. Limited access for recreational land use such as hunting and fishing, particularly in the upper portion of the Cache River basin.

With the exception of Lake Frierson near Jonesboro and Paragould, Crowley's Ridge State Park (near Paragould), Ring Slough WMA (Clay County), Cattail Marsh WMA (Greene County), and W.E. Brewer Scatter Creek WMA (Greene County), there is no public hunting or fishing access in the Cache River basin in Craighead, Clay, Greene, or Lawrence counties. To compensate for adverse environmental impacts associated with federal projects, consideration should be given to the acquisition of mitigation lands that maximize benefits to fish and wildlife resources and outdoor recreation. While not directly a Corps of Engineers mission, ancillary recreation benefits should be considered during project planning. Recreation can

be incorporated in a Corps project but is limited depending on the primary mission and project authority. For example, recreational features for ecosystem restoration cannot exceed ten percent of the total project costs (ER 1105-2-100. Paragraph 3-5.b.(6)). State and local governmental agencies should explore opportunities to provide access to the river and public lands (e.g., roads, piers, boat ramps).

Opportunities

- Provide for reliable water to support the region's agricultural economy for the next 50 years or more
- Remove the source of sediment in the upper portion of the Cache River to:
    - Reduce channel maintenance costs
    - Improve aquatic habitat in all downstream reaches of the Cache River
    - Provide smaller watershed lake style impoundments that could provide limited recreational opportunity on the western side of Crowley's Ridge
- Provide a more stable Cache River channel which would:
    - Reduce frequent flooding of agricultural lands, roads, and structures
    - Attenuate the downstream peak flow
    - Provide some in stream micro-habitat
- Provide improved riparian habitat
- Provide more connectivity in riparian habitat
- Provide improved main channel aquatic habitat
- Improve aquatic habitat by restoring low flows in some meanders in the middle and upper basin
- Improve quality of recreation and provide increased recreation opportunity

Recommendations

Recommendations[15] are for short term specific actions or management options, and a feasibility study for a long-term systematic water resources solution for the basin. Depending on the potential for a future federal feasibility study, some short term recommendations may or may not be warranted. Management options using valuable existing tools like the federal and state conservation programs would improve many aspects of the basins resources, e.g., improved habitat, improved water quality, and reduced channel maintenance resulting from erosion control. Potential recommendations to solve the water resource problems in the watershed were developed and evaluated based on effectiveness, engineering feasibility, and sustainability. The strategy employed by the team in the development of these recommendations was to first examine each agency's existing programs and authorities. If a program or authority exists that would address one of the identified problems in the basin, it was recommended for consideration. These programs and authorities are generally addressed under the short term recommendations numbered 1 through 5. A study was recommended if a problem was not well defined or exceeded existing authority. These studies are generally addressed under the long term recommendations numbered 6 and 7. This approach follows the EC 1105-2-411 guidance to collaboratively address watershed problems.

Short Term

There are specific instances where the potential to use existing authorities should be examined, and if a potentially feasible project exists, the necessary decision document to support a federal project should be developed. These efforts would require a non-federal sponsor to support the project study and construction. Additionally, there are several other instances where these authorities may be applicable and should be pursued if a larger encompassing federal feasibility study effort is not undertaken for the entire basin. There are also existing conservation programs that receive some federal funding and tend to be 'cost-share' programs that have been and should continue to be utilized in the basin. There is one federal Clean Water Act derived program that ANRC is pursuing that would have tremendous potential in the basin.

1. Investigate the potential to implement a small flood study for the City of McCrory and surrounding area.

The City of McCrory has an issue with flooding (See Figure 21). CAP Section 205 grants the Corps of Engineers authority to study and implement small-scale flood risk management projects if justified. A non-federal sponsor would need to request the Corps of Engineers for assistance to evaluate the problem. The Corps of Engineers could determine if there is a federal interest in a Section 205 project at this location. If an eligible sponsor exists and a feasible Section 205 project can be identified, this could provide some relief to the resident's in this small city. The limit for the federal funding for a Section 205 study and project is $10

[15] The recommendations, be they short term or long term, are numbered sequentially for reference purposes. This does not indicate any priority, but rather is merely a system to clarify what recommendations are addressed in differing forums.

million. With cost sharing from the non-federal sponsor, the project costs can be higher. A potential alternative would be for an upstream diversion on the eastern side of the city with some minor interior improvements. The potential CAP 205 project for McCrory would likely be less than this amount, but this limit amount is used for the purpose of this Watershed Assessment.

2. Investigate the potential to implement additional smaller scale ecosystem restoration.

There is opportunity for ecosystem restoration up and down the Cache River basin along the main stem of the Cache River and Bayou DeView. This would best be addressed by a comprehensive, basin-wide feasibility approach undertaken by multiple federal, state, and local agencies. In the absence of this, there exist approximately 25-30 historic meanders that have been cut-off by non-federal local drainage improvements along the Cache River between the blockage at Grubbs and McDougal Arkansas. Since the National Wildlife Refuge acquisition boundary ends near Grubbs, this northern portion of the basin has the potential for smaller scale restoration projects. Figure 22 illustrates some of these meanders. These potential projects would build on the success of the Lower Cache River Section 1135 restoration of two meanders to enhance connectivity and sustainability of the regions ecosystem resources from the diverse southern portion to the basin to the highly degraded northern part of the basin.

Any such meander restoration projects could be designed and implemented such that they would provide overall channel stabilization and could serve to reduce channel maintenance requirements in addition to providing localized in-channel and side-channel habitat. These meanders are generally so widely spaced that the restoration of a single meander, or a small group of meanders that are co-located as in Figure 22 would be possible and provide benefit regardless of if the remaining meanders were restored.

Absent a larger comprehensive study and basin authorization, the restoration of these meanders could be accomplished under the Corps of Engineers' CAP Section 206 authority or by others under their programs. The Corps of Engineers CAP Section 206 authority is similar to CAP Section 1135. The difference in Section 206 and Section 1135 is that the degradation in aquatic habitat addressed in Section 1135 projects was caused by a prior Corps of Engineers project while in Section 206 there was no degradation due to a Corps of Engineers project. The cost share difference between the two authorities is 75%/25% (federal/non-federal sponsor) for Section 1135 and 65%/35% (federal/non-federal sponsor) for Section 206. Only the portions of the Cache that were above the upstream extent of the 1970's authorized flood risk project (above Grubbs/Highway 18, AR) would be eligible for the CAP 206 program.

Figure 22: Potential Restoration Sites: Cache River Cut-off Meanders Resulting from Local Flood Control Projects

For estimate purposes, it is assumed that each of Clay, Greene, Lawrence, and Craighead County might have potential locations for several Section 206 projects were sponsors to step up for the effort. This is possible under this Section 206 authority since the benefits accrued from the restoration of either individual or smaller meander groups does not rely on restoring the remaining meanders, the meanders are geographically spaced well apart from each other, the potential restoration projects do not geographically overlap, and differing meanders could be championed by different sponsors. The recently completed lower Cache River Section 1135 project cost was approximately $7 million for the restoration of two meanders, or $3.5 million each meander. These meanders in the lower portion of the river are much larger than any in the northern portion of the river. It is reasonable to assume meanders in the northern portion of the basin may range from $1 to $3 million per meander to restore, including study costs for each particular project. Assuming three meanders restored per project and one project in each county that is about $6-9 million in each county or about $30 million in total potential restoration in the upper portion of the basin. Depending on which parties stepped forward to sponsor particular projects, this approach might take a long period or might never result in complete restoration at all the potential locations for meander restoration. These estimates would be addressing restoration under separate Section 206 projects with different sponsors. This would be more efficiently addressed under a comprehensive basin wide study.

3. Various local entities should collaborate with Arkansas Natural Resources Commission and/or Natural Resource Conservation Service to implement local measures to control erosion in the basin

Various local entities such as drainage districts, counties, the Cache River Non-Profit Association, or conservation districts, alone or in concert, should consider potential erosion control measures for gullies along the western slope of Crowley's Ridge. See Figures 17a-e for typical potential sediment source areas arising from gullies. Based upon general modeling performed (Bingner, Wilcox, and Gaines, 2010), gully stabilization could have a more significant effect on in-stream sediment loading than on-farm conservation practices. These conservation practices or best management practices are still worthwhile and will continue to have a positive effect on the sediment loading to the river, but absent gully control they will likely not significantly reduce the maintenances costs to the local drainage districts.

Gully stabilization could reduce the required maintenance, improve water quality, and improve aquatic habitat in ditches such as Big Creek and Ditch Number 10 coming into the Cache River from Crowley's Ridge. Conservation measures that would provide the greatest reduction in offsite sediment transport would depend on the nature and geography at each gully site. NRCS County Conservationist and County Conservation District personnel would be a valuable source of advice on what particular measures might work at individual sites. The particular cost for implementation of conservation measures under these cost shared programs varies greatly with the particular type and scale of measure implemented.

A larger study to include an overall sediment balance on the upper Cache River basin would be needed to reliably estimate the possible reduction in sediment loading to the Cache River, and also estimate the effect on the reduction of channel maintenance. However, even without a larger study, any reduction would be beneficial to the local drainage districts, improve the overall quality of the Cache River, and reduce sediment loading further downstream at points of constriction such as near Grubbs.

Clean Water Act Section 319 Non-Point Source Pollution Program: ANRC intends pursuing the development of the nine-element watershed management plan and filing an application under the CWA Section 319 program. This will allow the state to apply for federal funds to implement control measures that could help reduce the sediment loading in the Cache River for a myriad of benefits previously cited.

There may be potential in the future through the ANRC Section 319 nine-element watershed management plan for some cost share for these types of measures. However, control of the sediment sources may be worth pursuing regardless of any additional incentives for the drainage districts. Measures could be as simple as silt fencing or establishing vegetated buffers around significant sand sources, or extend to construction of sediment traps along the drains leaving the site, or revegetation of the entire site. All agreements with landowners would have to be executed with the local entity desiring the sediment control.

Regional Conservation Partnership Program: The RCPP requires a local sponsor to prepare a proposal for a regional conservation approach within the NRCS administered program. If approved, this regional sponsor performs outreach activities, including informing local landowners within the proposal area about the different NRCS conservation cost share programs available to landowners. The benefit of the program would be a higher priority in federal funding under conservation programs. As discussed previously, several groups have already taken this approach in the middle and lower Cache River Basin, like Jackson County for the 2012 CCPI effort. Several entities exist, such as drainage districts, county conservation districts, counties,

or the Cache River Non-Profit Association that could lead or assist in such a local sponsorship role. Such sponsorship could be undertaken collaboratively. Landowners interested in installing conservation measures on their lands in portions of the Cache River upstream of Jackson County (Craighead, Lawrence, Greene, and Clay) would benefit from the establishment of a RCPP. While many landowners in this portion of the basin have executed contracts with NRCS for features such as on-farm detention reservoirs and tail-water recovery systems, an approved RCPP would increase the likelihood of federal funding for conservation efforts.

The NRCS has constructed several watershed lakes in the basin. These lakes range in size from a few acres to a hundred or more acres. Several of these are on the western wide of Crowley's Ridge and were constructed under Public Law 566 authority. Additional lakes could be constructed under the RCPP or EQUIP programs if landowners were interested. These watershed lakes provide multiple benefits to several different stakeholders. The control structure of the lake serves to provide channel stabilization to arrest head cutting and downstream sediment transport, as well as a sediment trap for sediment coming into the impoundment. The impoundments can serve as a source of late summer instream water for downstream use, including aquatic habitat and irrigation. The impoundment can also serve as a local source for recreation.

4. Investigate the potential to implement Phase 2 of the Lower Cache River Meander Restoration.

In the lower Cache River, four meanders remain to be restored, and there is a desire by AGFC, ANHC, USFWS, and several non-governmental groups like The Nature Conservancy and others to complete the restoration of these meanders. Of these four meanders, the lower three could be restored in a similar manner to how two of the three upper meanders were restored under a Continuing Authorities Section 1135 project. This would be by removal of the upstream plug and placement of a low water weir to direct low flows back into the historic river course.

The Corps of Engineers has evaluated its capability to perform this work under Section 1135 authority. Based on the cost for the two meanders already restored, the cost for the remaining meanders would be about $6-8 million.

5. Resource Agencies should continue to implement their existing conservation and restoration programs.

The NRCS, the EPA and the USFWS have conservation or restoration missions that have applicability in the basin. Recommendation #3 above refers to the CWA Section 319 water quality program administered by EPA and the various conservation programs of the NRCS. The Cache River NWR contains about 70,000 acres and has an acquisition boundary of 287,000 acres in Cross, Jackson, Monroe, Poinsette, Prairie, and Woodruff Counties AR. Under the comprehensive conservation plan for the Central Arkansas National Wildlife Refuge Complex, the USFWS actively pursues conservation, management, and restoration of forest, moist soil, scrub-shrub, grassland, and aquatic habitats for increased benefit for fish and wildlife. Additionally, the refuges seek to provide the public with greater opportunities for compatible, wildlife-dependent recreational use, including providing better facilities (including roads, ATV trails, boat ramps, visitor contact stations, observation decks, fishing piers, hiking trails, boardwalks, and photo blinds to allow improved access

and public education programs. The USFWS continues to strategically conserve habitat by acquiring additional lands for the refuge - from willing sellers only - and as acquisition funding becomes available

The cost for continuation of existing programs and efforts is within each agencies budgetary process. Costs for these efforts will not be estimated separately.

Long Term

Basin-wide studies are recommended. The cornerstone of current federal water resource policy is developing comprehensive watershed solutions that address multiple issues. Different agencies could lead or be involved in the studies, depending on their respective missions. However, federal agencies would require authorization[16] and appropriations from Congress to pursue these recommendations.

The first study should address issues such as flooding and sedimentation, as well as opportunities for habitat restoration throughout the basin. This would be a Corps of Engineers led effort. The other feasibility study should address nutrient management, water supply within the basin, and remaining sediment and erosion control issues. A lead agency for that effort would need to be identified.

Together, these studies should evaluate not only the different features of the basin from the headwaters of the Cache to its confluence with the White River, but should also determine how actions in one part of the basin affect features and users in other parts of the basin. The studies should have a period of analysis not less than 50 years in order to provide for the sustainability of the basin for future users.

The long term recommendations to address the issues facing the Cache River basin cannot be accomplished by any individual agency or group alone. The problems range from basin wide, such as long term water supply, to upper-, middle-, and lower-basin specific issues. No stand-alone solution in one location is likely to resolve a problem without moving the problem to another portion of the basin. Collaboration and participation amongst various federal, state, and local agencies to leverage knowledge, experience, and resources are necessary.

An additional recommendation regarding the larger White River Basin is stated in the Conclusion section of this report.

6. A Corps of Engineers basin-wide feasibility study[17] is needed:

The study would be designed to address these issues:

- habitat and flood plain restoration,

[16] Several agencies have standing authorizations to do tasks like those discussed in recommendations #3, 4, and 5 above.
[17] While general study authority exists from House Document 308, 88th Congress and the Eastern Arkansas Comprehensive study authority, specific clarification to address Cache River problems could assist this effort, and appropriations would be required.

        - erosion control and sediment and nutrient reduction to the extent these stressors impact habitat and could support habitat restoration,
    - flooding,
    - other needs such as recreation within the basin.

Study Tasks would include:

- *Establishing the scope, schedule and deliverables of the feasibility study effort in collaboration with study partners,*
- *Ensuring a watershed systems approach is the cornerstone of the feasibility study,*
- *Performing hydrologic, hydraulic, and sediment modeling (including establishing a water budget and sediment budget),*
- *Identifying the potential for habitat restoration in collaboration with the interagency resource team,*
- *Identifying and assessing in-channel, side-channel, and flood plain flow/use modifications to:*
    - *Reduce the source of sediment and other source of habitat degradation,*
    - *reduce flood risk,*
    - *reduce channel maintenance,*
    - *and improve in-channel, slough, oxbow, riparian, and floodplain habitat,*
        - *reduce erosion, sedimentation, and nutrient loading to support aquatic habitat restoration,*
- *Ensuring that the effects on other reaches or portions of the basin from any measures are fully considered,*
- *Determine the economic feasibility for a federal investment recommendation, and*
- *Ensuring compliance with the National Environmental Policy Act and other pertinent environmental laws.*

The Corps of Engineers has the federal role of the nation's water resource development agency. Expertise in civil engineering, particularly hydrology and hydraulic engineering, help the Corps of Engineers perform this role. The Corps would lead a feasibility study in those areas that are a primary mission, including flood risk management and ecosystem restoration. While sediment and erosion control are not traditional Corps of Engineer's primary mission areas, these issues would need to be addressed since sediment loading is a significant contributor to aquatic habitat degradation.

The Corps of Engineers should perform surface water hydrology and hydraulic analyses. This would include the collection of necessary data and the building and use of basin wide hydrologic and hydraulic models. It is important to note that much of these data exist. Such analyses should be flexible enough to determine the effects of individual and cumulative changes to the overall system. An example of such changes would be if modification to certain reaches of the Cache River in the basin cause impacts to other reaches.

In some reaches, especially in the upper portion of the basin where channel maintenance causes high costs to the drainage districts, the potential for a more sustainable channel cross section that could move sediment along in a more efficient manner should be considered. This could also lead to some limited habitat restoration in areas where channelization has essentially eliminated in-stream and riparian habitat. The Corps would coordinate with an interagency team to identify opportunities for ecosystem restoration to improve instream or floodplain habitat.

The Corps of Engineers should also perform the necessary economic, social, and environmental analyses with input from other members of the interagency study team. There may be some regional erosion control features, such as those developed for the Mississippi Delta Headwaters Project (Shields, et Al. 1995) study that would be appropriate for the Corps of Engineers to implement if those measures provided ecosystem restoration benefits.

The Corps of Engineers would be responsible for considering how measures and improvement in some portions of the basin would affect other portions of the basin. For example, actions in the middle portion of the basin should not induce flooding in the upper or lower portion of the basin. This consideration could include analyses for sediment and debris build-up if such buildup lessens the flow carrying capacity from the flood risk management perspective. The Corps may need to coordinate with NRCS or ARS, and in particular the Watershed Physical Processes Research Unit in Oxford, Mississippi for this analysis. This would include any effects on sedimentation issues from opening up floodplain, two-stage channels, and differing buffering and stream bank conditions.

Under the new Corps water resources paradigm, the study would be limited in cost and production time to $3 million and 3 years. This requirement was placed into law by the Water Resources Reform and Development Act of 2014, Section 1001 and is commonly referred to as 3x3x3. It is expected such a comprehensive study would take approximately this period and funding for the total study costs. If during the scoping of the study with the study partners it is determined that this would not be sufficient, an appropriate waiver would be sought. If study authority is provided in a manner that allows for addressing smaller sub-basins through feasibility study, each of those efforts would require 3x3x3 compliance.

The Corps of Engineers would work closely with the interagency team and public to ensure compliance with the National Environmental Policy Act. The primary members of the interagency team and their support roles are as follows:

U.S. Fish and Wildlife Service- USFWS could participate in the feasibility study by:

- *Working with the Study Lead to scope the ecosystem restoration strategies portion of the feasibility study,*
- *Identifying areas for conservation management,*
- *Assist in performing restoration benefit calculations,*
- *Assist in performing impact analyses for any non-restoration project measures,*
- *Performing the agency's Coordination Act and Threatened and Endangered Species Act responsibilities, and*
- *Participating in any public meetings*

The USFWS through its Central Arkansas NWR Complex would participate with the other study partners to identify areas within the approved acquisition boundary where measures consistent with their mission might be of benefit. This mission includes conservation management of forest, moist soil, scrub-shrub, grassland, and aquatic habitats for increased benefit to wildlife and providing greater opportunity for wildlife-dependent recreational use for the public. Needs and opportunities associated with facilities (including roads, ATV trails, boat ramps, visitor contact stations, observation decks, fishing piers, hiking trails, boardwalks, and photo blinds), access, and public education programs should be identified by USFWS. The Refuge Complex personnel may participate by setting up field trips to particular sites, identifying sites that may provide

enhanced habitat value or that might lie in areas where connectivity of habitat is needed, attending meetings and reviewing documents.

The USFWS Ecological Service Field Office would execute its responsibilities under the Endangered Species Act and the Fish and Wildlife Coordination Act. This office would also work with the other study partners to identify ecosystem restoration opportunities, such as those associated with oxbows, low spots, sloughs, or meanders where some in channel or side channel habitat restoration might be appropriate. This office would work with the resource team to determine the appropriate habitat values (scarcity, connectivity, hydrological and geomorphic characteristics, endangered species habitat, etc) that would drive priority areas for habitat restoration. Also, this office would work with the team to consider the habitat impacts from any non-restoration measures and work to minimize those to reduce potential mitigation requirements.

Arkansas Natural Heritage Commission could participate in the feasibility study by:

- *Assisting the interagency team in formulating ecosystem restoration opportunities,*
- *Assisting the interagency team in identifying measures to avoid and minimize adverse impacts to environmental resources, and*
- *Assisting in impacts analyses for non-ecosystem restoration plan features.*

ANHC would help formulate ecosystem restoration opportunities. Additionally, the ANHC would assist in impacts analyses for flood risk management plan features. ANHC brings to the team a wealth of knowledge and experience associated with natural ecosystems and rare and sensitive species.

Arkansas Game and Fish Commission could participate in the feasibility study by:

- *Working with the Study Lead to scope the ecosystem restoration strategies portion of the feasibility study,*
- *Identifying areas for potential conservation management and inclusion in the State's Wildlife Management Area system,*
- *Proposing and evaluating physical measures that would enhance habitat quality or quantity,*
- *Assist in performing restoration benefit calculations,*
- *Assist in performing impact analyses for any flood risk measures,*
- *Performing the agency's Coordination Act responsibilities in conjunction with the USFWS,*
- *Identifying areas for increased public access and recreational opportunities, and*
- *Participating in public meetings*

The AGFC role in the conduct of a comprehensive basin-wide feasibility study would be similar to the USFWS participation with a couple of important distinctions.

Similar to the USFWS refuge role, the AGFC would be responsible for identifying opportunities to enhance conservation of the State's wildlife and aquatic species resources within the WMA's. The WMA system includes areas much further north in the basin than the approved federal Cache River NWR acquisition boundary, and contains a significant footprint in the Bayou DeView portion of the basin as well. This is the first distinction between the AGFC roles and the USFWS - the AGFC is not restricted by an acquisition boundary within which it can take on the role of operating and managing an area for public use and wildlife

habitat. The agency already operates these areas: Black Swamp, Cattail Marsh, Ring Slough, Frierson, Scatter Creek, and Bayou DeView WMA's, and Benson Creek Natural Area/WMA. These areas, except for Black Swamp (ANRC) and Benson creek (ANHC), all fall outside the Cache River approved acquisition boundary. The USFWS is not seeking opportunity to acquire these areas.

The second distinction is a stronger focus on public access by AGFC due to its role in managing the state's wildlife and fishery resources for the recreational hunting and fishing use by the public. AGFC would also provide advice regarding impact analyses and formulation of ecosystem restoration plans.

The AGFC Private Lands Biologists can identify opportunities to enhance conservation of the wildlife and aquatic species within the watershed by providing technical wildlife assistance to private landowners. These biologists can have an influence on soil and water practices implemented on landowners property in which they assist, further improving water quality within the watershed.

The Nature Conservancy could participate in the feasibility study by:

- *Identifying areas for potential conservation management for ecosystem restoration under the federal recommended plan,*
- *Providing experience, expertise, and information regarding stream sediment management.*

The Nature Conservancy is a cost share sponsor of the White River Basin Comprehensive Study, and has participated in watershed planning for the Cache River and Lower White River basins for many years. The non-profit organization has led several efforts to procure lands and implement conservation measures along with state and federal partners during this involvement. With its unique role as a non-governmental entity, TNC can continue to serve a role in the region identifying individual areas and landowners that may be candidates for conservation measures. TNC can also acquire lands for conservation. There have been instances where this capability has been necessary in order to conserve areas that tied together or connected larger habitat tracts for a multiplied effect. It is expected that this role would be necessary with the implementation of any basin-wide conservation framework.

7. A basin-wide feasibility study is needed:

The study would be designed to address this issue:

- groundwater and surface water conservation and water supply

In order to determine the specifics of any long-term sustainable solution for the management and use of the water resources of the Cache River basin, an encompassing effort to fully define the resources, the resource needs, resource stressors, and the natural setting (geologic, stream morphology, agricultural, wildlife and aquatic habitat, etc.) is needed. However, it is undetermined what agency is appropriate to lead this effort as it applies to nutrient management, future reliable water supply and water security. Aspects that would be within the purview of different agencies, such as water quality with the EPA need to be led by those agencies. While the Bureau of Reclamation supplies water to western states, there is no clear agency with the primary mission for water supply and water security in the eastern portion of the nation.

Many resources are fairly well known, such as agricultural production per acre and how that relates to irrigation. Other aspects are not as well quantified or defined. For example, controlling erosion along the western slope of Crowley's Ridge would certainly reduce the required channel maintenance activities by the local drainage districts and would improve the water quality due to reduced nutrient loading. However, the amount of sediment control needed and the economic feasibility of implementing sediment control measures will not be known until specific land-use/land-cover and stream data are collected and subsequent modeling is performed. Likewise, the habitat improvement that would be possible with nutrient reduction would need to be determined.

Benefits to the alluvial aquifer by detaining surface water during times of excess should be determined. On-farm surface water detention reservoirs certainly reduce the individual's farmer's reliance on groundwater for irrigation purposes. Without a watershed-wide annualized water budget performed over a period of record analysis, the potential reduction in groundwater usage cannot be determined. A water budget is also needed to ascertain if importing water from an adjacent watershed would be necessary to reduce the groundwater demand and conserve the aquifer. Without a water budget, it cannot be surmised if individual producers would make a cropping practice change to less water dependent crops, or if a large-scale irrigation water delivery project is justified. It is also unknown if increased detention of surface water for irrigation is a threat to the in-stream aquatic biota.

As with sediment and nutrient control, economic and environmental impact analyses would be needed to make a federal investment decision if the potential lead agency of this second feasibility study were federal. Data collection and modeling would be required to support and analyze and develop informed conclusions.

Federal, state, and local agencies would need to collaborate to perform this study. Each agency should participate in the aspects of the study that represent its respective mission area. Appendix B provides a brief summary of the agencies and types of tasks within the study they would likely perform.

Recommendation Value to Nation Table

Recommendation	Lead	Coordinating Agency	Potential Benefits/ Value to the Nation	Costs
1 Flood study - McCrory	Corps	Woodruff County or McCrory	Flood Risk Reduction for the City of McCrory	Study - likely <$300,000, Projects fed limit = $10 million
2 Small ecosystem restoration	Corps w/ local sponsor	USFWS/AGFC	Restoration of some in-stream and adjacent meander habitat, possibly some channel stabilization benefits and reduced channel maintenance costs.	Study - likely <$200,000 $6-9 million per project, up to four projects across 4 counties
3 Local conservation for erosion control/nutrient reduction	Local Sponsoring Group (i.e., Conservation District)	NRCS or ANRC	Conservation of soil and water resources, reduced sediment and nutrient loading in river, reduced maintenance costs, some habitat improvements on a slightly larger scale than on-going programs.	Highly variable
4 Lower Cache River Phase II Meander Restoration	Undetermined	Possibly non-governmental interest groups	Restoration of in-channel aquatic habitat in the lower end of the Cache River near Clarendon.	$7-9 million
5 Continued conservation program management	NRCS and ANRC		Conservation of soil and water resources, reduced sediment and nutrient loading in river, reduced maintenance costs, some habitat improvements	Within normal budgetary processes
6 Federal (Corps of Engineers) comprehensive feasibility study - Flood Risk and Ecosystem	Corps	Various federal, state, and local agencies	Comprehensive outcome to achieve the future vision of the basin - flood risk reduction in a partially restored BLH system of international significance.	Study - $3 million
7 Comprehensive feasibility study- Water Supply, Sediment and Erosion Control, and Nutrient Management	Undefined	Various federal, state, and local agencies	Comprehensive outcome to achieve the future vision of the basin - sustainable agricultural production within a sustainable and reliable basin landscape - including stable channels and land treatments.	Study - Unknown

Conclusion

The Cache River basin in eastern Arkansas is a basin that is important not only to its residents and Arkansas, but also the nation and international conservation community. Two features of the basin give rise to the national and global significance. The basin is one of the leading, and quite possibly the leading rice producing basin in the United States. The southern end of the basin is also recognized as a wetland of international importance. It is a major stop-over point in the Mississippi flyway for migratory waterfowl. The lower Cache River basin and lower White River basin are home to the largest remaining contiguous expanse of BLH in the United States north of the Atchafalaya Basin in southern Louisiana.

The basin has significant challenges to its economic, social, and ecologic future. Factors that affect this future are diverse and interrelated. Actions have taken place in portions of the basin that, while improving the water resource for some users, has impacted it for others.

Some short term actions would help individual aspects of the basin's water resources. The most important of these is to control the highest priority sediment and nutrient sources to the east of the Cache River in the upper portion of the basin. Additionally, there exist several potential Continuing Authorities Program projects in the basin.

A pair of comprehensive efforts undertaken by a team of federal, state, local, and non-governmental agencies is needed to examine multiple issues and determine a future state where the water resource use and conditions in the basin best serve the needs of all. Within the Corps mission areas, it could lead a study to address flooding and ecosystem restoration, and to whatever extent sediment disposition degrades habitat - sediment and erosion control. This could be done under a Corps of Engineers feasibility study effort. In a second comprehensive effort, the agricultural economy of the basin must be protected, and that means the reliability of the future water supply. The channels and waterways of the basin must be stabilized and floodplain reconnected to the river to ensure long term sustainability and minimization of maintenance costs. This also means stabilizing the landscape from non-point source pollution sources that load the river with sediment. The opportunity exists through these separate comprehensive efforts for managing this river basin system while restoring some of the basin's rich ecological history and providing more recreational opportunity in terms of quality and quantity.

To realize the future vision, the interagency team must work together with adequate resources and in full cooperation and collaboration to determine the nuances of a plan forward. This future vision is to:

Maintain and enhance the globally significant Cache River BLH ecosystem within a sustainable agriculture-based landscape to balance ecological, economic and social interests.

The Cache River is a tributary sub-basin of the White River Basin. This Cache Watershed Management Plan identifies the issues and provides recommendations for the sound management of water resources in the sub-basin. Similarly, the expectation of the larger White River Basin Comprehensive Study is to identify the problems, needs, and opportunities of the water resources in the 27.7 thousand square mile watershed; make

general recommendations for the management of the resource; and identify what organization or agency would lead the effort to address each of those issues. In this manner, this would be a comprehensive, collaborative watershed management plan for the entire White River Basin. It would establish multi-agency (Federal and state) collaborative programs to identify sub-watershed projects, which would potentially include habitat restoration, flood risk management, sediment management, water supply, recreational opportunities, and public outreach. Federal and state natural resource agencies and private conservation organizations are highly supportive of both the Cache Watershed Management Plan and completing the White River Basin Comprehensive study.

The White River Basin is of national importance for many reasons. Reservoirs in the basin contribute a substantial power supply to the Southwest Power Administration, provide a municipal and industrial water supply to several cities in Missouri and Arkansas, and provide a regional and national tourism destination for recreational use. Agriculture is an economic driver with row crops such as soybeans, corn, rice, and cotton in the delta portion and pork and poultry production in the upper portion of the basin. The delta portion of the watershed contains a Wetland of International Importance, per the 1986 Ramsar Convention, that provides significant waterfowl habitat. The White River Basin also provides habitat for several threatened or endangered species including Fat Pocketbook, Pink Mucket, Scaleshell, and Rabbits Foot mussels; Ozark Hellbender salamander; Pallid Sturgeon; Northern Long Eared and Indiana bats; Ivory Billed Woodpecker and Bald Eagle. Informed and coordinated management of the water resources in the basin through the completion of the White River Basin Comprehensive study is needed.

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Appendix A - Sponsor and Public Letters

- White County Judge
- White County Emergency Management Office
- Jackson County Judge
- Craighead County Judge
- Cache River Maintenance District of Clay County
- Arkansas Game and Fish Commission
- Arkansas Natural Heritage Commission
- Arkansas Natural Resources Commission
- United States Fish and Wildlife Service - Ecologic Services Office
- United States Fish and Wildlife Service - Cache River National Wildlife Refuge
- Mr. Calon Blackburn, ESQ

Appendix B - Potential Roles and Responsibilities in a Water Supply, Sediment and Erosion Control, and Nutrient Reduction Feasibility Study

(WS/WQ Feasibility Study)

Recommendation is for a comprehensive WS/WQ feasibility study and project to be undertaken to address the reliability of the future water supply problem and the water quality, sediment and erosion problems. While it is undetermined what agency would lead such a study, the various federal and state agencies that would have some role in that study is known. The areas of expertise those agencies possess that would provide aide to the study are also known. The following is a partial list of those agencies and the potential responsibilities those agencies would have. Were this recommendation pursued, resources agencies, including the USFWS, AGFC, and ANHC would perform their advisory role on the interagency team. This would be true of any Federal water resources study that had the potential to cause impacts to the natural resources dependent upon the water resource.

The Corps of Engineers is included in this list of potential participating agencies. While the Corps does not have a primary mission within water supply, water quality, or sediment and erosion control, the Corps is the leading source of hydrologic and hydraulic engineering expertise in the nation.

U.S. Department of Agriculture - NRCS could participate in the WS/WQ feasibility study by:

- *Working with the Study Lead to scope the water and on-farm conservation portion of the feasibility study,*
- *Leading all on-farm planning activities for determining the storage capacity for excess water (within and outside the basin) to reduce ground water usage for irrigation,*
- *Leading all on-farm planning activities related to other water conservation measures, such as tail-water recovery, to reduce ground water usage,*
- *Leading all on-farm planning activities associated with erosion and sedimentation, and*
- *Participating in public meetings*

The assessment of how much agricultural production land currently is operated under conservation practices, how much additional conservation is possible through various techniques, and determining what particular actions would produce the best conservation of the soil and water resources for various investment levels should be the purview of the NRCS. Providing planning assistance related to the current science of conservation techniques with structures like small grade control, field drop-pipe structures, detention reservoirs, tail-water recovery, no-till cropping, vegetated buffers, etc, should be the responsibility of the NRCS. All on-farm planning activities should be led by NRCS.
NRCS would also assist others when their techniques would be applicable to non-Agricultural lands.

U.S. Department of Agriculture - ARS could participate in the WS/WQ feasibility study by:

- *Providing data and data forecasting to determine the likely future conditions for agricultural production in the basin absent any project for water supply or conservation, and*
- *Providing information and recommendations regarding nutrient reduction strategies in the basin.*

The ARS should be included in study efforts at a minimum as a consultant for agricultural economic measurement and forecasting and scientific perspective. It is possible that the ARS could be retained to perform some of the soil erosion and sedimentation modeling, which has been performed in the past (Shield's et al, 1995). The Corps of Engineers has previously collaborated with the Watershed Physical Processes Research Unit, National Sedimentation Laboratory in Oxford, Mississippi, in the Cache River Basin and that collaboration should continue if this water supply and water quality feasibility study is undertaken.

Research has been led by ARS in the basin on nutrient loading and effects from that loading by the ARS. Nutrient loading is closely related to sediment loading. The ARS researchers who have performed this work to date could provide insight in strategies that would go hand in hand with erosion control and sediment reduction management strategies in the basin.

U.S. Department of Agriculture - FSA could participate in the WS/WQ feasibility study by:

- *Providing information on use and potential of the Conservation Reserve Program within the basin.*

The Farm Service Agency should be a consulting agency on the study for the Corps of Engineers and NRCS with respect to cropping practices and prices and the use of the Conservation Reserve Program in the basin. The agency's role is anticipated to be consultation in nature.

Environmental Protection Agency could participate in the WS/WQ feasibility study by:

- *Representing the agency's role and requirements as they relate to restoration, conservation, and regulatory aspects for water resources, and*
- *Administering the Section 319 Grant Program, if approved, by serving as contributory federal agency.*

Arkansas Natural Resources Commission could participate in the WS/WQ feasibility study by:

- *Working with the Study Lead to scope in particular the water supply portion of the feasibility study,*
- *Leading the effort to establish a basin-wide conjunctive use strategy with the other stakeholders,*
- *Proposing & evaluating the potential benefits and obstacles/hindrances of any particular management measures or strategies of conjunctive use,*
- *Providing information and projections for the possible use of tax incentives or credits for the individual landowner's conservation practices implementation,*
- *Installing well head meters to improve well specific withdrawal information,*

- *Evaluating and incorporating this well-use information into the existing body of groundwater information maintained by ANRC,*
- *Analyze groundwater information,*
- *Identifying potential infrastructure improvements,*
- *Identifying criteria for declaring drought and defining an allocation strategy during such times, and*
- *Working with the EPA to promote and implement the Section 319 program in the basin.*

ANRC holds much of the existing body of knowledge and data regarding groundwater demand and availability (http://ar.water.usgs.gov/PROJECTS/MerasModel.html). Due to the relationship with individual landowners, and with ANRC having the history of monitoring the alluvial aquifer along with the U. S. Geologic Survey, the task of installing well head meters most logically belongs to ANRC. The information that could be garnered from multiple years of monitoring withdrawals for irrigation would be invaluable in determining the potential benefit from converting groundwater as the primary irrigation source to a supplement for use when the surface could not meet the total demand. While there is reference to tax incentives and credits below from an administrative perspective, the ANRC would be the agency responsible for tracking acreage placed into conservation management under any such programs; and this data would be incorporated in the comprehensive basin-wide feasibility study, particularly as projections of a future with-project condition (an important aspect to quantify any potential project benefits).

With its existing knowledge and history of working with the water resources in the basin, ANRC's involvement would be critical to the scoping of any comprehensive basin-wide feasibility study. The Water Plan Update also specifically cites the development and implementation of a conjunctive water management strategy for the basin, so it logically follows that the agency would have a central role in the development of any plan of improvement.

This conjunctive water use plan offers the opportunity "to identify and leverage opportunities for collaborative efforts and to create a joint national dialogue for water priorities between states, tribes and the federal resource agencies" (http://www.building-collaboration-for-water.org/). This role would include proposing and evaluating the potential benefits and obstacles/hindrances of any particular management measures or strategies. If any municipal water and waste water infrastructure is considered in the comprehensive basin-wide WS/WQ feasibility study, ANRC would be the lead agency for identifying existing infrastructure and also participate in any sizing or upgrading alternatives development.

The management of both the surface water and the groundwater from an administrative perspective is a critical part of any basin-wide watershed management strategy. Issues in the Water Plan Update, such as the identifying criteria for declaring a drought emergency and for allocating water during such times, would fall on the ANRC to fully define. The state's administration of these types of issues would have to be included in the comprehensive basin-wide feasibility study since those issues would establish the parameters for how benefits are determined. Other administrative issues such as tax incentives or crediting for irrigation water conservation - whether it be surface water or groundwater - is a vehicle at the state level that could be part of a conjunctive water management strategy.

The potential to receive federal funding to implement any specific non-point source pollution control measures at specific location becomes a valid opportunity to address small scale issues within the basin.

ANRC would be the lead agency for any such small scale project. Therefore, ARNC would be an 'implementing' agency of any plan recommended out of a comprehensive basin-wide feasibility study if that plan included any Section 319 projects. Additionally, since the ANRC directly appoints two board members on each county conservation district, ANRC would help facilitate inclusion of the local county conservation districts into the feasibility study process.

The Cache River Non-Profit Association, county and local governments, drainage districts, and conservation districts could participate in the WQ/WS feasibility study by:

- *Facilitating site visits by study team members,*
- *Providing information regarding operation and maintenance of basin infrastructure, and*
- *Serving as a conduit of information to their constituency.*

These groups are important local stakeholders in the overall basin water resources. Each group either expends funds to maintain or operate the drainage or infrastructure features in the basin, or garner some benefit from the water resources in the basin, or both. Many of the representatives who serve as elected officials in these groups are also landowners and farmers. These groups will be valuable resources of local specific information, both historical, operation, or for the vision of the future in nature. These groups and individuals will need to avail themselves to participate in occasional visits to specific areas, and possibly host meetings within their regions. Frequent contact with these stakeholders will be critical to the success of any comprehensive basin-wide feasibility study effort.

U.S. Army Corps of Engineers could provide assistance to the WQ/WS feasibility study by:

- *Performing hydrologic and hydraulic modeling as needed for the water supply ,*
- *Performing analyses to determine groundwater deficit effects on surface water flows, wildlife and fishery users of surface water, and future cropping practices,*
- *Identifying potential sources of irrigation water,*
- *Determining the potential benefits of providing a more reliable water source through:*
    - *conservation measures and on-farm storage, and*
    - *an alternative water source,*
- *Ensuring that the effects on other reaches or portions of the basin from any measures are fully considered.*

The Corps of Engineers has the federal role of the nation's water resource development agency. Expertise in civil engineering, particularly hydrology and hydraulic engineering, help the Corps of Engineers perform this role. As such, the Corps of Engineers could provide water hydrology analyses support.

This could include data collection and a basin-wide hydraulic model. It is important to note that a model should be flexible enough to determine the affects of individual and cumulative changes to the overall system.

An example of such changes would be the detention of floodwaters in the springtime and reallocation during times when irrigation is needed. It would also explore the potential for introducing water from another basin if needed. The off-channel temporary storage concept has been recommended in the recently approved Water Plan Update (ARNC, December 2014). This surface water model would be used to estimate the reduced demand on the alluvial aquifer. Another aspect that needs examination is the potential of importing water from an adjacent basin such as the Black River and how that could most efficiently be done. A water balance/water budget is needed to determine the potential economic benefits associated with various water delivery alternatives in order to make a sound investment decision.

The Corps of Engineers could also perform economic, social, and environmental analyses to support this WQ/WS feasibility study.

While the Corps would be responsible for NEPA compliance on any flood risk management or ecosystem restoration study, the lead agency would be responsible for the WQ/WS feasibility study NEPA compliance.