



water resources / environmental consultants

# **LOWER LITTLE RIVER WATERSHED-BASED MANAGEMENT PLAN**

**NOVEMBER 2016**

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LOWER LITTLE RIVER  
WATERSHED-BASED MANAGEMENT PLAN

Prepared for

Arkansas Natural Resources Commission  
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## EXECUTIVE SUMMARY

### **Watershed Description**

The Little River in southwest Arkansas is a tributary of the Red River. The Little River originates in Oklahoma and enters Arkansas in Sevier County. The Little River watershed in Arkansas (referred to as the Lower Little River) encompasses a total of 1,794 square miles, including all of Sevier County and parts of Polk, Howard, Hempstead and Little River counties. The watershed is primarily rural. Approximately 53% of the watershed is forested. Animal agriculture is widespread in the watershed, including beef and dairy cattle, and poultry and swine feeding operations. Pasture associated with these operations accounts for 18% of the land cover in the watershed.

### **Water Resources**

Water resources of the Lower Little River watershed are important to the economy of southwest Arkansas and the well-being of its residents. The four Corps of Engineers reservoirs within the watershed are used for drinking water, as well as recreation, and industrial water supply. The Cossatot River upstream of Gillham Lake is part of the National Wild and Scenic Rivers system. This section of the Cossatot River, and its tributary Caney Creek, are designated as Extraordinary Resource Waters. This section of the Cossatot River, and its tributary Brushy Creek, are designated Natural and Scenic Waterways. Several waterbodies in the Lower Little River watershed are designated as Ecologically Sensitive Waterbodies, including the Cossatot River upstream of Gillham Lake, the Little River upstream of Millwood Lake, and Grassy Lake and Yellow Creek downstream of Millwood Lake.

### **Water Quality**

The Lower Little River and its tributaries have many designated uses set forth by the Arkansas Pollution Control and Ecology Commission, including aquatic Life Support, Primary and Secondary Contact Recreation, and Domestic, Industrial, and Agricultural Water Supply. However, portions of the Lower Little River and its tributaries have been identified as not supporting one or more of these designated uses due to high levels of metals, nutrients, minerals,

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bacteria, turbidity from sediment, and/or low dissolved oxygen (DO). In addition, there is also concern that designated uses of Millwood Lake are threatened by high sediment loads reducing the reservoir storage capacity. Nonpoint sources are suspected as sources of the bacteria and turbidity impairing uses in the Lower Little River watershed. Nonpoint sources of these pollutants that have been identified in the watershed include runoff from animal feeding operations, livestock access to streams, and erosion from: pasture, streambanks, and stream channels.

### **Nonpoint Source Pollution Management**

Through the 1998 Arkansas Unified Watershed Assessment, the Lower Little River watershed was identified as a priority area for water quality protection and restoration. A Watershed Restoration Action Strategy was prepared for the Lower Little River watershed in 2004. Recently, the Lower Little River watershed was selected, using a risk matrix process, as a priority watershed for the 2016-2021 Arkansas Nonpoint Source Pollution Management Plan (NPS management plan). As an action item of the NPS management plan, this nine-element, watershed-based, nonpoint source pollution management plan was prepared, using the 2004 Watershed Restoration Action Strategy for the Lower Little River watershed as a starting point.

This plan is intended to address the Lower Little River watershed in Arkansas. It includes discussion of current and historical water quality and quantity data from the watershed, as well as recent research in the watershed. Past, existing, and currently planned nonpoint source pollution management and outreach activities are also summarized.

Several water quality studies have been conducted that rank or characterize sediment and/or bacteria loads from the 12-digit HUC subwatersheds of the Lower Little River. For this plan, the 12-digit HUC subwatersheds are ranked based on the number of studies that identify subwatersheds with impaired streams due to turbidity or bacteria, as having high sediment or bacteria loads. The rankings for this plan are illustrated on Figures ES.1 and Figures ES.2 (Figures included at end of summary). The six subwatersheds with the highest plan ranks (four for sediment issues and two for bacteria issues) are the focus of the implementation portion of

the plan. Table ES.1 lists these subwatersheds along with the pollutants and sources to be targeted.

Through several watershed meetings, stakeholders identified suites of nonpoint source pollution management practices that could be implemented in the recommended subwatersheds to reduce pollutant loads so water quality standards are met (Table ES.2). These practices, along with estimates of associated pollutant load reductions and relative costs for their implementation, are included in the plan. Target load reductions have not been developed through the Total Maximum Daily Load study process for turbidity or bacteria in the recommended watersheds. Turbidity, TSS, and Escherichia Coli (*E. coli*) data were examined to develop target load reductions for this plan. Examples of available sources of technical and funding assistance for implementation of management practices are also identified.

Watershed processes and systems are dynamic. Therefore, an adaptive management approach is recommended for the Lower Little River watershed and outlined in this plan. As part of this approach, continued water quality and biological monitoring is recommended so that progress toward the vision and goals for the Lower Little River watershed can be tracked. As goals and objectives are accomplished, or resources change, this plan may be modified accordingly. The proposed schedule and milestones for implementing the activities outlined in this plan is shown in Table ES.3.

Table ES.1. The six subwatersheds that ranked highest for the presence of turbidity/sediment, and bacteria, issues in the Lower Little River watershed.

| Subwatershed name (HUC)                       | Target pollutants  | Target sources   |
|---|--------------------|--|
| Holly Creek (111401090801)                    | <i>E. coli</i>     | Livestock (cattle in streams, animal feeding operations, manure storage), pasture runoff                             |
| Sand Creek-Saline River (111401090901)        | Sediment/turbidity | Streambank erosion, silviculture activities  |
| Starch Creek-Saline River (111401090902)      | Sediment/turbidity | Streambank erosion, sheet/rill/wind erosion of pasture, silviculture activities                                      |
| Blue Bayou-Saline River (111401090903)        | Sediment/turbidity | Streambank erosion, sheet/rill/wind erosion of pasture, gully erosion of pasture and forest, silviculture activities |
| Saline River-Millwood Lake (111401090904)     | Sediment/turbidity | Streambank erosion, silviculture activities  |
| Lower Mine Creek-Millwood Lake (111401091004) | <i>E. coli</i>     | Livestock (cattle in streams, animal feeding operations, manure storage), pasture runoff                             |

Table ES.2. Management strategies collaboratively recommended for the Lower Little River watershed.

| Recommended Practice                       | Stakeholder Comments  |
|--|---|
| Stream crossings for livestock             | Stream crossings have been effective in reducing erosion along pasture streambanks.   |
| Forestry BMPs                              | Streamside Management Zones, stream crossings, and unpaved road BMPs are used in the watershed.   |
| Buffer zones                               | Not spreading litter within a certain distance of surface waters. There has not been much interest in this practice in the past. If buffers are wide enough, they can be enrolled in CRP. |
| Little control and/or export               | Similar to programs active in the Illinois River watershed. These are associated with state declared Nutrient Surplus Areas. Lower Little River watershed is not a Nutrient Surplus Area. |
| Fencing and alternate water supply         | This is a popular BMP in the watershed. Cross fencing is more popular than riparian fencing.  |
| Land leveling                              | There has been some land leveling on the cropland in the watershed.   |
| Erosion control training for unpaved roads | Erosion control methods need to be applicable for mountain roads, not just flat land roads.   |

Table ES 3. Implementation schedule.

| Activity   | Action (lead)  | Start | End  | Milestones (3-5 yrs)   | Indicator  | Long Term Goal  |
|------------|--|-------|------|--|--|---|
| TMDL       | Turbidity TMDL (ADEQ)  | 2020  | 2020 | ADH, ANRC, Millwood Lake Focus Committee request turbidity TMDL  | EPA approved TMDL  | Turbidity water quality standards met in impaired stream reaches listed in the 2014 303(d) list               |
| Monitoring | <i>E. coli</i> data collection for removal of Holly Creek and Mine Creek from state impaired waters list (ADEQ)  | 2017  | 2022 | Biennial 305(b) assessments, 303(d) lists  | Attainment or nonattainment classification   | Determine if Holly Creek and Mine Creek meet state <i>E. coli</i> standards                                   |
|            | Synoptic surveys in recommended subwatersheds to characterize TSS/sediment loads (Millwood Lake Focus Committee) | 2018  | 2020 | Survey completed Data analyzed<br>Target areas identified  | Critical areas designated for TSS loading  | Identify target areas for erosion control management strategies to achieve state turbidity standards          |
|            | Annual ambient water quality monitoring (ADEQ, USGS)   | 2017  | 2050 | Four years of water quality data collected   | Number of long term water quality stations<br>Number of sampling events              | Identify and track changes in water quality over time   |
|            | Install automated water samplers on Little River, Saline River, and Mine Creek (Millwood Lake Focus Committee)   | 2017  | 2020 | Automated water samplers obtained and installed<br>Arrangements made for retrieval and analysis of samples<br>At least 3 years of data collected | Number of samplers installed and working<br>Number of samples collected and analyzed | Characterize and track sediment and nutrient loads to Millwood Lake   |
|            | Basin Area Stream Survey in the Ouachita National Forest (USFS)  | 2017  | 2020 | 1 water quality and fishery survey at sites on Bushy Creek and Caney Creek   | Number of sampling events<br>Number of samples                                       | Characterize and track fishery conditions in the Ouachita National Forest                                     |
|            | Fish survey in the Lower Little River watershed (AGFC, UofA Pine Bluff)  | 2018  | 2020 | Two-year fish survey initiated   | Number of survey sites<br>Number of surveys  | Characterize distribution, status, and abundance of selected fish species in the Lower Little River watershed |

Table ES 3. Implementation schedule (continued).

| Activity                | Action (lead)   | Start | End  | Milestones (3-5 yrs)   | Indicator  | Long Term Goal  |
|-------------------------|---|-------|------|--|--|---|
|                         | Establish Stream Team(s) (stakeholders, AGFC)   | 2017  | 2018 | At least one Stream Team established   | Number of Stream Teams<br>Number of streams monitored by teams           | Identify and track changes in water quality over time   |
| Information & Education | Public meeting to discuss nonpoint source pollution in Lower Little River watershed (Cooperative Extension Service) | 2018  | 2018 | Meeting scheduled<br>Meeting advertised<br>Meeting held<br>Meeting summary published | Meeting held<br>Number of attendees                                      | Engage local stakeholders in nonpoint source pollution management                                       |
|                         | Informational booth at County fairs (Millwood Lake Focus Committee)   | 2018  | 2050 | Booths at 10 county fairs in counties of the Lower Little River watershed            | Number of fairs attended<br>Number of people visiting booths             | Increase awareness of water quality issues in Lower Little River watershed                              |
|                         | Arkansas grazing lands conference (Arkansas Grazing Lands Coalition)  | 2012  | 2030 | 3 to 5 conferences held  | Number of conference attendees from Lower Little River watershed         | Increased awareness and adoptions of pasture BMPs in Lower Little River Watershed                       |
|                         | Annual Forestry and Land Judging Contest (Howard & Pike County Conservation Districts)                              | 2016  | 2030 | 3 to 5 contests held   | Number of contestants from Lower Little River watershed                  | Increased awareness and adoption of silviculture BMPs by private timber owners/managers                 |
|                         | Field Days (Conservation Districts)   | 2016  | 2030 | 1 to 3 field days held in recommended 12-digit HUC subwatersheds                     | Number of field days in recommended subwatersheds<br>Number of attendees | Increase acceptance and use of BMPs that protect and improve water quality                              |
|                         | Water bill brochures (water utilities)  | 2018  | 2022 | Three annual brochures sent out  | Number of brochures distributed  | Increase awareness of connection between watershed activities and drinking water quality and water cost |

Table ES 3. Implementation schedule (continued).

| Activity                                    | Action (lead)  | Start | End  | Milestones (3-5 yrs)   | Indicator   | Long Term Goal   |
|---|--|-------|------|--|---|--|
|   | Presentations to interest groups (Millwood Lake Focus Committee)   | 2017  | 2022 | Five presentations   | Number of presentations<br>Number of interest groups<br>Number of attendees | Increase awareness of water quality issues in Lower Little River watershed   |
| Supplemental Watershed Implementation Plans | Prepare and implement supplemental watershed implementation plans in recommended 12-digit HUC subwatersheds with turbidity impairments (Millwood Lake Focus Committee) | 2017  | 2022 | Supplemental watershed implementation plan developed for one recommended 12-digit HUC subwatershed | Number of implementation plans accepted                                     | All water quality criteria met in impaired stream reaches listed in final 303(d) list within recommended subwatersheds |
| Implement Management Strategies             | Controlled Access and Livestock Fencing (CALF) Initiative (Arkansas Association of County Conservation Districts, USFWS)   | 2015  | 2022 | Contract for management practices in at least one recommended 12-digit HUC subwatershed            | Miles of fenced streambank in recommended subwatersheds                     | Reduced streambank erosion, improved stream habitat, turbidity and pathogen water quality criteria met                 |
|   | EQIP General (NRCS)  | 2015  | 2022 | Contract for management practices in at least one recommended 12-digit HUC subwatershed            | Number of practices   | Turbidity and pathogen water quality criteria met  |
|   | Management practices in recommended 12-digit HUC subwatersheds (County Conservation Districts)   | 2018  | 2022 | Begin implementation of management practices identified in watershed implementation plan           | Implementation goals outlined in watershed implementation plan              | All water quality criteria met in impaired stream reaches listed in final 2008 and/or 2014 303(d) lists                |

Table ES 3. Implementation schedule (continued).

| Activity  | Action (lead)   | Start | End  | Milestones (3-5 yrs)  | Indicator  | Long Term Goal   |
|---|---|-------|------|---|--|--|
| Evaluate  | Annual voluntary forestry BMP assessment (Arkansas Forestry Commission) | 2002  | 2050 | Two biennial surveys completed (2017 and 2020)                        | Published assessment reports   | Estimate and document extent of forestry BMP implementation, and identify areas to focus BMP education efforts   |
|   | Biennial water quality assessment (ADEQ)                                | 2016  | 2022 | EPA approved final 303(d) list post 2008                              | Attaining and nonattaining stream reaches in Lower Little River watershed  | All water quality criteria met in Lower Little River impaired stream reaches listed in final 2008 and/or 2014 303(d) lists   |
|   | Track implementation of BMPs in Lower Little River watershed (ANRC)     | 2017  | 2022 | Biennial report of implementation activities in watershed             | Linear feet/acres of BMPs implemented<br>Water quality improvement   | All water quality criteria met in Lower Little River impaired stream reaches listed in final 2008 and/or 2014 303(d) lists   |
| Update Lower Little River Watershed Management Plan | Public Meetings (Millwood Lake Focus Committee)                         | 2023  | 2023 | Organize public meetings  | Number of attendees  | Stakeholder input to watershed management planning   |
|   | Update Watershed Management Plan (Millwood Lake Focus Committee)        | 2023  | 2023 | Obtain implementation data from ANRC<br>Conduct evaluation activities | Updated watershed management plan completed<br>Recommended 12-digit HUC subwatersheds identified<br>Stakeholder relationships continued/improved | Maintain watershed management plan as a living document that reflects stakeholder interest and concerns related to improving water quality in the Lower Little River watershed |

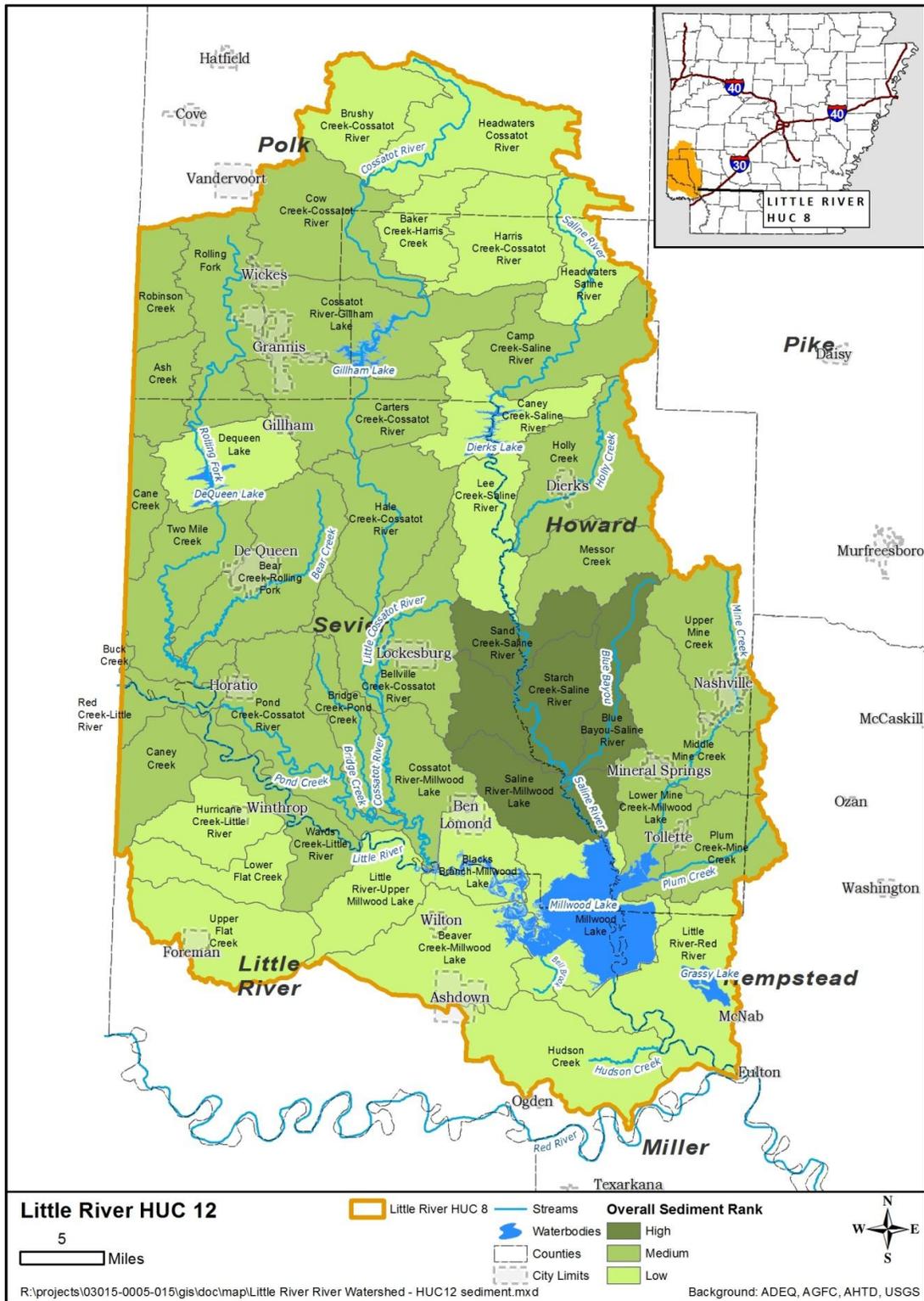


Figure ES.1. Plan ranking of Lower Little River 12-digit HUCs for turbidity/sediment issues.



Figure ES.2. Plan ranking of Lower Little River 12-digit HUCs for bacteria issues.

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## 1.0 INTRODUCTION

### 1.1 Document Overview

The Lower Little River watershed (hydrologic unit code [HUC] 11140109) has been identified as a nonpoint source priority watershed by the Arkansas Natural Resources Commission (ANRC) 2011-2016 Nonpoint Source (NPS) Pollution Management Plan (ANRC 2011). The goal of the priority watershed program is to reduce pollutants so that all streams achieve their designated uses through implementation of a watershed-based management plan that includes the nine elements recommended by the US Environmental Protection Agency (EPA) (EPA 2008). This document contains the nine-element watershed-based plan for the Lower Little River watershed.

Formal watershed management planning in the Lower Little River watershed began in the early part of the 21<sup>st</sup> Century. In 2004, a Watershed Restoration Action Strategy (WRAS) was completed for the Lower Little River watershed (Lower Little River Watershed Coalition 2004).

This document serves as an update to the WRAS. As such, it provides an opportunity to review the work that has occurred in the watershed, and evaluate progress. This includes review of information that has been developed since the WRAS was written.

This document follows the organization developed by the EPA Watershed Plan Builder for nine-element watershed plans (EPA 2011). Section 2 describes many of the features of the watershed. Much of the background information in Section 2 of this plan is taken from the WRAS, with newly available information added where appropriate. Section 3 list water quality standards along with available monitoring and resource data. Section 4 discusses pollutant sources in the watershed, utilizing information from a number of studies that were initiated as a result of the WRAS. Section 5 provides information on pollutant loads in the watershed, and identifies critical areas of the watershed for addressing nonpoint source pollution. Section 6 identifies watershed goals and objectives. Section 7 discusses management strategies for controlling nonpoint source pollution in the Lower Little River watershed. Section 8 outlines the overall management plan, with schedule, list of activities, and indicators and monitoring to track progress and effects.

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

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

| Element | Description  | Location in this plan                   |
|---------|--|---|
| 1       | The identification of causes, sources of pollution, and extent of water quality impairment   | Sections 3.2.1.3 and 4.0, and Table 5.3 |
| 2       | Expected load reductions once management actions are implemented   | Section 7.6                             |
| 3       | A description of nonpoint source pollution management actions that stakeholders can participate in and help to implement, especially in critical areas | Section 7.0                             |
| 4       | An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon | Sections 7.0 and 9.0                    |
| 5       | Education and outreach strategies to encourage stakeholders to learn more about selecting, designing and implementing management actions               | Section 8.4                             |
| 6       | A schedule for implementing identified management measures   | Section 8.1                             |
| 7       | A description of measureable milestones along the way to a fully implemented vision  | Section 8.1                             |
| 8       | A set of criteria that can be used to determine if water quality is improving towards attaining water quality standards                                | Section 8.7                             |
| 9       | A monitoring component to determine if implemented management actions are really improving water quality   | Section 8.3                             |

## 1.2 Process

Development of the Lower Little River watershed-based management plan followed the steps outlined by EPA in the Handbook for Developing Watershed Plans (EPA 2008):

1. Building partnerships,
2. Characterizing the watershed,
3. Finalizing management goals and identifying solutions, and
4. Designing an implementation program.

### **1.2.1 Team**

ANRC worked with consultants to develop this watershed-based management plan, utilizing the input of watershed stakeholders. Stakeholders who participated in development of this plan include Millwood Lake Focus Committee, US Army Corps of Engineers, farmers, Natural Resources Conservation Service, County Conservation Districts, Arkansas Department of Health, and water utilities.

### **1.2.2 Public Participation**

Four public meetings were held as part of the process of developing the Lower Little River watershed-based management plan. The purposes of these public meetings were to inform stakeholders of the plan and the process for developing it, and to request and obtain stakeholder input for the plan. In particular, stakeholder input was sought in identifying priority issues in the watershed, recommending subwatersheds for implementation of management strategies, and selecting appropriate management strategies for addressing nonpoint source pollution in the watershed. Sign-in sheets for the public meetings are included as Appendix A.

## **1.3 Adaptive Watershed Management**

This Watershed-Based Plan for the Lower Little River watershed was developed to include the adaptive watershed management concept. This plan was developed using information available as of 2015, based on the current understanding of the condition of, and processes at work in, the watershed. Watershed processes and systems are dynamic, and our understanding of them changes over time. Adaptive watershed management is an iterative process of evaluating the results of management, and adjusting actions based on what has been learned, in order to achieve sustainable watershed management. Adaptive watershed management involves goal-setting, implementation of management strategies to work toward the goals, monitoring the results of management, evaluation of the results of management, and revision of goals and/or management strategies, which are then implemented, monitored, evaluated, and so on. All of these elements of adaptive watershed management are included in this plan.

## **2.0 WATERSHED DESCRIPTION**

### **2.1 Physical and Natural Features**

#### **2.1.1 Watershed Boundaries**

The Lower Little River Watershed, identified by the US Geological Survey (USGS) Hydrologic Unit Code (HUC) 11140109, lies within the Red River Basin in southwestern Arkansas. The watershed encompasses a total of 1,794 square miles in Arkansas, including all of Sevier County and parts of Polk, Howard, Hempstead and Little River counties (Figure 2.1) (Lower Little River Watershed Coalition 2004).

#### **2.1.2 Hydrology**

The Little River flows into Arkansas from Oklahoma west of Horatio in Sevier County. Once in Arkansas, the Little River continues to flow east, forming the boundary between Sevier and Little River Counties, until it reaches Millwood Lake. After leaving Millwood Lake, the Little River travels southeast 16 miles to its confluence with the Red River. The total length of the Little River in Arkansas is approximately 87 miles. The major tributaries of the Lower Little River in Arkansas include the Rolling Fork (358 square miles drainage), Cossatot River (541 square miles drainage), and Saline River (358 square miles drainage). There are four major reservoirs located in the Lower Little River watershed; De Queen, Gillham and Dierks Lakes, all of which drain into the reservoir Millwood Lake (Lower Little River Watershed Coalition 2004).

The Ouachita Mountains have a marked influence on runoff. Because of the rugged topography and thin soils in this region of the basin, nearly 33 % of the precipitation, approximately 6 million acre-feet, flows off in a short time as surface runoff. Average annual runoff in the Ouachita Mountains is 1,200 acre-feet per square mile. Streams in the Ouachita Mountains are swift, have rudimentary flood plains, and flow in narrow, steep-sided valleys (Lower Little River Watershed Coalition 2004).

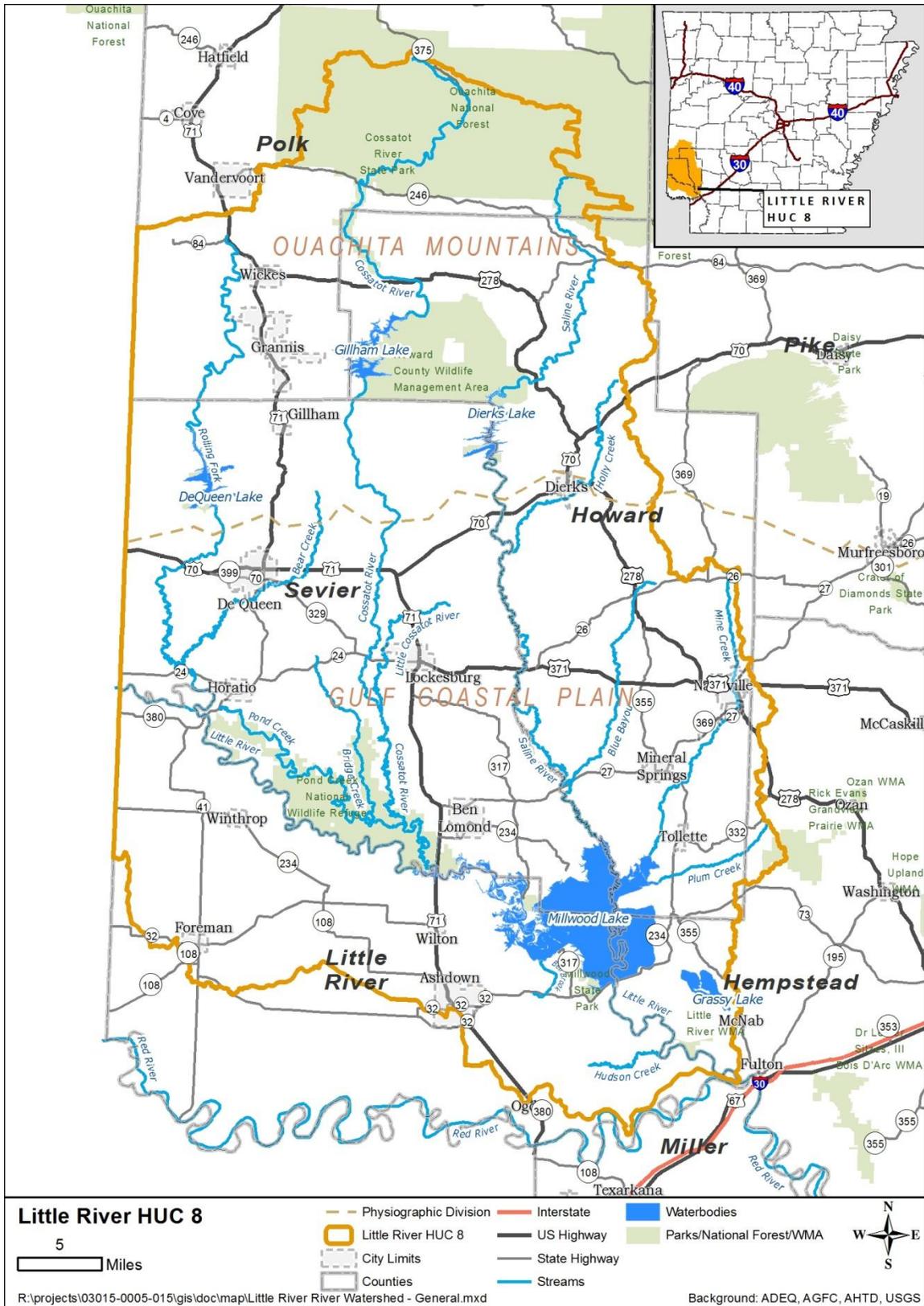


Figure 2.1. Map of Lower Little River watershed

The low relief and lower rainfall in the plains of the southern Lower Little River watershed results in markedly reduced runoff rate when compared to the Ouachita Mountain region. Average annual runoff in the Gulf Coastal Plain is 800 acre-feet per square mile. Annual runoff at the State Line is estimated to average 2.3 million acre-feet (Lower Little River Watershed Coalition 2004).

Water entering the soil more than that needed to replace depleted soil moisture percolates downward through the soil and enters the zone of saturation where it recharges the groundwater reservoir. The amount of groundwater recharge in the basin is unknown, but probably does not exceed 1% of the total precipitation in the northern part where slopes are steep, soils are thin, and bedrock has limited permeability. Recharge may be as much as 5% in the southern part, where slopes are gentle, soils are thick, and the bedrock permeable (Lower Little River Watershed Coalition 2004).

During periods of no rainfall, streams in the basin are maintained entirely by springs and seepage from the groundwater reservoir. In the northern part, where the rocks have limited storage capacity, streams frequently go dry. All US Geological Survey (USGS) gauging stations within the basin have temporary periods of no measurable flow about 5% of the time. In the southern part, where rocks can store large amounts of water, streams have cut their channels below the water table and are fed by groundwater seepage from the contact of terrace deposits with the underlying bedrock. Flows are generally lowest from July through November and highest from March through May (Lower Little River Watershed Coalition 2004).

Many streambeds in the Gulf Coastal Plain have channels extend below the water table. These streams are fed by groundwater seepage (Lower Little River Watershed Coalition 2004).

### **2.1.3 Climate/Precipitation**

The Lower Little River watershed has a temperate, continental climate that is moist and sub-humid. As a transitional area, it receives warm, moist air from the Gulf of Mexico and is regularly penetrated by cool, dry air moving from the north/northwest. Rapid penetration of cool air frequently results in significant variations of temperature, precipitation, cloudiness and wind velocity (Lower Little River Watershed Coalition 2004).

Seasonal characteristics of climate vary in intensity from year to year, but changes between seasons are gradual. The heaviest seasonal rains occur in the spring and fall associated with frontal passage. The greatest incidence of severe local storms and tornadoes occur in the spring. Spring months are mild, with cool nights and warm days. Summers are usually hot, and the high humidity causes the high temperatures to be more unpleasant than they would be in drier air. Autumn has long periods of mild, sunny days with sufficient rainfall for good vegetative growth. Winters are generally moderate and sunny with cold periods usually lasting only a few days. Normal frost-free periods in the basin range from 190 to 233 days in the Ouachita Mountains to 200 to 245 days in the Gulf Coastal Plain. This period generally occurs between March and November. The average maximum temperature is 74.0 degrees Fahrenheit and the average minimum temperature is 48.4 degrees Fahrenheit. The average annual precipitation in the watershed ranges from 42 to 56 inches, with an average of 48 inches. Rainfall is distributed uniformly throughout the year. Based on the 1964-1997 record the average rainfall is 54.13 inches, with an annual evaporation rate of standing water of 52.12 inches (Lower Little River Watershed Coalition 2004).

#### **2.1.4 Surface Water Resources**

Major rivers in the Lower Little River watershed include the Little River, Rolling Fork River, Cossatot River, and Saline River. The major reservoirs located in the watershed include De Queen, Gillham and Dierks Lakes, all of which drain into the reservoir Millwood Lake.

Streams in the upper Lower Little River watershed, within the Ouachita Mountains, often go dry during the summer. Streams in the part of the watershed within the Gulf Coastal Plain usually maintain flows during the drier times of the year. The most recent published 7Q10 values for USGS gages in the Lower Little River watershed are shown in Table 2.1.

Table 2.1. 7Q10 values for USGS gages in the Lower Little River watershed (USGS 2008).

| Station ID | Location                        | 7Q10 Flow (cfs) |
|------------|---------------------------------|-----------------|
| 07339200*  | Rolling Fork near Grannis       | 0.04            |
| 07339500   | Rolling Fork near DeQueen       | 0.16            |
| 07340000   | Little River near Horatio       | 3.95            |
| 07340300   | Cossatot River near Vandervoort | 8.37            |
| 07340400*  | Cossatot River near Umpire      | 6.87            |
| 07341000   | Saline River near Dierks        | 0               |
| 07341200   | Saline River near Lockesburg    | 0.32            |

\* Partial record station

The USGS recently analyzed precipitation, flow, reservoir pool elevations, and reservoir releases from the period 1951-2011 at selected locations in Arkansas, Louisiana, and Missouri. The Little River USGS gage near Horatio (07340000) was included in this analysis, along with the four USACE reservoirs located in the Lower Little River watershed (Wagner, Krieger and Merriman 2014). The results of the trend analyses for the locations within the Lower Little River watershed are summarized in Table 2.2.

Table 2.2. Results from long term trend analysis of selected surface water indicators at locations in the Lower Little River watershed.

| Indicator                           | Trends Identified*      |                   |                   |              |                   |
|-------------------------------------|-------------------------|-------------------|-------------------|--------------|-------------------|
|                                     | Little River nr Horatio | Millwood Lake     | DeQueen Lake      | Gillham Lake | Dierks Lake       |
| Annual mean daily flow/releases     | Increasing              | Decreasing        | <b>Decreasing</b> | Decreasing   | Decreasing        |
| Annual maximum daily flow/releases  | <b>Decreasing</b>       | Decreasing        | <b>Decreasing</b> | Decreasing   | <b>Decreasing</b> |
| Annual minimum daily flow/releases  | <b>Increasing</b>       | Increasing        | <b>Increasing</b> | Increasing   | <b>Increasing</b> |
| Annual mean daily pool elevation    | --                      | Increasing        | Increasing        | Increasing   | Decreasing        |
| Annual maximum daily pool elevation | --                      | <b>Decreasing</b> | Decreasing        | Increasing   | Decreasing        |
| Annual minimum daily pool elevation | --                      | <b>Increasing</b> | Decreasing        | Increasing   | Decreasing        |

\* **Bold red text** indicates the trend is statistically significant.

One of the purposes of the four US Army Corps of Engineers (USACE) reservoirs in the Lower Little River watershed is water supply. These reservoirs are managed by the USACE Little Rock District. The amount of storage allocated to water supply in each of these reservoirs is summarized in Table 2.3.

Table 2.3. Surface water storage in USACE reservoirs in the Lower Little River watershed.

| Reservoir     | Total storage at conservation pool, acre-feet | Water supply storage, acre-feet <sup>a</sup> | Water supply storage currently contracted, acre-feet <sup>a</sup> |
|---------------|---|--|---|
| DeQueen Lake  | 25,000  | 17,885                                       | 17,885  |
| Dierks Lake   | 15,000  | 10,100                                       | 10,100  |
| Gillham Lake  | 23,000  | 20,600                                       | 20,400  |
| Millwood Lake | 188,000 <sup>b</sup>                          | 150,000                                      | 93,118  |

<sup>a</sup> (USACE 2015a)

<sup>b</sup> (Richards and Green 2013)

Millwood Lake was constructed and is operated by USACE for flood-risk reduction, water supply and recreation. The lake was completed in 1966. A sediment survey performed by USGS in 2013 revealed that the capacity of Millwood Lake has been reduced between 32% and 44 % since construction due to sedimentation (Richards and Green 2013). The Millwood Lake Focus Group states that storage capacity has declined more rapidly than predicted when the USACE designed the reservoir ( Millwood Lake Citizen Focus Committee 2009).

### 2.1.5 Groundwater Resources

There are seven recognized aquifers in the Lower Little River watershed, listed in Table 2.4 and mapped on Figure 2.2. The aquifers within the watershed are considered minor aquifers and are only important as local sources of water.

The geologic formations that serve as aquifers in the Gulf Coastal Plain area of the watershed (southern portion), from youngest to oldest , are Quaternary age alluvium associated with the Red River and its tributaries, the Nacatoch Sand, the Ozan Formation, the Tokio Formation, and the Trinity Group, all of Cretaceous age. All but the Ozan aquifer have been, or are, used as a significant source of water supply in the watershed. The hydraulic conductivity of

these formations is moderate to high, and most wells in these aquifers yield water at 50-150 gallons per minute (gpm) (Kresse, et al. 2014).

A thick sequence of Paleozoic rock formations in the Ouachita Mountains serves as an important source of groundwater supply for domestic users, in addition to a limited number of small commercial and community water supply systems. The shallow saturated section of the combined formations in the Ouachita Mountains is referred to as the Ouachita Mountains aquifer (Kresse, et al. 2014). Formations comprising the aquifer are predominately thick sequences of shale, siltstones, sandstones, and other quartz formations (i.e., chert, novaculite), with minor occurrences of carbonates and other rocks. Groundwater flow paths in this aquifer are defined by local topography, where flow occurs from elevated areas to valley floors, terminating in small stream systems. Groundwater storage in the aquifer is limited primarily to fractures and faults. Yields from wells in the Ouachita Mountains aquifer have a fairly large range, as a result of the varying lithologies, but are typically less than 10 gpm. The Big Fork Chert has been identified as the most productive formation in this aquifer (Kresse, et al. 2014).

Most wells in the Ouachita Mountains aquifer are less than 100 feet deep, but can range up to approximately 700 feet deep, with static water levels generally less than 20 feet below land surface, and flowing-artesian wells found throughout the region (Albin 1965, Kresse and Hays 2009). Pumping water levels may be as much as 150 feet below land surface in deeper wells. Seasonal water-level fluctuations in wells generally are less than 10 feet; however, larger fluctuations are common in abnormally wet or dry years because the aquifers generally have small storage capacities and are recharged by rapid infiltration of local precipitation (Albin 1965).

Table 2.4. Nomenclature, geologic age, yield, and use of aquifers in the Lower Little River watershed.

| Region             | Formation or Group of Formations  | Geologic Age                     | Hydrogeologic Unit Name    | Yield       | Aquifer Use <sup>1</sup> |
|--------------------|---|----------------------------------|----------------------------|-------------|--------------------------|
| Coastal Plain      | Alluvium and terrace deposits   | Quaternary                       | Red River alluvial aquifer | 200-750 gpm | IR, PS, IN               |
|                    | Nacatoch Sand   | Cretaceous                       | Nacatoch aquifer           | 1-300 gpm   | PS                       |
|                    | Ozan Formation  | Cretaceous                       | Ozan aquifer               | 1 gpm       |                          |
|                    | Tokio Formation   | Cretaceous                       | Tokio aquifer              | <20-90 gpm  | PS, IN                   |
|                    | Trinity Group <sup>2</sup>  | Cretaceous                       | Trinity aquifer            | 0-200 gpm   | PS, IN                   |
| Ouachita Mountains | Johns Valley Shale<br>Jackfork Sandstone<br>Stanley Shale<br>Arkansas Novaculite<br>Missouri Mountain Shale<br>Blaylock Sandstone<br>Polk Creek Shale<br>Bigfork Chert<br>Womble Shale<br>Blakeley Sandstone<br>Mazarn Shale<br>Crystal Mountain Sandstone<br>Collier Shale | Ordovician through Pennsylvanian | Ouachita Mountains aquifer | <10 gpm     | D                        |

Groundwater in the Lower Little River watershed is largely contained in the Tokio aquifer underlying the Gulf Coastal Plain. From 1980 to 2010, withdrawals from the Tokio aquifer decreased 81%. Groundwater flow in the Tokio Aquifer is generally towards the south or southeast (Schrader and Rodgers 2013). In 2014, water levels were measured in 10 Tokio aquifer wells in Howard County and 3 Tokio aquifer wells in Sevier County. Groundwater levels declined between 2011 and 2014 at four of the wells in Howard County. The rest of the wells in Howard County and all of the wells in Sevier County showed groundwater level increases between 2011 and 2014 (ANRC 2015). A cone of depression is evident about one of the wells in southern Howard County, but the cause is unknown (Schrader and Rodgers 2013).

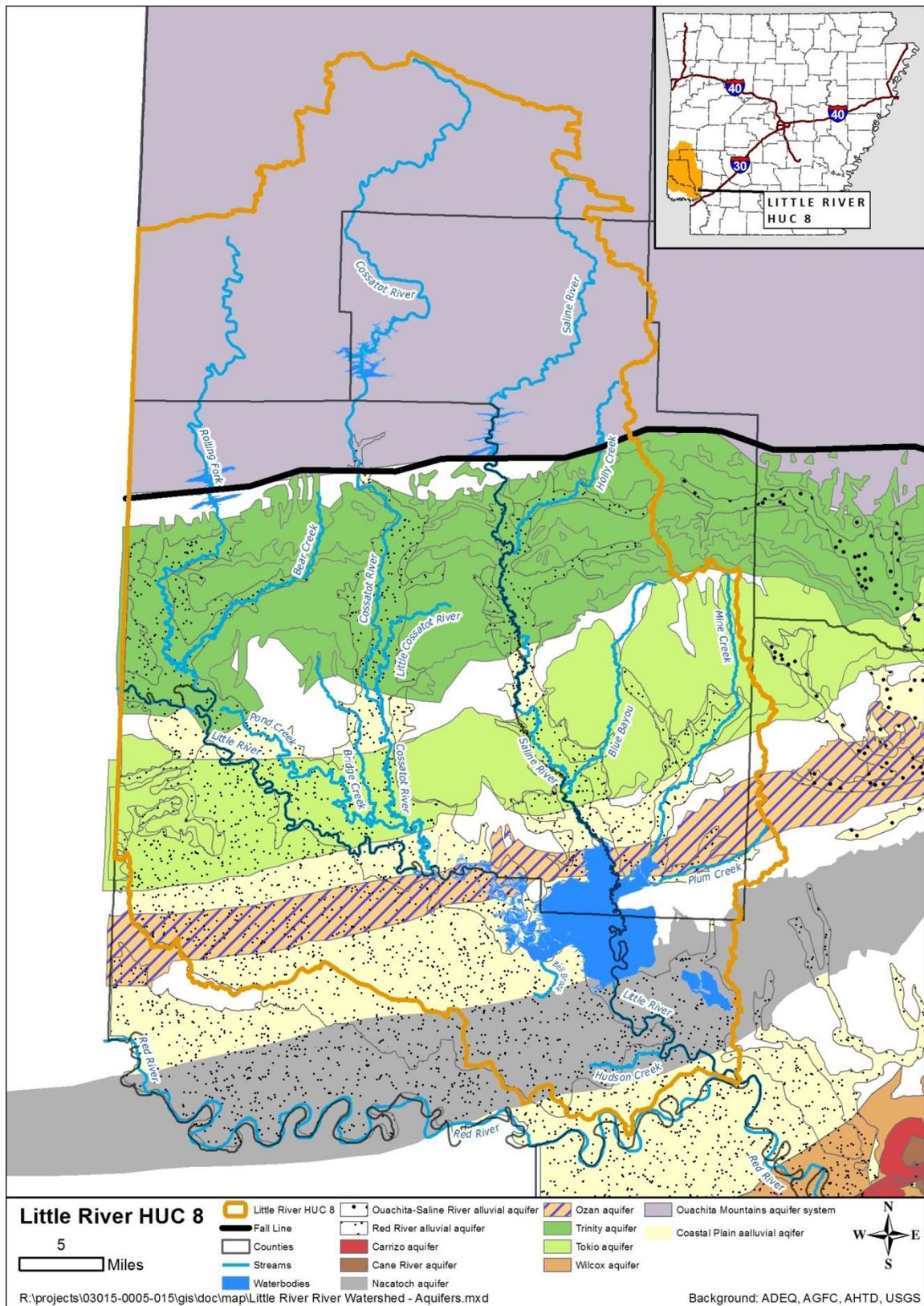


Figure 2.2. Aquifers of the Lower Little River watershed (Kresse, et al. 2014).

### **2.1.6 Flood Plains**

Floodplains are very small to nonexistent in the Ouachita Mountains region of the Lower Little River watershed. Significant floodplains are associated with the major streams in the Gulf Coastal Plain region of the watershed (Figure 2.3). The largest floodplains in the watershed are associated with the Little River. The Federal Emergency Management Agency (FEMA) has designated approximately 232,389 acres in the Lower Little River watershed as flood hazard area (i.e., floodplain) (FEMA 2015a).

### **2.1.7 Dams**

There are four large reservoirs in the Lower Little River watershed (Figure 2.1).

### **2.1.8 Topography/Elevation**

The Little River Basin includes two physiographic provinces: The Ouachita Mountains and the Gulf Coastal Plain (Figure 2.1). The Ouachita Mountains make up the northern highland of the watershed and begin about 20 miles north of Highway 70 near De Queen Reservoir. The Ouachita Mountains have some of the most rugged topography in Arkansas, with an average relief of several hundred feet and local relief that exceeds 1,700 feet in places (Lower Little River Watershed Coalition 2004).

In the southern portion of the watershed, the Gulf Coastal Plain slopes south and southeastward toward the Gulf of Mexico. In contrast to the Ouachita Mountains, the Gulf Coastal Plain is an area of low relief, rarely exceeding 100 feet, and the topography is gently rolling to hilly (Lower Little River Watershed Coalition 2004).

### **2.1.9 Geology**

The Lower Little River watershed includes two geologic provinces: The Ouachita Mountains in the north and the Gulf Coastal Plain in the south (Figure 2.1). Geologic formations in the watershed range in stratigraphic order from the earliest deposited layers of the Ordovician Period to Quaternary age alluvium. The Quaternary alluvial and terrace deposits are located along major rivers in the planning region (Figure 2.4).

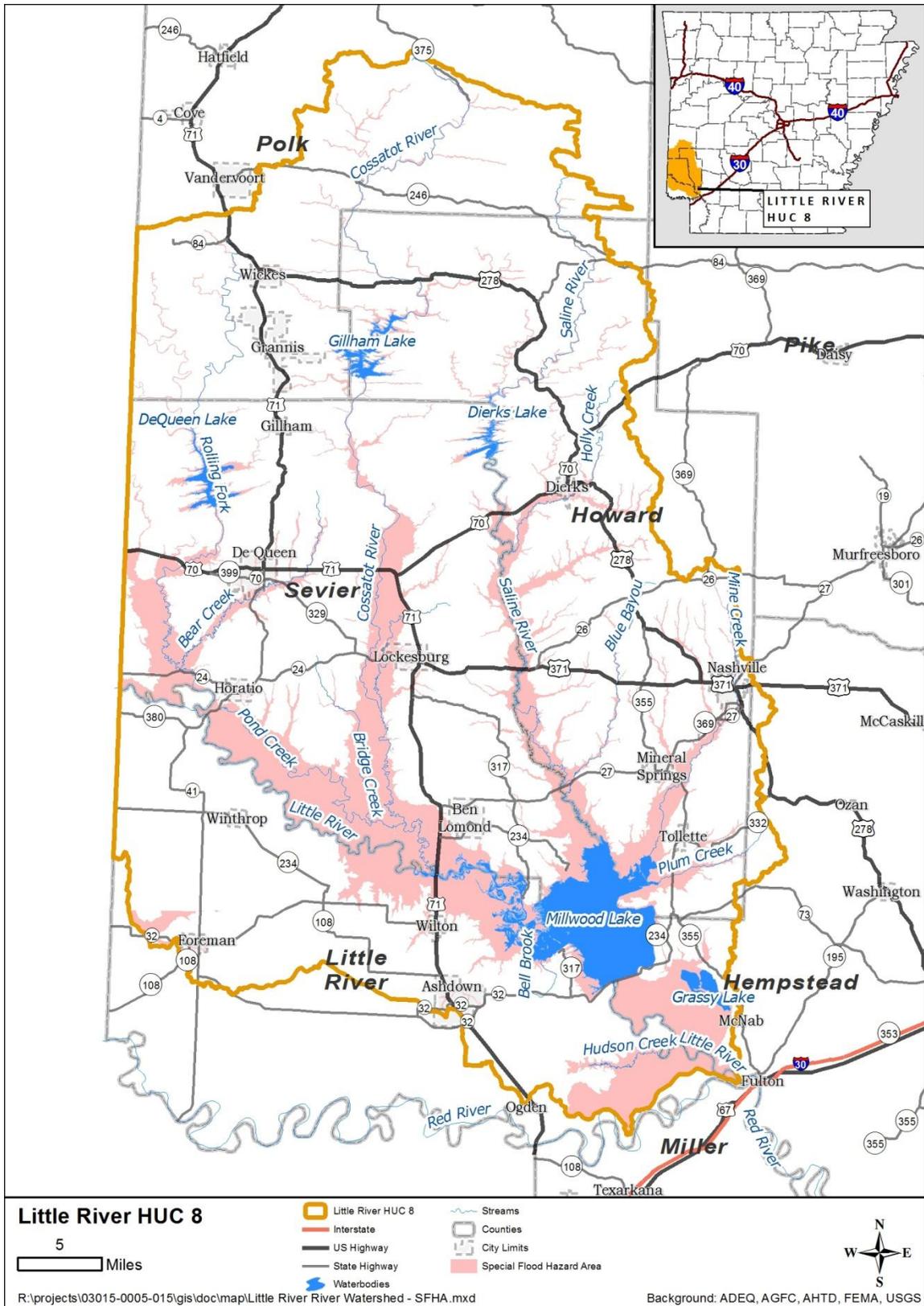


Figure 2.3. FEMA designated flood hazard areas of the Lower Little River watershed (FEMA 2015a).

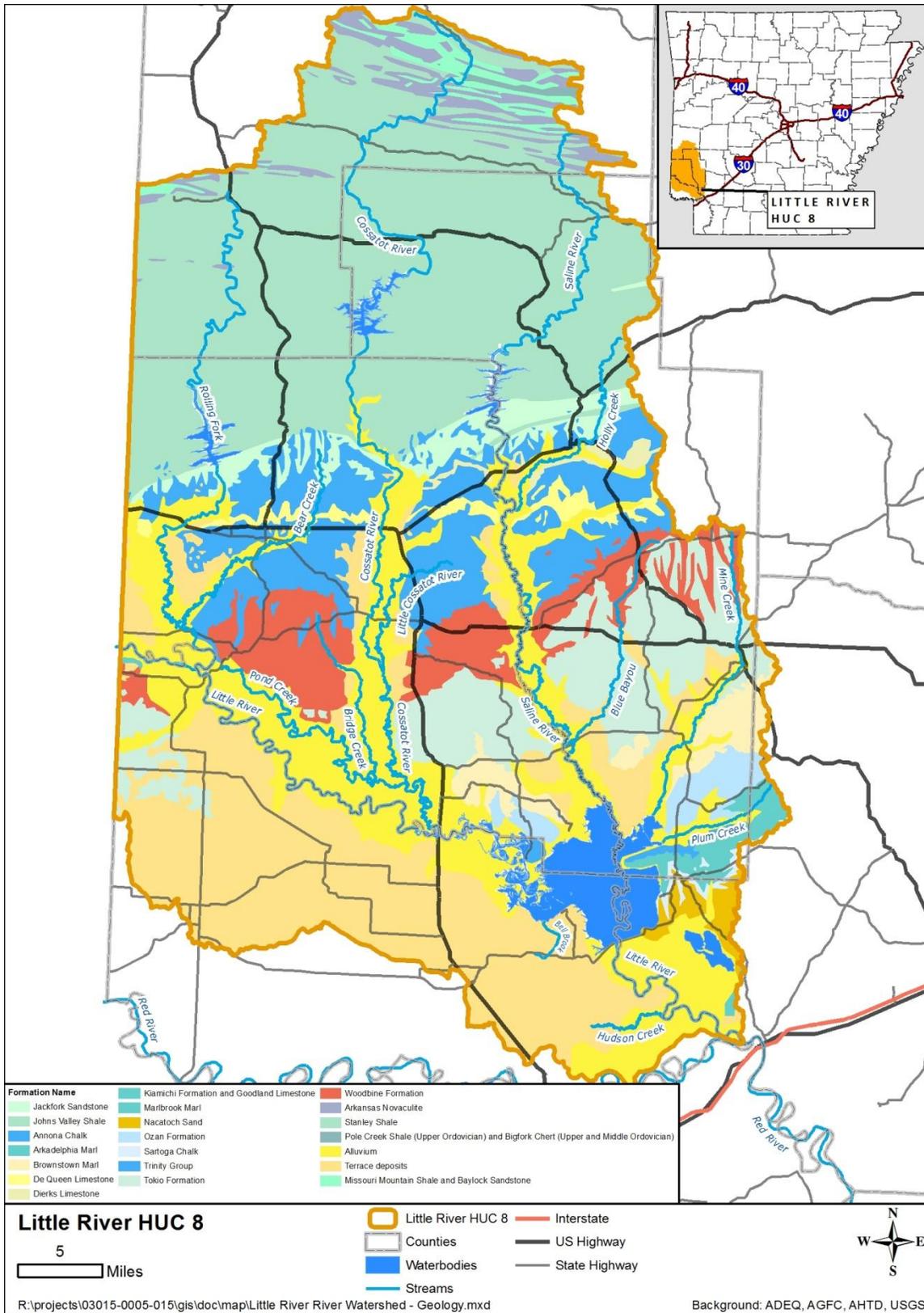


Figure 2.4. Surface geology of the Lower Little River watershed (from Haley et al. 1993).

### **2.1.9.1 Geology of the Ouachita Mountains**

The Ouachita Mountains consist of folded sedimentary rock. The sedimentary rocks of the Ouachita Mountains consist of a thick sequence of shale, chert, sandstone, conglomerates, novaculite, and volcanic tuff deposited during the Paleozoic Era within an elongate, subsiding trough (Renken 1998). The Ouachita Mountains are true geosynclinal mountains uplifted and deformed by the compressional events associated with continental collision. The general structure of the Ouachita Mountains is a broad uplift with complex folds and numerous complex faults (McFarland 2004).

The Stanley Shale is the most widespread formation in the Ouachita Mountains. The oldest formations in the Lower Little River watershed occur along the northern boundary. These are the Ordovician Polk Creek Shale, and the Silurian Missouri Mountain Shale and Blaylock Sandstone. The Devonian Arkansas Novaculite is also exposed in this area of the watershed. In the southern Ouachita Mountains, the Jackfork Sandstone occurs, primarily in major mountain ridges.

### **2.1.9.2 Geology of the Gulf Coastal Plain**

The geology of the Gulf Coastal Plain in the Lower Little River watershed generally consists of unconsolidated to semi-consolidated deposits of Cretaceous age sand, clay, marl, and gravel overlain by Quaternary terrace and alluvial deposits. Surface materials are generally unconsolidated to semi-consolidated sand and clay. The recent alluvial and Quaternary terrace deposits are associated with the Red River and its tributaries.

Cycles of rising and falling sea levels from the Cretaceous through the Tertiary periods resulted in older deposits cropping out in bands of varying widths roughly parallel to the Fall Line, and dipping gently to the south and southeast. The Cretaceous-age formations present in the Lower Little River watershed consist of sand, clay, gravel, marl, limestone, and chalk, deposited in shallow, marginal, and usually restricted marine environments. Most of the formations are coarse sand, clay, or gravel. The age of the exposed formations decreases to the south. The oldest formation, located just south of the Ouachita Mountains, is the Trinity Group, which contains gypsum. The Woodbine, Tokio and Ozan Formations represent the middle

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Cretaceous and contain some lignite. The remainder of the Cretaceous formations, those located in the southern area of the watershed, are from the upper Cretaceous period.

### **2.1.10 Soils**

The major soil groups in the Lower Little River watershed are shown on Figure 2.5 and described in Table 2.5. The major soil groups in the Ouachita Mountains are Carnasaw-Clebit-Sherless and Yanush-Avant-Bigfork. These soils are deep and tend to be gravelly and/or stony. The major soil groups of the Gulf Coastal Plain in the southern watershed include clays, silt loams, and fine sandy silt loams. These soils are usually very deep. Alluvial soils occur in the floodplains along the Little River and its larger tributaries in the Gulf Coastal Plain. Major soil groups associated with the Blackland Prairie are also present in the southern watershed.

In the Ouachita Mountains, soils are characteristic of shallow to deep, steep to vary gently sloping, loamy uplands that developed over sandstone and shale under the cover of trees. Sols Bruns Acides from sandstone and acid shale are the most extensive soils in the mountain slopes and dissected plateaus. Red-Yellow Podzolic soils are on limestone, Reddish-Brown Lateric soils are in some limestone valleys and basins. In addition, Lithosols and rough stony land occupy the steep slopes and Planosols provide valley underlain for the slopes. Alluvial soils can be found in the major river valleys (Lower Little River Watershed Coalition 2004).

### **2.1.11 Vegetation**

Four vegetative cover types are present in the Lower Little River watershed; Upland and Bottomland Timber, Seasonal Herbland, Wetland, and Cropland.

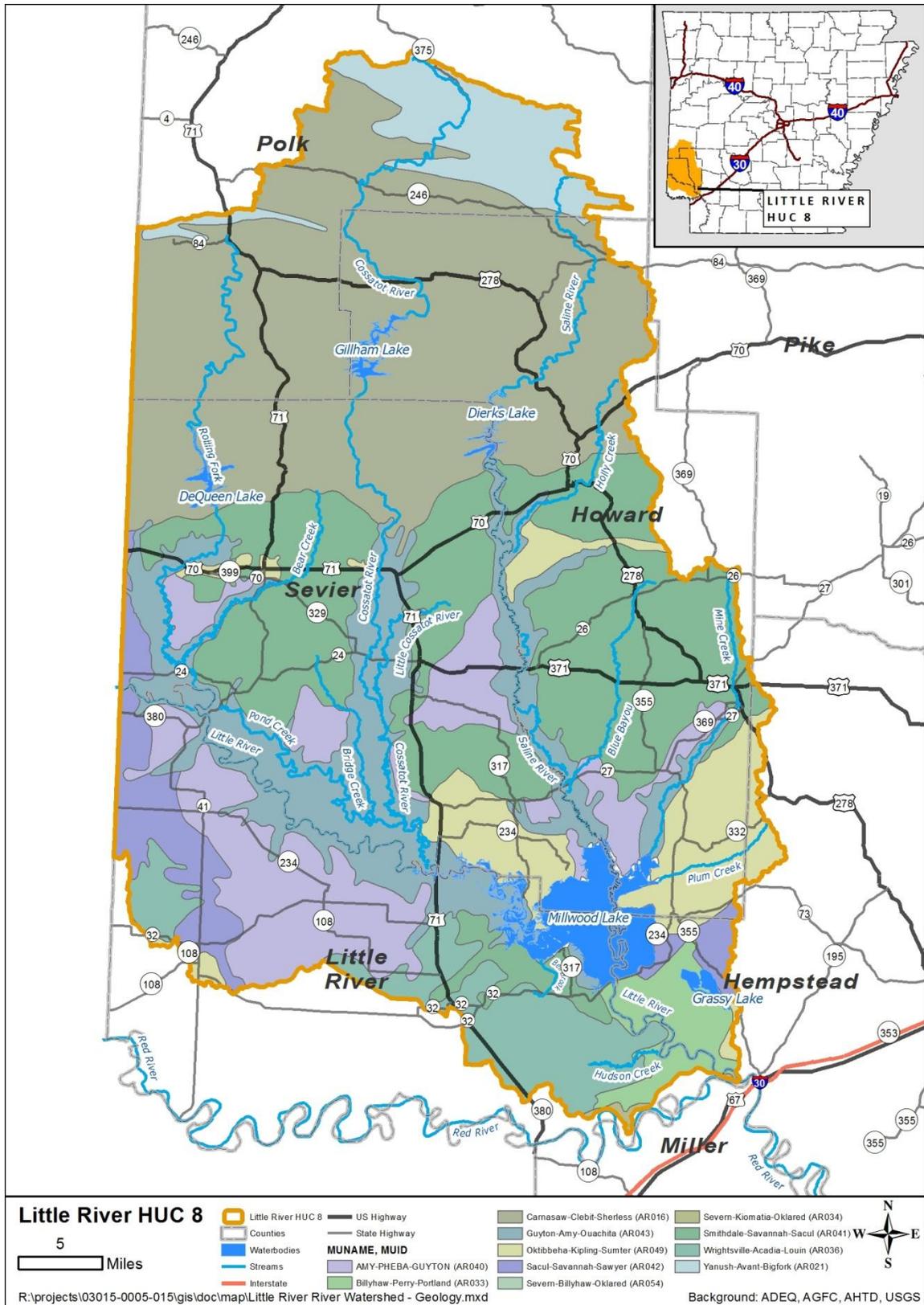


Figure 2.5. Major soil groups in the Lower Little River watershed (from STATSGO).

Table 2.5. Characteristics of major soil associations of the Lower Little River watershed (NRCS n.d.).

| Soil Association          | Principle landscape where soil association occurs    | Soil association characteristics      |  |                                   |                                |  | Character |
|---------------------------|--|---------------------------------------|--|-----------------------------------|--------------------------------|--|-----------|
|                           |  | Depth                                 | Drainage                               | Permeability                      | Slope                          |  |           |
| Camasaw-Clebit-Sherless   | Ouachita Mountains                                   | Deep and moderately deep              | Well drained                           | Slowly to moderately rapidly      | Gently sloping to very steep   | Loam, very gravelly, very fine sandy loam, fine sandy loam |           |
| Yanush-Avant-Bigfork      | Ouachita Mountains                                   | Very deep and moderately deep to deep | Well drained                           | Moderately                        | Gently sloping to very steep   | Gravelly to very gravelly to very stony silt loam          |           |
| Billyhaw-Perry-Portland   | Floodplains and slackwater areas of the Red River    | Very deep                             | Poorly to moderately well drained      | Very slowly                       | Nearly level to gently sloping | Clay, silty clay   |           |
| Amy-Pheba-Guyton          | Pleistocene terraces                                 | Deep to very deep                     | Somewhat poorly to very poorly drained | Slowly to moderately slowly       | Level to nearly level          | Silt loam  |           |
| Guyton-Amy-Ouachita       | Pleistocene terraces and natural levees              | Deep to very deep                     | Poorly drained to well drained         | Slowly to moderately slowly       | Level to nearly level          | Silt loam  |           |
| Okribbeha-Kipling-Sumter  | Blackland Prairie                                    | Moderately to very deep               | Somewhat poorly to well drained        | Slowly to very slowly             | Nearly level to steep          | Clay loam, silt loam, silty clay                           |           |
| Sacul-Savannah-Sawyer     | Uplands and terraces of the Gulf Coastal Plain       | Very deep                             | Moderately well drained                | Slowly to moderately slowly       | Nearly level to steep          | Very fine sandy loam, fine sandy loam, silt loam           |           |
| Severn-Billyhaw-Oklaled   | Floodplains  | Very deep                             | Moderately well to well drained        | Very slowly to moderately rapidly | Level to gently sloping        | Very fine sandy loam, clay, fine sandy loam                |           |
| Severn-Kiomatia-Oklaled   | Floodplains  | Very deep                             | Well drained                           | Moderately rapidly to rapidly     | Level to gently sloping        | Very fine sandy loam, loamy fine sand, fine sandy loam     |           |
| Smithdale-Savannah-Sacul  | Ridge tops and hill slopes of the Gulf Coastal Plain | Very deep                             | Moderately well to well drained        | Slowly to moderately              | Gently sloping to very steep   | Very fine to fine sandy loam                               |           |
| Wrightsville-Acadia-Louin | Pleistocene terraces in the Blackland Prairie        | Deep to very deep                     | Somewhat poorly to poorly drained      | Very slowly                       | Level to gently sloping        | Silt loam, silty clay loam                                 |           |

### **2.1.11.1 Upland and Bottomland Timber**

Pre-European settlement forests (1850's) were largely shortleaf pine with a grassy understory on south facing slopes, pine-oak-hickory on north facing slopes, and oak-gum or cypress in wetlands or riparian areas. During settlement many of these forests were harvested or converted to cropland or pasture.

Currently, forestland makes up about 53% of the watershed area (Homer, et al. 2015). It includes loblolly and shortleaf pine, pine-hardwood and some hardwood forests. Loblolly and shortleaf pine represent the dominant forest types and account for about 44% of the acreage with about 66% of this being planted and the remaining 44% in natural stands. Oak-hickory accounts for about 28% and Oak-pine for another 21%. These forest types are mainly found on more northerly aspects, ridgetops and in areas receiving less precipitation. Oak-gum or cypress and elm-ash-cottonwood located in stream bottoms account for the remaining 7% (Lower Little River Watershed Coalition 2004).

### **2.1.11.2 Seasonal Herbland**

Seasonal herbland includes native range, native pasture and improved pasture. Developed warm-season grasses make up the major portion of the grassland. The remainder is in cool-season or native species. Well-managed native range is a mixture of species such as big bluestem, Indiangrass, switchgrass, little bluestem and eastern gamagrass. These areas may also include legumes and forbs. If not managed properly, invader species such as silver bluestem, windmillgrass, annual thee-awn, Japanese brome and western ragweed may become dominant. Introduced pasture in the basin area consists mainly of bermudagrass, lovegrass and fescue (Lower Little River Watershed Coalition 2004).

### **2.1.11.3 Wetlands**

Based on flood plain soils, wetlands encompassed 237,236 acres prior to settlement (1830) compared to 41,951 acres in 1982. Important tracts of bottomland hardwoods remain within the floodplain of the Little River (Lower Little River Watershed Coalition 2004). The largest remaining tract of bottomland hardwoods along the Little River is located in the 26,879

acre Pond Creek National Wildlife Refuge (NWR). Pond Creek NWR is an extensive wetland complex comprised of forested overflow bottoms and riparian forests of the Little River, the Cossatot River, Bridge Creek, and Pond Creek. The refuge is approximately 95 % forested, with small areas of open water, shrub swamps, beaver ponds, open marsh, and roads (USFWS 2014a).

Another important wetland area is Grassy Lake, located downstream of Millwood Lake. Grassy Lake is dominated by Bald Cypress with numerous stands of southern wild rice (Moore 1950).

#### **2.1.11.4 Cropland**

Cropland occurs primarily in Little River County. Crops include soybeans, wheat, and corn (USDA National Agricultural Statistics Service 2014).

#### **2.1.12 Exotic/Invasive Species**

The USGS Nonindigenous Aquatic Species database lists 15 species that are found the Lower Little River watershed (Table 2.5) (USGS 2015d). The University of Georgia Center for Invasive Species and Ecosystem Health lists six invasive aquatic plant species that have been found in the Lower Little River watershed (Table 2.6) (University of Georgia Center for Invasive Species and Ecosystem Health 2015). Five of the nonindigenous fish species are stocked in one or more of the reservoirs in the watershed (USGS 2015d). Two of the nonindigenous aquatic species found in the watershed have been identified as Aquatic Nuisance Species (ANS) in Arkansas by the Arkansas Game and Fish Commission (AGFC); Asian clam (*Corbicula fluminea*) and Nutria (*Myocastor coypus*). Three of the aquatic nuisance plant species for Arkansas have been reported in the Lower Little River watershed; Alligator Weed (*Alternanthera philoxeroides*), hydrilla (*Hydrilla verticillata*), and Eurasian water-milfoil (*Myriophyllum spicatum*) (AGFC 2013). Hydrilla, water lily, and alligator weed cover large areas of Millwood Lake, impacting access and water withdrawals, and slowing flow and increasing sedimentation (Millwood Lake Citizen Focus Committee 2009, 2010).

Table 2.6. Nonindigenous and invasive aquatic species found in the Lower Little River watershed (USGS 2015d, University of Georgia Center for Invasive Species and Ecosystem Health 2015).

| Common name            | Scientific name                       | Source           | Notes        |
|------------------------|---------------------------------------|------------------|--------------|
| Waterflea              | <i>Daphnia lumholtzi</i>              | USGS             |              |
| Inland Silverside      | <i>Menidia beryllina</i>              | USGS             |              |
| Rock Bass              | <i>Ambloplites rupestris</i>          | USGS             |              |
| Threadfin Shad         | <i>Dorosoma petenense</i>             | USGS             |              |
| Grass Carp             | <i>Ctenopharyngodon idella</i>        | USGS             |              |
| Common Carp            | <i>Cyprinus carpio</i>                | USGS             |              |
| Fathead Minnow         | <i>Pimephales promelas</i>            | USGS             |              |
| Northern Pike          | <i>Esox lucius</i>                    | USGS             | stocked      |
| Brown Bullhead         | <i>Ameiurus nebulosus</i>             | USGS             |              |
| Wiper                  | <i>Morone chrysops x M. saxatilis</i> | USGS             | stocked      |
| Striped Bass           | <i>Morone saxatilis</i>               | USGS             | stocked      |
| Saugeye                | <i>Sander canadensis x vitreus</i>    | USGS             | stocked      |
| Walleye                | <i>Sander vitreus</i>                 | USGS             | stocked      |
| Nutria                 | <i>Myocastor coypus</i>               | USGS             | Arkansas NAS |
| Asian Clam             | <i>Corbicula fluminea</i>             | USGS             | Arkansas NAS |
| Alligator Weed         | <i>Alternanthera philoxeroides</i>    | University of GA | Arkansas NAS |
| Carolina Fanwort       | <i>Cabomba caroliniana</i>            | University of GA |              |
| Hydrilla               | <i>Hydrilla verticillata</i>          | University of GA | Arkansas NAS |
| Eurasian Water-Milfoil | <i>Myriophyllum spicatum</i>          | University of GA | Arkansas NAS |
| Fragrant Waterlily     | <i>Nymphaea odorata</i>               | University of GA |              |
| Cattail                | <i>Typha spp.</i>                     | University of GA |              |

### 2.1.13 Wildlife

Wildlife species present within the Lower Little River watershed include those that rely on timbered habitats such as white-tailed deer, fox squirrels, gray squirrels, cottontail rabbits, swamp rabbits, skunks, coyotes, black bear, bobcat, mountain lion, foxes, raccoons, opossums, mice, rats, wild turkeys, bobwhite quail, woodpeckers, owls, hawks and songbirds such as nuthatches, warblers and chickadees. Several species of reptiles and amphibians also inhabit timbered areas. Wildlife species that are commonly associated with seasonal herbland within the watershed include white-tail deer, rabbits, skunks, coyotes, foxes, mice, rats, bobwhite quail, mourning doves, hawks, flycatchers, shrikes, sparrows, reptiles and amphibians (Lower Little River Watershed Coalition 2004). As of November 2000, 331 species of birds have been

identified on and around Millwood Lake (Arkansas Department of Parks and Tourism 2001). Alligators have been reported in Millwood Lake and Grassy Lake. Alligators have been present in Hempstead County since before restocking efforts were initiated in 1973. The Lower Little River Watershed is within one of five areas in Arkansas believed to have the largest concentrations of alligators (Watt, Tappe and Roth 2002).

Fishery resources within the Lower Little River watershed are both plentiful and diverse. This is due in part to the habitat diversity, which ranges from lake, to small tributary stream, to large river system habitats. At least 86 fish species representing 21 taxonomic species have been identified in the Lower Little River watershed (Seagraves 2006). Major sport fish species present include catfish, white bass, bluegill, crappie, largemouth bass and smallmouth bass. Millwood has the reputation for being one of the hottest bass fishing lakes in the United States (Lower Little River Watershed Coalition 2004).

#### **2.1.14 Protected Species**

There are several state and federally listed threatened and endangered species present in the Lower Little River watershed, including fish, mussels, and plants. Table 2.7 lists the state and federally protected species believed present in the Lower Little River watershed. The Rabbitsfoot, Ouachita Rock-pocketbook, and Winged Mapleleaf are endangered mussel species that have been recently found in the Little River (Harris, et al. 2009, USFS 2013). The US Forest Service (USFS) monitors populations of threatened Leopard Darters at a permanent monitoring site on the Cossatot River. However, no Leopard Darters have been counted there (USFS 2011, USFS 2013).

Table 2.7. Protected species found in the Lower Little River watershed.

| Common name              | Scientific name                          | Category     | State Status | Federal status |
|--------------------------|--|--------------|--------------|----------------|
| American burying beetle  | <i>Nicrophorus americanus</i>            | Invertebrate | Endangered   | Endangered     |
| Ouachita rock pocketbook | <i>Arkansia wheeleri</i>                 | Invertebrate | Endangered   | Endangered     |
| Pink mucket              | <i>Lampsilis abrupta</i>                 | Invertebrate | Endangered   | Endangered     |
| Rabbitsfoot              | <i>Quadrula cylindrica cylindrica</i>    | Invertebrate | Endangered   | Threatened     |
| Scaleshell               | <i>Leptodea leptodon</i>                 | Invertebrate | Endangered   | Endangered     |
| Arkansas Meadow-rue      | <i>Thalictrum arkansanum</i>             | Plant        | Threatened   | None           |
| Durand's White Oak       | <i>Quercus sinuata</i>                   | Plant        | Threatened   | None           |
| False Guara              | <i>Stenosiphon linifolius</i>            | Plant        | Threatened   | None           |
| Maple-leaf oak           | <i>Quercus acerifolia</i>                | Plant        | Threatened   | None           |
| Ouachita Twistflower     | <i>Streptanthus squamiformis</i>         | Plant        | Threatened   | None           |
| Prairie Evening Primrose | <i>Oenothera pilosella ssp. Sessilis</i> | Plant        | Threatened   | None           |
| Rein orchid              | <i>Platanthera flava</i>                 | Plant        | Threatened   | None           |
| Scarlet-pea              | <i>Indigofera miniata</i>                | Plant        | Threatened   | None           |
| Waterfall's Sedge        | <i>Carex latebracteata</i>               | Plant        | Threatened   | None           |
| Leopard Darter           | <i>Percina pantherina</i>                | Vertebrate   | Endangered   | Threatened     |

### 2.1.15 Sensitive Areas

Several stream segments within the Lower Little River watershed have been designated as Ecologically Sensitive Waterbodies by the Arkansas Pollution Control and Ecology Commission. These include:

- Cossatot River and its tributaries upstream of Gillham Lake reservoir,
- Robinson Creek,
- Little River upstream of Millwood Lake reservoir, and
- Grassy Lake and Yellow Creek below Millwood Lake.

The Little River upstream of the confluence with the Cossatot River has been designated as critical habitat for the Rabbitsfoot mussel by the US Fish and Wildlife Service (USFWS)

(USFWS 2015a). The National Audubon Society has designated Millwood Lake and the Little River bottoms downstream of Millwood dam as Important Bird Areas (Audubon Arkansas 2015).

Caddo Water Works Corporation bottles water from the Aquamena Spring in the National Forest in Polk County (Arkansas Geological Survey 2015).

## **2.2 Land Use/Land Cover**

The predominant land covers in the Lower Little River watershed are forest, and pasture and hay. Land cover of the Lower Little River watershed is summarized in Figure 2.6, and mapped in Figure 2.7. Land use in the watershed is primarily forestry/silviculture and livestock/poultry production.

### **2.2.1 Open Space**

Open space includes natural areas, wildlife and native plant habitat, important wetland or watershed lands, stream corridors, passive or low-impact activities, little or no land disturbance, and/or trails for non-motorized activities. There are several protected natural areas in the Lower Little River watershed, including;

- Pond Creek NWR;
- Nacatoch Ravines, White Cliffs, Saratoga Blackland Prairie, Cossatot River, and Fernwood Seep state natural areas;
- State wildlife management areas;
- State parks;
- National forest; and
- Wilderness area.

### **2.2.2 Wetlands**

Approximately 6% of the Lower Little River watershed, 68,265 acres, is wetlands. Wetlands occur primarily along the Little River and Pond Creek (within the Pond Creek NWR), around Millwood Lake, and downstream of Millwood Lake along the Little River and Yellow Creek, and around Grassy Lake.

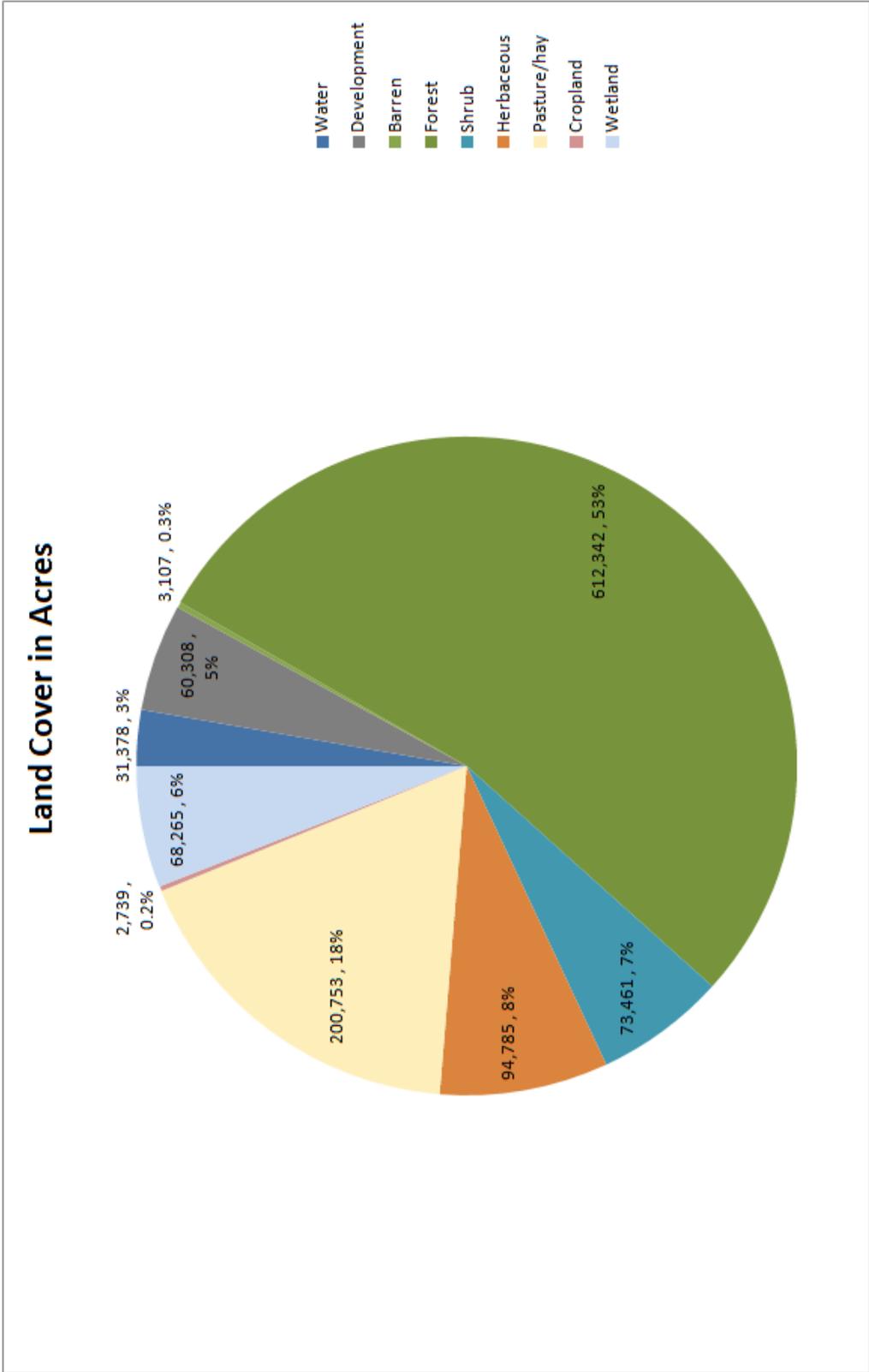


Figure 2.6. Land cover in the Lower Little River watershed (Homer, et al. 2015).

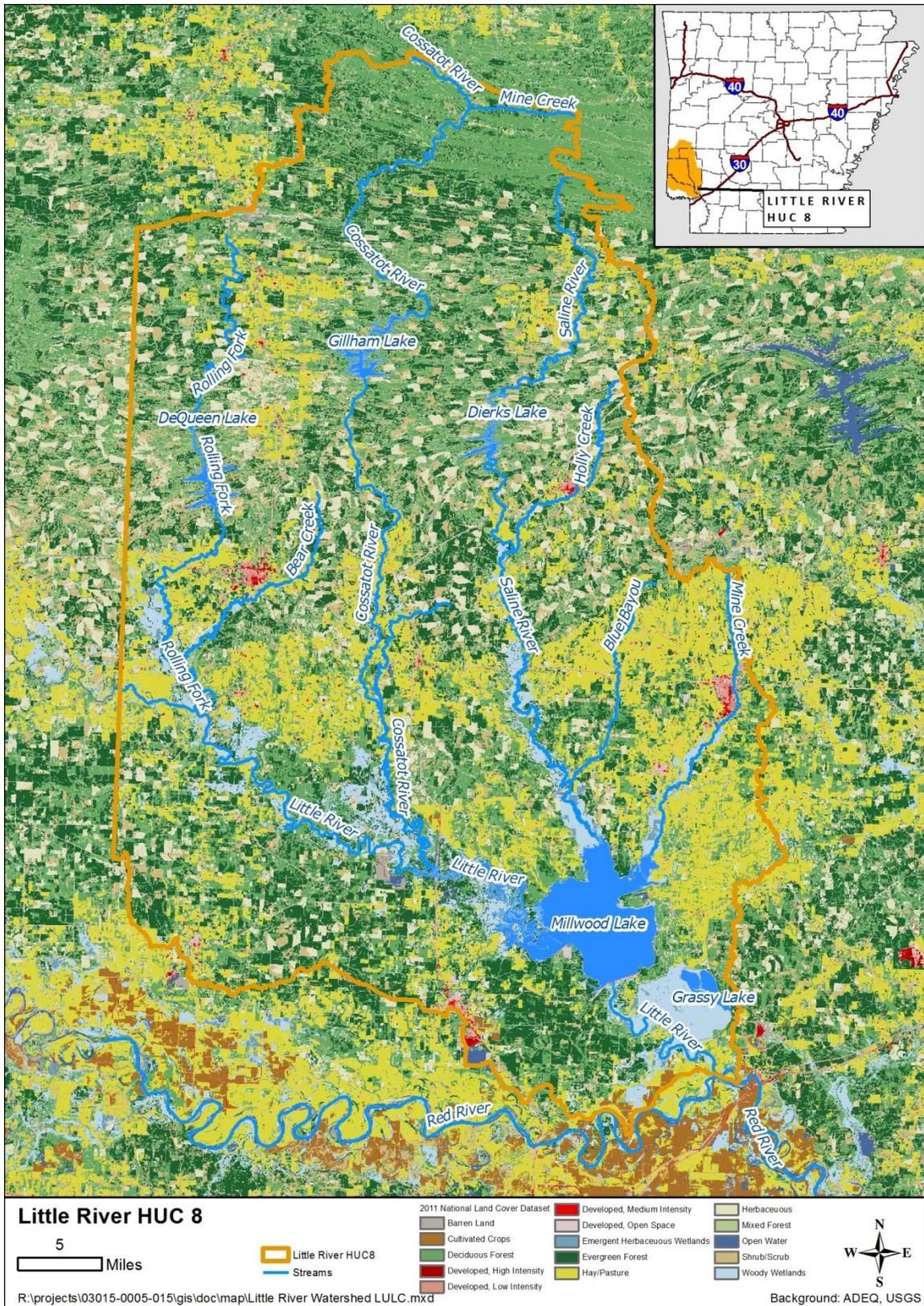


Figure 2.7. Land cover map of the Lower Little River watershed (Homer, et al. 2015).

### **2.2.3 Forested Areas**

Forestland makes up about 53% of the watershed area. It includes loblolly and shortleaf pine, pine-hardwood and hardwood forests. In 2014, oak-hickory was one of the dominant forest types, accounting for approximately 27% of the acreage. Loblolly and shortleaf pine accounted for about 24% of the acreage with about 86% of this being planted and the remaining 14% in natural stands. Oak-pine accounts for another 11%. These forest types are mainly found on more northerly aspects, ridgetops and in areas receiving less precipitation. Oak-gum or cypress and elm-ash-cottonwood located in stream bottoms account for 6%. Other forest types account for the remaining 32% of forest area (USFS 2015a).

In Howard County, almost 50% of the land is owned by the timber company Weyerhaeuser (Association of Arkansas Counties 2015a). In 2014, 54% of the forest land in the Lower Little River watershed was owned by forest industries. Another 32% were in non-industrial private ownership. The remaining 14% of forestlands consist of USFS ownership (about 11%), State and County ownership (about 1%), and other Federal ownership managed by the USFWS and USACE (about 2%) (USFS 2015a).

### **2.2.4 Agricultural Lands**

Agricultural lands make up about 18% of the Lower Little River watershed area. Only 1% of the agricultural lands are cropland. Cropland occurs primarily in Little River County. Crops include soybeans, wheat, and corn (USDA National Agricultural Statistics Service 2014).

The majority of the agricultural lands consist of pasture and hayland. Livestock and poultry production are significant in the Lower Little River watershed. Pasture and hayland in the watershed are commonly used for disposal of manure from confined animal production operations.

Recent livestock and poultry numbers reported by the US Department of Agriculture (USDA) National Agricultural Statistics Service for the counties of the Lower Little River watershed are compared to numbers from 2002 in Table 2.8. In all of the counties, broiler production has increased an order of magnitude. For the most part, production of other livestock in these counties is slightly lower in 2012 than in 2002.

Table 2.8. Inventories of selected livestock in the counties of the Lower Little River watershed.

|                 | Polk      |            | Hempstead  |            | Sevier    |            | Little River |            | Howard    |            |
|-----------------|-----------|------------|------------|------------|-----------|------------|--------------|------------|-----------|------------|
|                 | 2002      | 2012       | 2002       | 2012       | 2002      | 2012       | 2002         | 2012       | 2002      | 2012       |
| Cattle & calves | 38,751    | 28,675     | 61,211     | 55,935     | 31,854    | 32,892     | 31,277       | 34,666     | 44,646    | 41,882     |
| Beef cows       | D*        | D*         | D*         | D*         | 20,105    | 19,938     | 13,625       | 14,414     | 21,317    | 16,773     |
| Hogs & pigs     | 7,744     | 2,925      | 3,469      | 4,045      | 13,436    | 4,746      | D*           | D*         | 35,758    | 21,240     |
| Layers          | 236,393   | 269,050    | 591,272    | 676,508    | 56,031    | 88,677     | D*           | 43,117     | 557,520   | 367,690    |
| Broilers        | 4,582,054 | 30,642,336 | 11,001,979 | 41,187,604 | 6,799,414 | 41,385,544 | 2,213,940    | 15,595,098 | 7,645,202 | 37,161,741 |

\* data withheld to avoid disclosure of data for individual farms

## 2.2.5 Mining

There are a number of non-coal mines in the watershed permitted by the Arkansas Department of Environmental Quality (ADEQ). Information from these permits is summarized in Table 2.9. Table 2.10 lists active mining facilities reported by the Arkansas Geological Survey. Some of these mines are duplicated between the two tables. There are several rock quarries, and a number of open-cut sand and gravel mining operations.

Table 2.9 Mining facilities in the Lower Little River watershed with active ADEQ permits.

| Permit No.     | Facility Name                | County       | Nearest town | Material Mined  |
|----------------|------------------------------|--------------|--------------|-----------------|
| 0532-MN-A3     | CertainTeed Gypsum           | Howard       | Nashville    | Gypsum          |
| 0457-MN-A2, A4 | Blue Bayou Sand and Gravel   | Howard       | Nashville    | Sand and gravel |
| 0673-MN        | James M Goodson Mining       | Howard       | Nashville    | Sand and gravel |
| 0076-MQ        | Vista Crest Properties, Inc. | Howard       | Nashville    | Rock            |
| 0458-MN- A4    | Meridian Aggregates, Co.     | Polk         | Hatton       | Sand and gravel |
| 0031-MQ-A2     | Meridian Aggregates, Co.     | Polk         | Hatton       | Rock            |
| 0498-MN-A7     | Cossatot Rock, LLC           | Sevier       | Lockesburg   | Sand and gravel |
| 0383-MN-A4     | Trinity Materials            | Sevier       | Lockesburg   | Sand and gravel |
| 0088-MQ        | Amelia Minerals, LLC         | Sevier       | Dierks       | Rock            |
| 0160-MN-A6     | Hanson Aggregates West, Inc. | Little River | Ashdown      | Sand and gravel |
| 0654-MN        | Matteson, Worth              | Little River | Foreman      | Sand            |

Table 2.10. Active mining facilities reported by the Arkansas Geological Survey.

| Facility Name                        | County       | Nearest town          | Material mined  |
|--------------------------------------|--------------|-----------------------|-----------------|
| Gifford-Hill gravel pit              | Little River | Wilton                | Sand and gravel |
| Unknown                              | Little River | Jewel                 | Chalk           |
| The junction pit                     | Sevier       | Red Wing              | Sand and gravel |
| Gravel pit                           | Sevier       | Lockesburg            | Sand and gravel |
| Gravel pit                           | Sevier       | Central               | Sand and gravel |
| Sand pit                             | Sevier       | DeQueen               | Sand and gravel |
| Cossatot pit                         | Sevier       | Union                 | Sand and gravel |
| HMB Quarry                           | Sevier       | Red Wing, Provo       | Crushed stone   |
| CertainTeed Nashville Plant and Mine | Howard       | Briar                 | Gypsum          |
| Blue Bayou Sand and Gravel           | Howard       | Blue Bayou            | Sand and gravel |
| Gravel pits                          | Howard       | Temperanceville       | Sand and gravel |
| Shale pits                           | Howard       | Baker Springs, Galena | Shale           |
| Hatton Quarry                        | Polk         | Hatton                | Crushed stone   |
| Shale pit                            | Polk         | Hartley               | Shale           |

## **2.2.6 Recreation**

Outdoor recreation lands in the Lower Little River watershed includes two State Parks, three Wildlife Management Areas (WMAs), one (NWR, four USACE reservoirs, and the Ouachita National Forest. Outdoor recreational activities in the Lower Little River watershed include boating, camping, hunting, fishing, hiking, and bird watching. The Cossatot River upstream of Gillham Lake is the most challenging whitewater in Arkansas with sections ranging in difficulty from Class II to Class V whitewater.

## **2.2.7 Developed Areas**

There are a number of smaller cities and towns in the Lower Little River watershed. Overall, there are 60,308 acres of developed land in the watershed. Ashdown, DeQueen, and Nashville are the largest cities in the watershed.

## **2.2.8 Transportation**

The major north-south transportation corridor in the watershed is US Highway 71. US Highways 70 and 371 are the major east-west transportation routes in the watershed. Railroads also transport commodities to and through the watershed. There is one county-owned airport in the watershed near DeQueen. Another county-owned airport is located just outside the watershed near Nashville.

## **2.2.9 Political Boundaries and Jurisdictions**

### **2.2.9.1 Federal Lands**

Table 2.11 lists federally owned and managed lands and waterbodies in the Lower Little River watershed, along with the federal agencies responsible for them.

Table 2.11. Federal lands within the Lower Little River watershed.

| Area/waterbody name                                      | Land/waterbody area     | Responsible federal agency |
|--|-------------------------|----------------------------|
| Cossatot National Wild and Scenic River                  | 30.6 miles              | USACE, USFS                |
| Pond Creek NWR   | 26,879 acres            | USFWS                      |
| Millwood Lake  | 29,500 acres            | USACE                      |
| Dierks Lake  | 1,360 acres             | USACE                      |
| De Queen Lake  | 1,680 acres             | USACE                      |
| Gillham Lake   | 1,370 acres             | USACE                      |
| Ouachita National Forest                                 | 1,434,872 acres (in AR) | USFS                       |
| Caney Creek Wilderness (within Ouachita National Forest) | 14,290 acres            | USFS                       |

### 2.2.9.2 State Lands

State lands in the Lower Little River watershed include state parks, wildlife management areas, and state natural areas. Information on the state lands in the watershed is summarized in Table 2.12.

Table 2.12. State lands in the Lower Little River watershed.

| Area Name   | Land Area   | Responsible State Agency                 |
|---|---|--|
| Cossatot River State Park   | 5,401 acres   | Arkansas Department of Parks and Tourism |
| Millwood State Park   | 824 acres   | Arkansas Department of Parks and Tourism |
| Natural Areas:<br>Nacatoch Ravines<br>White Cliffs<br>Saratoga Blackland Prairie<br>Cossatot River<br>Fernwood Seep | 2,122 acres<br>573 acres<br>66 acres<br>4,470 acres<br>10 acres | Arkansas Natural Heritage Commission     |
| Wildlife Management Areas:<br>Howard County WMA<br>Little River WMA<br>Rick Evans Grandview Prairie WMA             | 26,656 acres<br>590 acres<br>4,885 acres                        | AGFC                                     |

### **2.2.10 Relevant Authorities**

Waters of the Lower Little River watershed are under the jurisdiction of federal and state agencies and regulations. Lands in the watershed are under the jurisdiction of state, county, and local agencies and regulations.

#### **2.2.10.1 Federal Authorities**

There are 12 federal agencies involved in water resources management in the Lower Little River watershed. These agencies are listed in Table 2.13, along with their respective activities in the watershed.

#### **2.2.10.2 Arkansas Authorities**

There are nine state agencies and one state nonprofit organization with responsibilities in the Lower Little River watershed. These agencies are listed in Table 2.14, along with a description of their water resources management responsibilities within the watershed.

#### **2.2.10.3 Local Authorities**

There are a number of local and regional entities involved in activities related to water resources management in the Lower Little River watershed. Examples are shown in Table 2.15, along with descriptions of their activities related to water resources management.

Table 2.13. Federal agencies with water resources-related responsibilities in the Lower Little River watershed.

| Federal Agency   | Responsibility in Arkansas   |
|--|--|
| EPA  | <ul style="list-style-type: none"> <li>• Oversees state agencies in implementation of management and funding programs under               <ul style="list-style-type: none"> <li>○ Clean Water Act,</li> <li>○ Safe Drinking Water Act,</li> <li>○ RCRA,</li> <li>○ Superfund,</li> <li>○ Federal Insecticide, Fungicide, and Rodenticide Act, and</li> <li>○ Surface Mining Control and Reclamation Act</li> </ul> </li> <li>• Conducts total maximum daily load (TMDL) studies and other water quality studies in the watershed</li> <li>• Implements programs under the Toxic Substances Control Act</li> </ul> |
| FEMA   | <ul style="list-style-type: none"> <li>• Prepares flood hazard maps for the region and encourages local governments to guide development decisions away from defined flood hazard risk areas through participation in the National Flood Insurance Program</li> <li>• Ashdown, De Queen, Dierks, Foreman, Gillham, Horatio, Lockesburg Mineral Springs, and Nashville participate in the program, as well as unincorporated areas of Hempstead, Howard, Polk, and Sevier Counties FEMA (Federal Emergency Management Agency 2015).</li> </ul>  |
| National Oceanic and Atmospheric Administration                                | Participates in monitoring precipitation and climate   |
| Natural Resources Conservation Service (NRCS) National Water Management Center | <ul style="list-style-type: none"> <li>• Located in Little Rock</li> <li>• Serves as a water resources information exchange</li> <li>• Provides support and training related to               <ul style="list-style-type: none"> <li>○ environmental compliance,</li> <li>○ hydrology and hydraulics,</li> <li>○ stream geomorphology and restoration,</li> <li>○ water quality and quantity,</li> <li>○ watershed and dam rehabilitation, and</li> <li>○ technology outreach</li> </ul> </li> </ul>   |
| USACE  | <ul style="list-style-type: none"> <li>• Manages federal water supply and flood control projects in the watershed: De Queen, Dierks, Gillham, and Millwood Lakes.</li> <li>• Implements sections of the Clean Water Act related to impacts to navigable waters (Little River) and wetlands</li> <li>• Constructs flood control, irrigation, and water supply projects authorized by the Water Resources Development Act</li> <li>• Oversees dam safety for federal dams</li> </ul>   |

Table 2.13. Federal agencies with water resources-related responsibilities in the Lower Little River watershed (continued).

| Federal Agency            | Responsibility in Arkansas   |
|---------------------------|--|
| USDA                      | <ul style="list-style-type: none"> <li>• Conducts the Census of Agriculture</li> <li>• Conducts the Natural Resources Inventory</li> <li>• Manages Conservation Effects Assessment Projects (watershed and regional)</li> </ul>  |
| USDA Farm Services Agency | Implements the Conservation Reserve Program for erosion control and habitat restoration in the watershed   |
| USFS                      | <ul style="list-style-type: none"> <li>• Manages the Ouachita National Forest and associated surface waters</li> <li>• Forest management incentive programs</li> <li>• Participates in forest inventory</li> <li>• Manages Urban and Community Forestry Program</li> </ul>   |
| NRCS                      | <ul style="list-style-type: none"> <li>• Implements over 20 Farm Bill programs for erosion control and habitat restoration funding and technical assistance in the watershed</li> <li>• Appraises the status and trends of soil, water, and related resources on non-federal land in the state and assesses their capability to meet present and future demands</li> </ul>   |
| USDA Rural Development    | <ul style="list-style-type: none"> <li>• Implements USDA rural utilities financial assistance programs</li> </ul>  |
| USFWS                     | <ul style="list-style-type: none"> <li>• Implements the Endangered Species Act and programs to <ul style="list-style-type: none"> <li>○ Promote management of ecosystems,</li> <li>○ Promote conservation of migratory birds,</li> <li>○ Promote preservation of wildlife habitat,</li> <li>○ Promote restoration of fisheries,</li> <li>○ Combat invasive species, and</li> <li>○ Promote international wildlife conservation</li> </ul> </li> <li>• Implements the Partners For Wildlife Program for restoration of wetlands, streams, and riparian areas</li> <li>• Conducts the National Wetland Inventory</li> <li>• Oversees state wildlife planning through the State Wildlife Grant Program</li> </ul> |
| USGS                      | <ul style="list-style-type: none"> <li>• Flow and stage monitoring of rivers and streams</li> <li>• Groundwater level monitoring</li> <li>• Water quality monitoring</li> <li>• Groundwater modeling</li> <li>• Water quality modeling</li> <li>• Water data storage and management</li> </ul>   |

Table 2.14. Arkansas agencies and entities with responsibilities related to water resources in the Lower Little River watershed.

| Arkansas State Entity                    | Responsibility  |
|--|---|
| ADEQ                                     | <ul style="list-style-type: none"> <li>• Implements state water quality policy and the Clean Water Act NPDES program</li> <li>• Develops and enforces water quality standards</li> <li>• Investigates citizen complaints regarding water pollution</li> <li>• Oversees solid waste management</li> <li>• Operates the hazardous waste management program</li> <li>• Manages contaminated site clean-up and redevelopment programs</li> <li>• Develops and enforces mining and mine site reclamation regulations</li> <li>• Manages the storage tank regulation program</li> <li>• Permits no-discharge facilities and underground injection operations</li> <li>• Water quality monitoring and assessment</li> </ul>  |
| ANRC                                     | <ul style="list-style-type: none"> <li>• Regulates, permits, and tracks water use and dam construction</li> <li>• Monitors climate</li> <li>• Administers federal water resources funding programs</li> <li>• Prepares and implements water resources and nonpoint source pollution management plans</li> <li>• Develops and maintains mitigation banking and restoration incentive programs for aquatic resources</li> <li>• Supports conservation districts</li> <li>• Promotes public health and safety and minimize flood losses through <ul style="list-style-type: none"> <li>○ training,</li> <li>○ education,</li> <li>○ technical assistance in floodplain management, and</li> <li>○ accrediting floodplain administrators</li> </ul> </li> </ul> |
| Arkansas Department of Health            | <ul style="list-style-type: none"> <li>• Regulates public water supply systems</li> <li>• Implements the Safe Drinking Water Act source water protection programs</li> <li>• Issues fish consumption advisories</li> <li>• Implements state health rules and regulations that apply to water resources</li> <li>• Regulates septic tanks and licenses septic tank cleaners</li> <li>• outdoor bathing and swimming</li> <li>• Implements state marine sanitation program</li> </ul>   |
| Arkansas Department of Parks and Tourism | <ul style="list-style-type: none"> <li>• Manages the two state parks and associated water resources in the planning region</li> <li>• Prepares comprehensive outdoor recreation plan</li> <li>• Manages outdoor recreation grant program</li> </ul>   |
| Arkansas Forestry Commission             | <ul style="list-style-type: none"> <li>• Provides guidelines for protection of water resources in forestry operations</li> <li>• Monitors use of forestry BMPs</li> <li>• Participates in forest inventory</li> <li>• Implements forest management incentive programs</li> <li>• Implements Urban and Community Forestry program</li> </ul>   |

Table 2.14. Arkansas agencies and entities with responsibilities related to water resources in the Lower Little River watershed (continued).

| Arkansas State Entity                       | Responsibility  |
|---|---|
| AGFC  | <ul style="list-style-type: none"> <li>• Manages protection, conservation and preservation of fish and wildlife in Arkansas through               <ul style="list-style-type: none"> <li>○ habitat management,</li> <li>○ wildlife management areas,</li> <li>○ fish stocking,</li> <li>○ hunting and fishing regulations, and</li> <li>○ education and outreach programs</li> </ul> </li> <li>• Prepares state Wildlife Action Plan</li> <li>• Implements conservation grant programs</li> <li>• Manages three wildlife management areas in the watershed</li> </ul> |
| Arkansas Geological Survey                  | <ul style="list-style-type: none"> <li>• Participates in research of, and provides information and education about, state water resources</li> <li>• Mapping</li> <li>• Water well construction records</li> </ul>  |
| Arkansas Livestock and Poultry Commission   | Regulates disposal of livestock carcasses, which helps protect water quality  |
| Arkansas Natural Heritage Commission (ANHC) | <ul style="list-style-type: none"> <li>• Surveys and conducts research on natural communities in the state</li> <li>• Acquires natural areas for preservation</li> <li>• Manages five natural areas in the watershed</li> </ul>   |

Table 2.15. Local and regional entities with responsibilities related to water resources management in the Lower Little River watershed.

| Regional or Local Entity                                      | Water Resources Involvement   |
|---|---|
| County Conservation Districts                                 | Work with state and federal agencies to implement measures for the control of erosion and flooding, and conservation of soil and water resources                        |
| County Government   | Responsible for unincorporated areas, including floodplain management and zoning  |
| Irrigation Districts (e.g., Walnut Bayou Irrigation District) | Created by circuit court order to distribute water resources  |
| Southwest Arkansas Planning and Development District          | <ul style="list-style-type: none"> <li>• Water supply and wastewater infrastructure improvements</li> <li>• Assist Regional Solid Waste Management Districts</li> </ul> |
| Regional Solid Waste Management Districts                     | Manage collection, disposal, and recycling of solid waste   |
| Southwest Arkansas Water District                             | Public nonprofit organizations for distribution of water from Millwood Lake   |
| Water districts and associations                              | <ul style="list-style-type: none"> <li>• Water supply planning and management</li> <li>• Supply water and wastewater services</li> </ul>                                |
| Lower Little River Watershed Coalition                        | Development and implementation of watershed restoration action strategy   |

## 2.3 Demographic Characteristics

### 2.3.1 Population

Demographic information from the US Census Bureau for the counties within the Lower Little River watershed is presented below. Numbers of people are presented in Table 2.16. The watershed is primarily rural, with no urbanized areas, as defined by the US Census Bureau. However, there are three urban clusters (as defined by the US Census Bureau) within the watershed; De Queen in Sevier County, Nashville in Howard County, and a portion of Ashdown in Little River County (US Census Bureau 2012).

Between 2000 and 2010, population decreased in Hempstead, Howard, and Little River counties, and increased in Polk and Sevier counties. Between 2010 and 2014, population decreased in Polk County as well as Hempstead, Howard, and Little River counties while Sevier County continued to increase. Hempstead, Howard, Little River, and Polk counties are projected to have little change in population in 2020, while the Sevier County population may increase.

Table 2.16. Numbers of people in the Arkansas counties of the Lower Little River watershed.

| County       | 2000 (a)            |                      | 2010 (a)            |                      | 2014<br>population<br>estimate (a) | 2020 projection (b) |
|--------------|---------------------|----------------------|---------------------|----------------------|------------------------------------|---------------------|
|              | Total<br>population | Percent<br>urban (c) | Total<br>population | Percent<br>urban (d) |                                    |                     |
| Hempstead    | 23,587              | 44.7                 | 22,609              | 44.2                 | 22,327                             | 21,418 – 23,576     |
| Howard       | 14,300              | 33.1                 | 13,789              | 32.5                 | 13,500                             | 13,030 – 14,158     |
| Little River | 13,628              | 27.3                 | 13,171              | 31.5                 | 12,532                             | 12,064 – 12,939     |
| Polk         | 20,229              | 25.8                 | 20,662              | 26.6                 | 20,225                             | 18,583 – 21,634     |
| Sevier       | 15,757              | 37.0                 | 17,058              | 36.4                 | 17,426                             | 16,664 – 20,070     |

(a) (US Census Bureau 2014a)

(b) (UALR Institute for Economic Advancement 2013)

(c) (US Census Bureau 2003)

(d) (US Census Bureau 2012)

Additional demographic information for the counties in the Lower Little River watershed are listed in Table 2.17. This includes numbers for commuting, household structure, age, gender, race, median income, poverty, workers, and education. The majority of commuters drive alone. The majority of households consist of two-parent families. All counties also have fairly large numbers of both single parent and single person households. The median age in the watershed is around 39, with somewhat more people under the age of 18 than 65 and older. There are roughly

similar numbers of males and females, though all counties have slightly more females. The majority of persons in the watershed are White non-hispanic, particularly in Polk County where the ratio is more than 90%. The four other counties in the watershed have significant numbers of other races: Black non-hispanic in Little River County, Hispanic in Sevier County, and both of those in Hempstead and Howard counties. No other race accounts for more than 2% of the population. Median household incomes are below the state average in all counties, with higher numbers than statewide percentages of people and families below poverty level in all but Little River County. The unemployment rate is higher than the state average in Hempstead, Howard, and Sevier counties and lower in Little River and Polk counties. Only Polk County has a higher rate of high school graduation than the state average, though Hempstead and Little River counties are near it, and all counties are below the state average for bachelor and graduate degrees.

Table 2.17. Additional demographic information.

|                                   | Hempstead<br>County | Howard<br>County | Little River<br>County | Polk<br>County | Sevier<br>County | State of<br>Arkansas |
|-----------------------------------|---------------------|------------------|------------------------|----------------|------------------|----------------------|
| Commuting (number of persons) (b) |                     |                  |                        |                |                  |                      |
| Total                             | 8,946               | 5,699            | 5,383                  | 7,976          | 6,485            | 1,225,869            |
| Drove alone                       | 7,286               | 4,312            | 4,522                  | 6,409          | 4,380            | 82.2%                |
| Carpooled                         | 1,136               | 936              | 696                    | 1,060          | 1,788            | 11.1%                |
| Walk or other                     | 352                 | 249              | 115                    | 200            | 128              | 3.6%                 |
| Mean travel time (minutes)        | 19.7                | 18.7             | 23.4                   | 20.3           | 21.4             | 21.3                 |
| Worked at home                    | 172                 | 202              | 50                     | 307            | 189              | 3.2%                 |
| Household structure (a)           |                     |                  |                        |                |                  |                      |
| Family households                 | 6,107               | 3,791            | 3,707                  | 5,878          | 4,398            | 67.6%                |
| Two parent families               | 4,108               | 2,747            | 2,716                  | 4,712          | 3,302            | 49.5%                |
| Single parent families            | 1,999               | 1,044            | 991                    | 1,166          | 1,096            | 18.1%                |
| Single person household           | 2,404               | 1,412            | 1,509                  | 2,258          | 1,389            | 27.1%                |
| Other nonfamily household         | 328                 | 162              | 195                    | 314            | 188              | 5.3%                 |
| Age (number of persons) (a)       |                     |                  |                        |                |                  |                      |
| Median age                        | 37.7                | 38.4             | 41.2                   | 43.1           | 33.7             | 37.4                 |
| 65 and older                      | 3,396               | 2,104            | 2,253                  | 4,025          | 2,147            | 14.4%                |
| Under 18                          | 5,878               | 3,623            | 3,137                  | 4,921          | 5,040            | 24.4%                |
| Gender (number of persons) (a)    |                     |                  |                        |                |                  |                      |
| Female                            | 11,704              | 7,133            | 6,768                  | 10,499         | 8,549            | 50.9%                |
| Male                              | 10,905              | 6,656            | 6,403                  | 10,163         | 8,464            | 49.1%                |

Table 2.17. Additional demographic information (continued).

|  | Hempstead<br>County | Howard<br>County | Little River<br>County | Polk<br>County | Sevier<br>County | State of<br>Arkansas |
|--|---------------------|------------------|------------------------|----------------|------------------|----------------------|
| Race (number of persons) (a)                   |                     |                  |                        |                |                  |                      |
| White non-hispanic                             | 12,770              | 9,292            | 9,831                  | 18,549         | 10,416           | 74.5%                |
| Hispanic                                       | 2,713               | 1,349            | 357                    | 1,190          | 5,220            | 6.4%                 |
| Black non-hispanic                             | 6,623               | 2,813            | 2,508                  | 54             | 717              | 15.3%                |
| Native American                                | 77                  | 94               | 186                    | 348            | 324              | 0.7%                 |
| Asian  | 82                  | 84               | 39                     | 88             | 62               | 1.2%                 |
| Other race                                     | 37                  | 19               | 15                     | 13             | 21               | 0.3%                 |
| >1 race non-hispanic                           | 307                 | 138              | 235                    | 420            | 298              | 1.6%                 |
| Income (b)                                     |                     |                  |                        |                |                  |                      |
| Median household income                        | \$32,056            | \$35,879         | \$39,673               | \$32,835       | \$35,153         | \$40,768             |
| Families below poverty level                   | 22.2%               | 19.6%            | 9.9%                   | 17.3%          | 19.0%            | 14.4%                |
| People below poverty level                     | 27.4%               | 23.2%            | 14.0%                  | 23.1%          | 24.4%            | 19.2%                |
| Employment (b)                                 |                     |                  |                        |                |                  |                      |
| Unemployed                                     | 9.6%                | 9.4%             | 6.5%                   | 7.1%           | 11.5%            | 8.9%                 |
| Management, business, science,<br>arts         | 2,249               | 1,318            | 1,068                  | 2,220          | 1,371            | 31.2%                |
| Service  | 1,391               | 967              | 1,021                  | 1,158          | 912              | 17.2%                |
| Sales, office                                  | 2,076               | 1,066            | 1,077                  | 1,836          | 1,144            | 24.1%                |
| Resources, construction,<br>maintenance        | 1,176               | 685              | 796                    | 1,317          | 1,193            | 10.9%                |
| Production, transportation,<br>material moving | 2,319               | 1,900            | 1,528                  | 1,559          | 2,106            | 16.6%                |
| Self-employed                                  | 708                 | 397              | 370                    | 922            | 510              | 6.4%                 |
| Education (population 25 or older) (b)         |                     |                  |                        |                |                  |                      |
| High School graduate                           | 81.7%               | 76.0%            | 83.4%                  | 85.1%          | 66.3%            | 83.7%                |
| Bachelor degree                                | 14.1%               | 12.0%            | 10.6%                  | 12.3%          | 8.6%             | 20.1%                |
| Graduate degree                                | 4.0%                | 4.7%             | 2.7%                   | 3.9%           | 2.7%             | 6.8%                 |

(a) (US Census Bureau 2010)

(b) (US Census Bureau 2013)

### 2.3.2 Economics

Significant industries in the Lower Little River watershed include agriculture, timber, manufacturing, transportation, and tourism (Association of Arkansas Counties 2015b) (Central Arkansas Library System 2015). The value of sales and receipts reported for the counties within the Lower Little River watershed in the 2012 economic census is summarized in Table 2.18. Agriculture and timber are not economic sectors reported in the economic census, though the US Census Bureau does provide data for a portion of the timber sector. However, both these sectors do contribute value to manufacturing, real estate, wholesale trade, and transportation and warehousing economic sectors (U of A Division of Agriculture 2012).

Table 2.18. Sales and receipts for Arkansas counties in the Lower Little River watershed, in \$1,000 (US Census Bureau 2014b, 2015).

| Economic Sector              | Hempstead             | Howard                | Little River         | Polk                  | Sevier                | Total       |
|------------------------------|-----------------------|-----------------------|----------------------|-----------------------|-----------------------|-------------|
| Forestry & Logging*          | \$1,587               | \$2,550               | \$2,716              | \$4,764               | \$1,416               | \$13,003    |
| Manufacturing                | \$787,209             | \$1,023,134           | \$159 <sup>†</sup>   | \$26,032 <sup>†</sup> | \$1,135 <sup>†</sup>  | \$1,837,669 |
| Wholesale Trade              | \$52,029 <sup>‡</sup> | \$34,243 <sup>‡</sup> | †,‡                  | †,‡                   | \$19,369 <sup>‡</sup> | \$105,641   |
| Retail Trade                 | \$202,582             | \$166,199             | \$106,339            | \$199,777             | \$196,507             | \$871,404   |
| Transportation & Warehousing | \$6,608 <sup>†</sup>  | \$34,898              | \$15,254             | \$26,446              | \$3,041 <sup>†</sup>  | \$86,247    |
| Accommodation & Food Service | \$23,262              | \$10,380 <sup>†</sup> | \$7,368 <sup>†</sup> | \$19,147              | \$10,925              | \$71,082    |
| Total                        | \$1,073,277           | \$1,271,404           | \$131,836            | \$276,166             | \$232,393             | \$2,985,046 |

\*Non-employer firm data from IRS tax return information; does not include values, if any, for employer establishments.

<sup>†</sup>Data for some or all employer establishments withheld by US Census to avoid disclosing data for individual companies.

<sup>‡</sup>Data for non-employer establishments not available or not comparable.

The largest economic sector in the counties of the Lower Little River watershed is manufacturing – particularly poultry processing. Timber is also cited as a significant industry (Central Arkansas Library System 2015), though it is difficult to determine the full extent due to census data collection and confidentiality constraints. Retail trade also accounts for substantial economic activity. In addition to the values shown in Table 2.17, there are large employers inside the watershed with sales and receipts withheld from the US Census data: two manufacturers in Little River County and poultry processors in both Polk and Sevier County. (Poultry processing facilities in Hempstead and Howard counties are included in the table.) (Arkansas Economic Development Commission 2013).

### 2.3.2.1 Agriculture

Agriculture is the largest industry in Arkansas, and is an important economic driver in the Lower Little River watershed. This includes cattle production, poultry and egg production, row crop agriculture (including vegetables), orchards (including peaches and pecans), and food processing. Arkansas is the second largest broiler producer in the country (US Department of Agriculture Economic Research Service 2012). The values of sales of selected agricultural commodities for each of the counties in the Lower Little River watershed are shown in Table 2.19. Poultry and eggs account for the vast majority of agricultural sales in all counties except Little River, where they still account for more than half of the total sales.

Table 2.19. Value of sales of agricultural commodities, in \$1,000, for counties in the Lower Little River watershed (USDA National Agricultural Statistics Service 2014).

| Commodity                          | Hempstead | Howard    | Little River | Polk      | Sevier    | Total     |
|------------------------------------|-----------|-----------|--------------|-----------|-----------|-----------|
| All agricultural products          | \$198,491 | \$179,081 | \$76,510     | \$117,773 | \$137,415 | \$709,270 |
| All crops                          | \$4,551   | \$1,389   | \$17,789     | \$1,648   | \$810     | \$26,187  |
| Grains, oilseeds, dry beans & peas | \$168     | -         | \$13,411     | †         | -         | \$13,579  |
| Fruits, tree nuts, & berries       | †         | \$469     | \$2,846      | †         | †         | \$3,315   |
| Other crops & hay                  | \$1,639   | \$900     | \$1,420      | \$1,437   | \$771     | \$6,167   |
| All livestock                      | \$193,939 | \$177,692 | \$58,631     | \$116,125 | \$136,604 | \$682,991 |
| Poultry & eggs                     | \$172,515 | \$152,253 | \$46,293     | \$102,392 | \$122,638 | \$596,091 |
| Cattle & calves                    | \$18,940  | \$15,426  | \$11,801     | \$11,755  | \$11,658  | \$69,580  |
| Hogs & pigs                        | \$1,787   | \$9,913   | †            | \$1,641   | \$2,132   | \$15,473  |
| Forest products                    |           |           |              |           |           |           |

†Data withheld by USDA NASS to avoid disclosing data for individual operations.

### 2.3.2.2 Tourism

Tourism is the second largest industry in Arkansas. The Arkansas Department of Parks and Tourism reports that, in 2014, over \$122 million of travel expenditures were made in the counties within the Lower Little River watershed, and tourism generated over \$2.9 million in

local tax revenue (Table 2.20). The USACE has estimated economic impacts of the reservoirs located in the Lower Little River watershed. Overall, the four USACE reservoirs in the watershed generate over 300 jobs, and over \$36 million in revenue, wages, and taxes (Table 2.21). The USFWS estimates that the Pond Creek NWR generates \$969,220 in expenditures annually (USFWS n.d.).

Table 2.20. Economic impacts of tourism\* for counties in the Lower Little River watershed (Arkansas Department of Parks and Tourism 2015).

|                             | <b>Hempstead</b> | <b>Howard</b> | <b>Little River</b> | <b>Polk</b>  | <b>Sevier</b> |
|-----------------------------|------------------|---------------|---------------------|--------------|---------------|
| Travel expenditures         | \$51,857,061     | \$4,550,553   | \$24,446,801        | \$24,776,191 | \$16,920,583  |
| Travel-generated payroll    | \$9,800,012      | \$530,144     | \$3,483,393         | \$4,433,785  | \$2,585,614   |
| Travel-generated employment | 535 jobs         | 24 jobs       | 193 jobs            | 253 jobs     | 146 jobs      |
| Travel-generated local tax  | \$1,235,838      | \$88,729      | \$751,142           | \$525,457    | \$330,994     |

\*2014 Preliminary

Table 2.21. Economic benefits from USACE reservoirs in the Lower Little River watershed in 2012 (USACE 2015b).

| <b>Reservoir</b> | <b>Total Sales</b> | <b>Jobs</b> | <b>Payroll</b> | <b>Value Added<sup>1</sup></b> |
|------------------|--------------------|-------------|----------------|--------------------------------|
| DeQueen          | \$2,760,000        | 47          | \$974,000      | \$1,603,000                    |
| Dierks           | \$4,392,000        | 79          | \$1,462,000    | \$2,526,000                    |
| Gillham          | \$2,278,000        | 40          | \$741,000      | \$1,286,000                    |
| Millwood         | \$9,198,000        | 139         | \$3,455,000    | \$5,699,000                    |
| Total            | \$18,628,000       | 305         | \$6,632,000    | \$11,114,000                   |

<sup>1</sup> includes wages, salaries, payroll benefits, profits, rents, and indirect business taxes

### 2.3.2.3 Timber

The timber industry is important to the economy of the Lower Little River watershed. Arkansas was the 4<sup>th</sup> largest producer of saw logs in the South in 2012. Forestry is the leading employer in south Arkansas (U of A Cooperative Extension Service 2014). Weyerhaeuser Company and Domtar are two large forest products companies that own land in the Lower Little River watershed. Weyerhaeuser Company has mill operations near DeQueen and Dierks. Domtar operates a pulp and paper manufacturing plant located in Ashdown.

## 3.0 WATERSHED CONDITION

### 3.1 Water Quality Standards

#### 3.1.1 Designated Uses

The Cossatot River upstream of Gillham Lake reservoir, and Caney Creek are designated as “Extraordinary Resource Waters.” The Cossatot River upstream of Gillham Lake, and Brushy Creek are designated as “Natural and Scenic Waterways.” The Cossatot River upstream of Gillham Lake, Robinson Creek upstream of Cross Creek, Little River upstream of Millwood Lake, and Grassy Lake and Yellow Creek downstream of Millwood Lake are designated as “Ecologically Sensitive Waterbodies” (Arkansas Pollution Control and Ecology Commission 2014).

Other designated uses of the streams in the watershed are Primary Contact Recreation (>10 square mile watershed), Secondary Contact Recreation, Domestic, Industrial and Agricultural Water Supply, Perennial Ozark Highlands and Gulf Coastal Fishery (>10 square mile watershed and discharge >1 cfs), and Seasonal Ozark Highlands and Gulf Coastal Fishery (<10 square mile watershed). Use variations granted in the watershed are listed in Table 3.1 (Arkansas Pollution Control and Ecology Commission 2014).

Table 3.1. Designated use variations granted for waterbodies in the Lower Little River watershed.

| Waterbody Name                                     | Description   | Designated Use Variation                        |
|--|---|---|
| Rolling Fork River                                 | From unnamed tributary A at Grannis to DeQueen Lake reservoir | No domestic water supply use                    |
| Unnamed tributaries to Rolling Fork River A and A1 | Entire length   | No domestic water supply use                    |
| Mine Creek   | From Highway 27 to Millwood Lake reservoir                    | No domestic water supply use                    |
| Caney Creek  | Entire length   | No domestic or industrial water supply use      |
| Lick Creek   | Entire length   | Seasonal Gulf Coast Fishery, no primary contact |

### 3.1.2 Numeric and Narrative Water Quality Criteria

Numeric water quality criteria for selected parameters are listed in Table 3.2. Numeric water quality criteria for toxic substances and metals can be found in Regulation 2 of the Arkansas Pollution Control and Ecology Commission (Arkansas Pollution Control and Ecology Commission 2014). In addition to numeric water quality criteria, state narrative criteria have been developed for the following: nuisance species; color; taste and odor; solids, floating material, and deposits; toxic substances; oil and grease; temperature; turbidity; and nutrients. Site specific numeric water quality criteria for nutrients have not yet been developed for the Lower Little River watershed.

Table 3.2. Numeric water quality criteria for the Lower Little River watershed.

| Parameter        | Conditions        |   | Criteria          |                |
|------------------|-------------------|---|-------------------|----------------|
| Temperature      |                   |   | 30° C             |                |
| Turbidity        | Base flow         |   | 21 NTU            |                |
|                  | All flows         |   | 32 NTU            |                |
| Dissolved Oxygen | Primary season    |   | 5 mg/L            |                |
|                  | Critical season   | < 10 sq mi  | 2 mg/L            |                |
|                  |                   | 10 – 500 sq mi  | 3 mg/L            |                |
|                  |                   | > 500 sq mi   | 5 mg/L            |                |
| pH               |                   |   | 6.0 – 9.0 su      |                |
| <i>E. coli</i>   | Primary Contact   | Extraordinary Resource Waters, Ecologically Sensitive Waterbodies, Natural and Scenic Waterway, lakes, reservoirs | Individual sample | 298 col/100mL  |
|                  |                   | All other waters  | Geometric mean    | 126 col/100mL  |
|                  |                   |   | Individual sample | 410 col/100mL  |
|                  | Secondary Contact | Extraordinary Resource Waters, Ecologically Sensitive Waterbodies, Natural and Scenic Waterway, lakes, reservoirs | Individual sample | 1490 col/100mL |
|                  |                   | All other waters  | Geometric mean    | 630 col/100mL  |
|                  |                   |   | Individual sample | 2050 col/100mL |

Table 3.2. Numeric water quality criteria for the Lower Little River watershed (continued).

| Parameter                    | Conditions        |            |                   | Criteria       |
|------------------------------|-------------------|------------|-------------------|----------------|
|                              |                   |            |                   |                |
| Fecal coliform               | Primary Contact   | All waters | Individual sample | 400 col/100mL  |
|                              |                   |            | Geometric mean    | 200 col/100mL  |
|                              | Secondary Contact | All waters | Individual sample | 2000 col/100mL |
|                              |                   |            | Geometric mean    | 1000 col/100mL |
| Chloride                     |                   |            |                   | 20 mg/L        |
| Sulfate                      |                   |            |                   | 20 mg/L        |
| Total dissolved solids (TDS) |                   |            |                   | 100 mg/L       |

Turbidity criteria that apply in the Lower Little River watershed are listed in Table 3.2. Separate turbidity criteria are specified for base flow conditions. The base flow criteria should not be exceeded in more than 20% of samples collected June to November. The all flow criteria should not be exceeded in more than 25% of all samples collected over an entire year (Arkansas Pollution Control and Ecology Commission 2014).

Bacteria water quality criteria that apply in the Lower Little River watershed are summarized in Table 3.2. These criteria are considered to be met if less than 25% of no less than 8 samples collected during each season are below the criteria.

### 3.1.3 Antidegradation Policy

The antidegradation policy of the Arkansas water quality standards are summarized below:

- Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.
- Water quality that exceeds standards shall be maintained and protected unless allowing lower water quality is necessary to accommodate important economic or social development, although water quality must still be adequate to fully protect existing uses.
- For outstanding state or national resource waters, those uses and water quality for which the outstanding waterbody was designated shall be protected.
- For potential water quality impairments associated with a thermal discharge, the antidegradation policy and implementing method shall be consistent with Section 316 of the Clean Water Act.

## **3.2 Available Monitoring and Resource Data**

This section describes available data for water quality, flow, and biological parameters in the Lower Little River watershed.

### **3.2.1 Surface Water Quality Data**

This section describes and discusses available surface water quality data in the Lower Little River watershed. This includes water quality monitoring and modeling, surface water impairments, and water quality characteristics.

#### **3.2.1.1 Monitoring**

Surface water quality data have been collected in the Lower Little River watershed by ADEQ, EPA, and USGS. ADEQ monitors surface water quality in the Lower Little River watershed through several programs. There are 15 active ambient and four roving ADEQ water quality monitoring network sites in the watershed. Sites in the ambient monitoring network are sampled monthly. Roving sites are divided into four regional groups. Each group of roving sites is sampled for chemical and bacterial analysis on a rotating basis, bimonthly over a 2-year period, every 6 years (ADEQ 2015a). Roving stations in the Lower Little River watershed were last sampled in 2009.

The four reservoirs in the Lower Little River watershed have been classified by ADEQ as Significant Publicly Owned Lakes. Four statewide assessments of Significant Publicly Owned Lakes have been completed every five years since 1989. The last assessment was conducted in 2004. In 2008, the lakes water quality monitoring program was modified to collect data suitable for developing numeric nutrient criteria for lakes. Since 2011, water quality samples have been collected at the four USACE reservoirs in the Lower Little River watershed one to four times a year (ADEQ 2014a).

There is one active USGS water quality monitoring station in the Lower Little River watershed. Sampling frequency has varied over time. Most recently, water quality data have been collected quarterly or bi-monthly (USGS 2015a).

In 2006, EPA began the National Aquatic Resources Survey program to conduct probability-based surveys of the condition of the nation's water resources. This program grew out of the earlier National Wadeable Streams Assessment. Water quality samples were collected at a site on Bell Branch in 2004 as part of the National Wadeable Streams Assessment. Water quality sampling was conducted at Millwood Lake and Gillham Lake in 2007 and 2009 as part of National Aquatic Resources Surveys (EPA 2013a).

The locations of active and recent surface water quality monitoring in the watershed are shown on Figure 3.1. The periods of record for water quality data from active monitoring sites are listed in Table 3.3. A detailed water quality data inventory, that includes older data, is available in Appendix B.

### **3.2.1.2 Modeling**

Gitau and Chaubey (2007) prepared and calibrated a SWAT model of the Lower Little River watershed to aid in prioritizing 11-digit HUC subwatersheds for implementation of nonpoint source best management practices (BMPs). The parameters flow, sediment, total phosphorus, and total nitrogen were modeled for the period 2001 through 2003.

### **3.2.1.3 Impaired Uses and Water Quality Threats**

#### **3.2.1.3.1. Pollutants of Concern**

Siltation/turbidity, pathogens, metals, and nutrients have been identified by ANRC as pollutants of concern for the Lower Little River watershed (ANRC 2005). ADEQ also identifies metals and nutrients as pollutants of concern in the watershed (ADEQ 2015a). Stakeholders are concerned about sediment. Given the land uses and types of waterbodies in the Lower Little River watershed, stakeholders are concerned that nutrients may be, or become, a nonpoint source water quality issue.

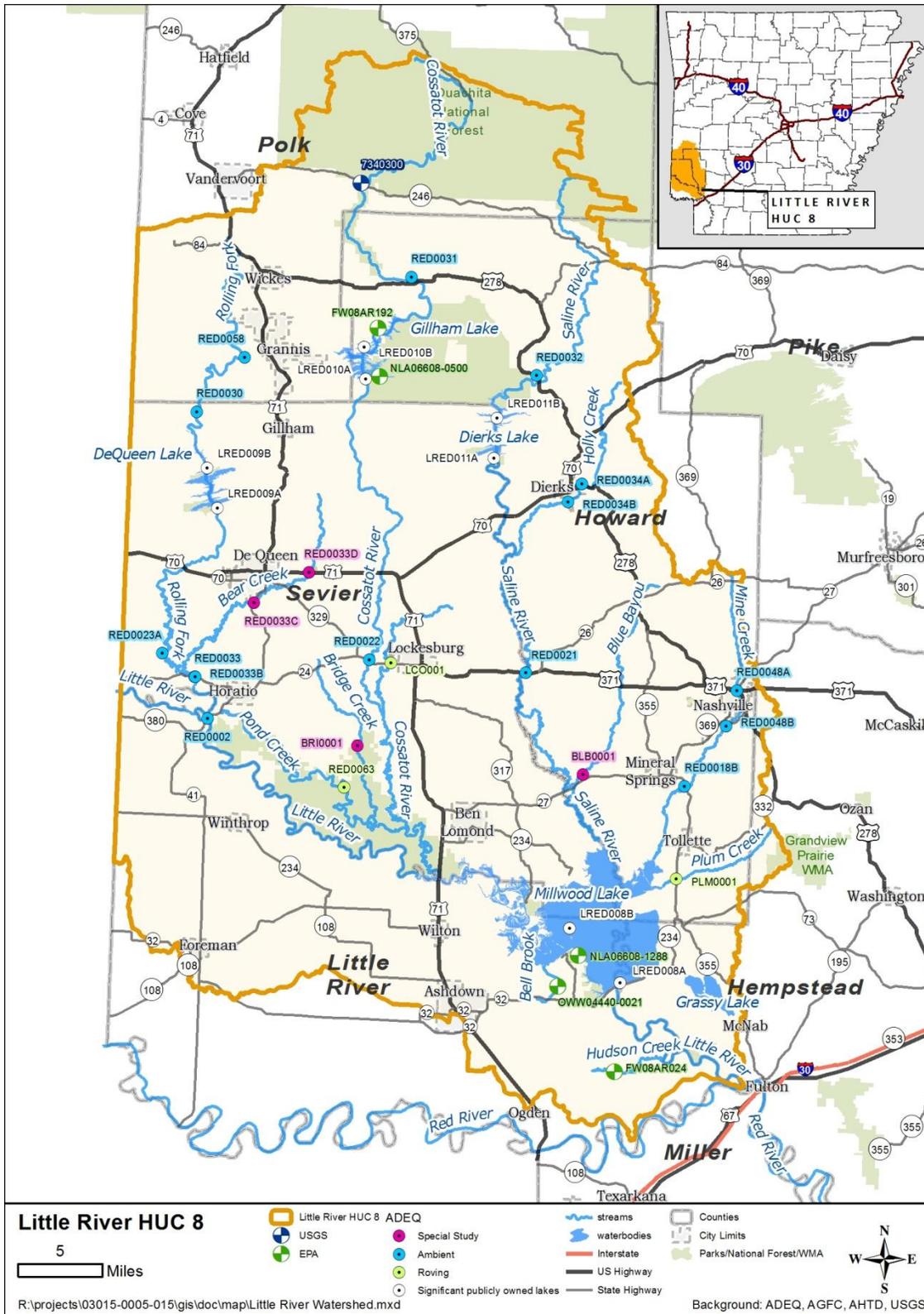


Figure 3.1. Active and recent surface water quality monitoring locations in the Lower Little River watershed.

Table 3.3. Periods of record for active and recent surface water quality monitoring stations in the Lower Little River watershed (ADEQ 2014a, 2015a).

| Station ID    | Monitoring Agency/ Organization | Waterbody                             | Date of first sample | Date of most recent sample | Program/ project                  |
|---------------|---------------------------------|---------------------------------------|----------------------|----------------------------|-----------------------------------|
| [2 stations]  | ADEQ                            | Blue Bayou, Bridge Creek              | 7/23/1991            | 3/16/2009                  | Special study                     |
| [3 stations]  | ADEQ                            | Mine Creek, Coleman Cr                | 9/3/1997             | 11/28/2011                 | Special study                     |
| [4 stations]  | ADEQ                            | tributaries                           | 9/4/1990             | 1/6/2015                   | Ambient                           |
| [4 stations]  | ADEQ                            | tributaries                           | 1/22/1991            | 1/6/2015                   | Ambient                           |
| [4 stations]  | ADEQ                            | Bear Creek, Rolling Fork, Robinson Cr | 2/14/2011            | 11/28/2011                 | Special study                     |
| [7 stations]  | ADEQ                            | reservoirs                            | 1999                 | 2015                       | Significant publicly owned lakes  |
| LCO001        | ADEQ                            | Little Cossatot River                 | 8/1/2000             | 3/16/2009                  | Roving                            |
| LRED010B      | ADEQ                            | Gillham Lake                          | 3/16/2011            | 6/30/2015                  | Significant publicly owned lakes  |
| PLM0001       | ADEQ                            | Plum Creek                            | 7/23/1991            | 3/16/2009                  | Roving                            |
| RED0002       | ADEQ                            | Little River                          | 9/4/1990             | 12/16/2014                 | Ambient                           |
| RED0018B      | ADEQ                            | Mine Creek                            | 4/22/1997            | 1/6/2015                   | Ambient                           |
| RED0031       | ADEQ                            | Cossatot River                        | 10/2/1990            | 1/6/2015                   | Ambient                           |
| RED0033B      | ADEQ                            | Bear Creek                            | 10/14/1997           | 9/25/2007                  | Ambient                           |
| RED0048A      | ADEQ                            | Mine Creek                            | 9/3/1997             | 11/28/2011                 | Ambient                           |
| RED0048B      | ADEQ                            | Mine Creek                            | 9/3/1997             | 1/6/2015                   | Ambient                           |
| RED0058       | ADEQ                            | Rolling Fork River                    | 3/27/2000            | 1/6/2015                   | Ambient                           |
| RED0063       | ADEQ                            | Pond Creek                            | 7/17/2007            | 3/16/2009                  | Roving                            |
| RED0064       | ADEQ                            | Walnut Bayou                          | 5/30/2007            | 3/16/2009                  | Roving                            |
| NLA06608-0500 | EPA                             | Gillham Lake                          | 9/14/2007            | 9/14/2007                  | National Aquatic Resources Survey |
| NLA06608-1288 | EPA                             | Millwood Lake                         | 8/27/2007            | 8/27/2007                  | National Aquatic Resources Survey |
| OWW04440-0021 | EPA                             | Bell Brook                            | 7/14/2004            | 7/14/2004                  | Wadeable Streams Assessment       |
| 7340300       | USGS                            | Cossatot River                        | 8/18/1967            | 12/22/2014                 | Ambient                           |

### 3.2.1.3.2. Impaired Surface Waters

The last EPA approved state impaired waters list (i.e., 303(d) list) for Arkansas was from 2008. Impaired waters in the Lower Little River watershed from the 2008 list are given in Table 3.4 and mapped on Figure 3.2. A total of 1,021 miles of streams and 31,180 acres of lakes in the watershed were classified as impaired on the 2008 303(d) list (ADEQ 2008).

Table 3.4. Impaired waters of the Lower Little River watershed, 2008 303(d) list.

| Stream name           | Stream Segment | Impaired use               | Pollutant(s)              | Pollutant source        | Category                       |
|-----------------------|----------------|----------------------------|---------------------------|-------------------------|--------------------------------|
| DeQueen Lake          | Not applicable | Drinking water             | Beryllium                 | Unknown                 | Additional assessment required |
| Millwood Lake         | Not applicable | Drinking water             | Beryllium                 | Unknown                 | Additional assessment required |
| Blue Bayou            | 009            | Primary contact            | Pathogens                 | Unknown                 | Added by EPA                   |
| Saline River          | 010            | Fishery                    | Lead                      | Unknown                 | Additional assessment required |
| Holly Creek           | 013            | Primary contact            | Pathogens                 | Unknown                 | TMDL needed                    |
| Holly Creek           | 013            | Fishery                    | Zinc                      | Not specified           | 5e <sup>a</sup>                |
| Saline River          | 014            | Fishery                    | Dissolved oxygen          | Unknown                 | Additional assessment required |
| Bear Creek            | 025            | Drinking water             | Nitrate                   | Municipal point source  | 5e <sup>a</sup>                |
| Mine Creek            | 933            | Fishery                    | Copper, zinc, sulfate     | Industrial point source | 5e <sup>a</sup>                |
| Mine Creek            | 933            | Fishery                    | Dissolved oxygen          | Unknown                 | 5f <sup>b</sup>                |
| Mine Creek            | 033            | Ag & Industry water supply | Sulfate                   | Unknown                 | Additional assessment required |
| Mine Creek            | 033            | Primary contact            | Pathogens                 | Unknown                 | Additional assessment required |
| Rolling Fork          | 919            | Fishery                    | Total phosphorus, nitrate | Industrial point source | TMDL completed                 |
| Rolling Fork          | 919            | Fishery                    | Copper                    | Industrial point source | 5e <sup>a</sup>                |
| Little Cossatot River | 920            | Fishery                    | TDS                       | Unknown                 | Additional assessment required |

<sup>a</sup> Impairment caused by point source discharge. Future discharge permit restrictions are expected to correct the problem

<sup>b</sup> The cause behind the waterbody not meeting the water quality standard is not a pollutant, but other types of pollution

The most recent state biennial assessment of water quality was conducted in 2014. Waterbodies in the Lower Little River watershed included on the Arkansas 2014 impaired waters list resulting from that assessment are shown in Table 3.5. A total of 65.4 miles of streams, and no lakes, in the watershed have been classified as impaired based on the 2014 assessment.

Table 3.5. Impaired waters of the Lower Little River watershed, 2014 303(d) list (ADEQ 2015a).

| <b>Stream name</b> | <b>Stream Segment</b> | <b>Impaired use</b> | <b>Pollutant(s)</b>       | <b>Pollutant source</b> | <b>Category</b>        |
|--------------------|-----------------------|---------------------|---------------------------|-------------------------|------------------------|
| Little River       | 001                   | Not specified       | Temperature               | Not specified           | Impaired               |
| Saline River       | 010                   | Fishery             | Turbidity, copper         | hydropower              | Impaired, low priority |
| Holly Creek        | 013                   | Primary contact     | Pathogens                 | Not specified           | TMDL completed         |
| Little River       | 023                   | Fishery             | Turbidity                 | Not specified           | Impaired               |
| Mine Creek         | 033                   | Primary contact     | Pathogens                 | Not specified           | TMDL completed         |
| Mine Creek         | 033                   | Not specified       | Sulfate                   | Industrial point source | Impaired, low priority |
| Rolling Fork       | 919                   | Fishery             | Total phosphorus, nitrate | Industrial point source | TMDL completed         |

Comparing the lists of impaired waters from 2008 and 2014, there are both differences and similarities. There are a variety of reasons for the differences. The beryllium impairments of the drinking water reservoirs were removed as a result of changes to the water quality standard for beryllium. There has been a significant decrease in nitrate levels in Bear Creek, to the extent that it has been removed from the impaired waters list (ADEQ 2015a). The DO impairment for Saline River, and sulfate impairment for Mine Creek were removed from the impaired waters list because new data indicated those water quality standards are being met (ADEQ 2014b). The lead impairment for the Saline River was removed from the 303(d) list in 2010. New data has apparently also resulted in the identification of new impairments for segments of the Little River and Saline River.

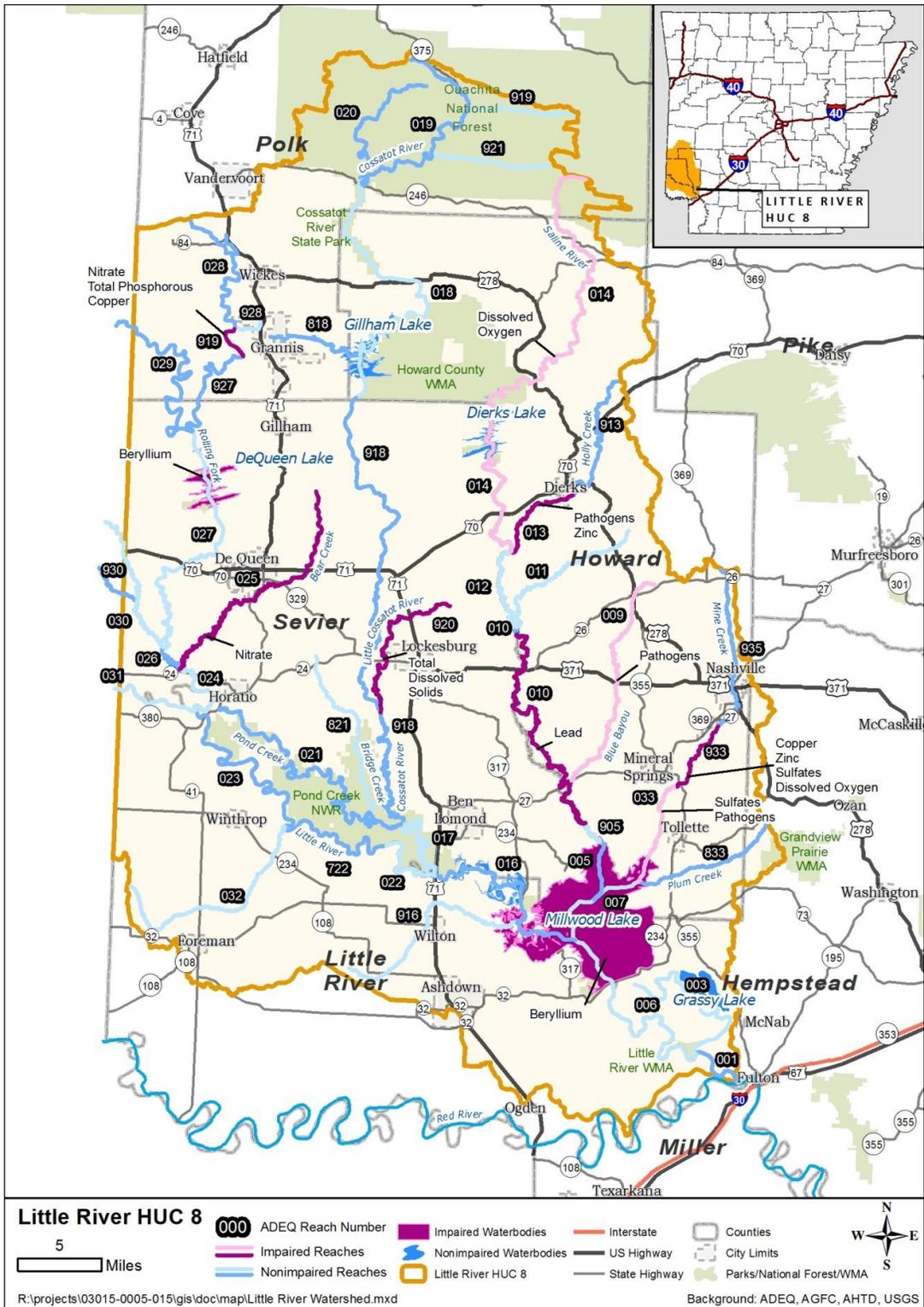


Figure 3.2 Impaired waterbodies in the watershed from the 2008 303(d) list.

Although the biennial water quality assessments have identified turbidity and/or sediment as impairing water quality in only a couple stream reaches, sedimentation in Millwood Lake is a concern among stakeholders in the Lower Little River watershed. There is concern that Millwood Lake is losing water supply storage capacity more rapidly than expected when the reservoir was designed. In addition, sedimentation in some areas of the reservoir is affecting recreational uses. Sediment can also impact sensitive stream species present in the Lower Little River watershed (see Section 4 for information on specific species of concern).

Selected unknown/nonpoint source pollutants of concern are discussed in the following sections. Available data is examined to characterize differences in water quality in different areas of the watershed, and changes in water quality over time. In addition, pollutant loads are discussed.

#### **3.2.1.4 Sediment Water Quality**

Total suspended solids (TSS) and turbidity are typically monitored as indicators of sediment water quality issues. Only the USGS has measured suspended sediment concentrations at seven stations in the Lower Little River watershed over time periods ranging from 1930 to present. Periods of record for these stations range from less than one to 40 years. The analytical method used to measure suspended sediment concentration is different from the method used to measure TSS. As a result, TSS and suspended sediment concentration are not interchangeable (Gray et al. 2000). All monitoring programs of the Lower Little River watershed include TSS and/or turbidity.

##### **3.2.1.4.1. Measured Sediment Parameters Around the Watershed**

Turbidity, TSS, and suspended sediment data have been collected in the Lower Little River watershed during the period from 2010 through 2014. These data are discussed below.

#### **Stream Turbidity**

Turbidity data have been collected by ADEQ at over 20 stream water quality monitoring stations in the Lower Little River watershed during the period from 2010 through 2014 (see Figure 3.1 for station locations). A summary plot of these data is shown in Figure 3.3.

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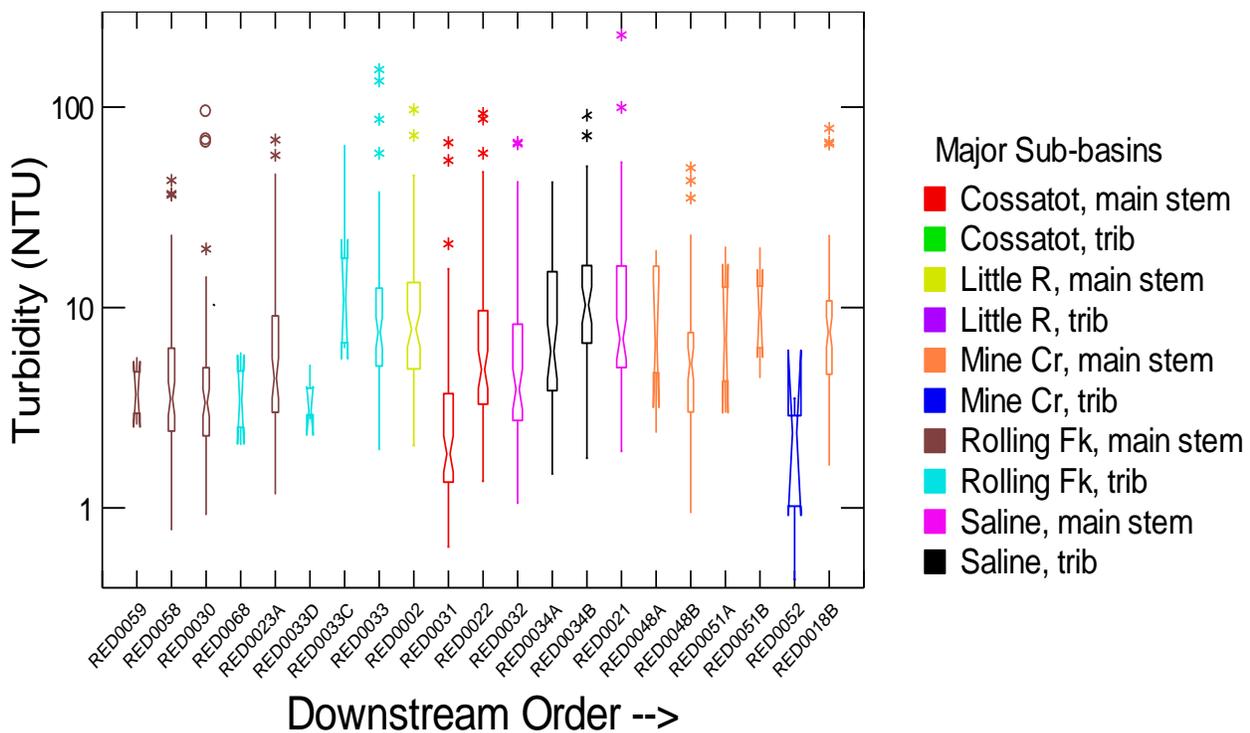


Figure 3.3 Turbidity data from streams in the Lower Little River watershed 2010 - 2014.

Turbidity levels in the Rolling Fork River, Cossatot River and Saline River appear to be higher at downstream locations than at upstream locations. This is also true for tributaries to these streams, e.g., Bear Creek (RED0033D, RED0033C, and RED0033) and Holly Creek (RED0034A and RED0034B). In Bear Creek, Cossatot River, Saline River, and Holly Creek, the median turbidity levels (shown as the narrowest part of the notches in the boxes) at the downstream stations (RED0033, RED0022, RED0021, RED0034B) were statistically significantly higher than median turbidity levels at the upstream stations (RED0033D, RED0031, RED0032, RED0034A), i.e., the notches in the boxes do not overlap. Turbidity levels appear to be relatively similar along the entire length of Mine Creek. When data from the main stem monitoring stations for each stream are combined, median turbidity levels in the Cossatot River and Rolling Fork River are statistically significantly lower than median turbidity levels in the Little River, Saline River, and Mine Creek. The highest median turbidity values are from the

Bear Creek (RED0033C and RED0033), Little River (RED0002), and Holly Creek (RED0034B) water quality stations.

### Reservoir Turbidity

Summary plots of turbidity data collected by ADEQ from the reservoirs in the watershed during the period from 2010 through 2014 are shown on Figure 3.4. Median turbidity levels for Millwood Lake are statistically significantly greater than median levels for the other monitored reservoirs in the watershed, at all depths. This is not surprising, given the morphometry and location of the Millwood Lake reservoir. Median turbidity levels in Dierks Lake tend to be higher than the median turbidity levels in DeQueen Lake and Gillham Lake. Median turbidity levels in DeQueen Lake and Gillham Lake are nearly the same.

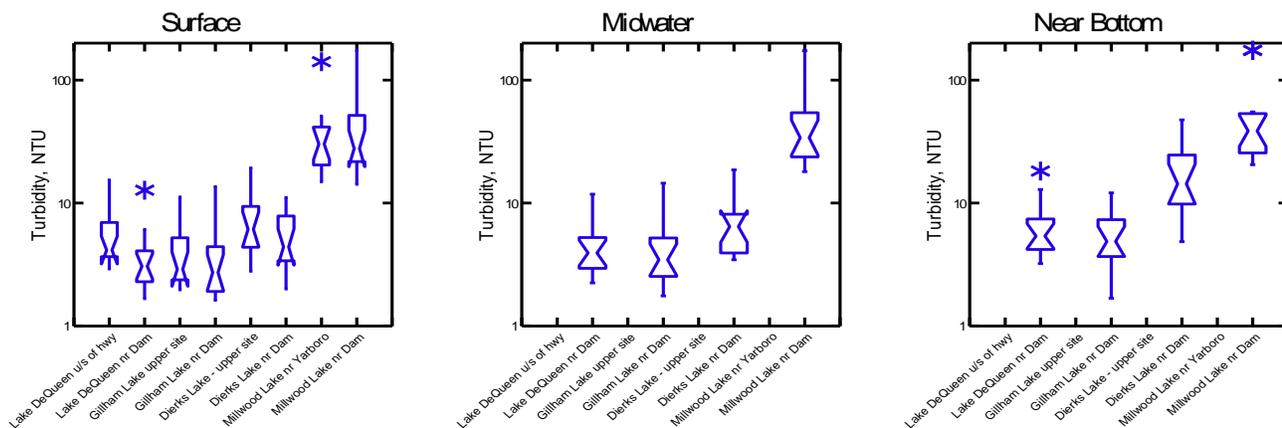


Figure 3.4 Turbidity data from reservoirs in the Lower Little River watershed 2010 - 2014.

In Millwood Lake, the median surface turbidity levels at both water quality monitoring stations are practically the same. In the other reservoirs, median surface turbidity levels are lower near the dam than at the upstream stations. However, median surface turbidity levels at the two stations in these reservoirs are not statistically significantly different.

During the National Lakes Assessment, EPA collected water quality data from Gillham Lake and Millwood Lake, including turbidity measurements. Based on these turbidity measurements, EPA assigned Gillham Lake to the intermediate disturbance class, and classified Millwood Lake as least disturbed (EPA 2013c).

### Stream TSS

TSS measurements have been collected by ADEQ at over 20 water quality monitoring stations in the Lower Little River watershed during the period from 2010 through 2014. A summary plot of these data is shown in Figure 3.5.

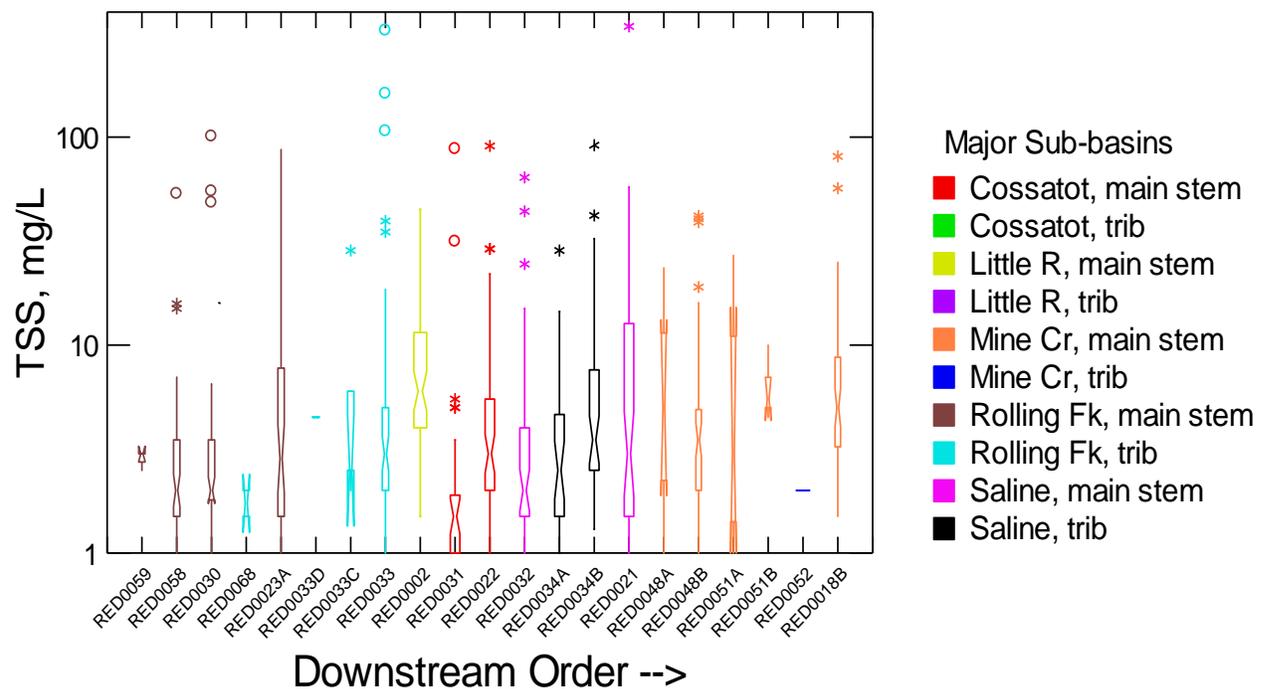


Figure 3.5 TSS data from streams in the Lower Little River watershed, 2010 – 2014.

As with turbidity, TSS concentrations appear to be higher at downstream monitoring stations on the Rolling Fork River, Cossatot River, Saline River, and Holly Creek. However, only in the Cossatot River is the median TSS concentration at the downstream station statistically significantly higher than at the upstream station. When data from the main stem sampling stations for each stream are combined, median turbidity levels in the Saline River, Cossatot River, and Rolling Fork River are statistically significantly lower than median turbidity levels in the Little River and Mine Creek. The highest median TSS concentration is at the Little River water quality station (RED0002).

### Reservoir TSS

Summary plots of TSS measurements collected by ADEQ from the reservoirs in the watershed during the period from 2010 through 2014 are shown on Figure 3.6. As with turbidity, median TSS concentrations in Millwood Lake are statistically significantly greater than median TSS concentrations in the other reservoirs in the watershed. In the other reservoirs, median surface TSS concentrations are lower near the dam than at the upstream stations. However, median surface TSS concentrations at the two stations in the reservoirs are not statistically significantly different. Median surface TSS concentrations from the two stations in Millwood Lake are practically the same.

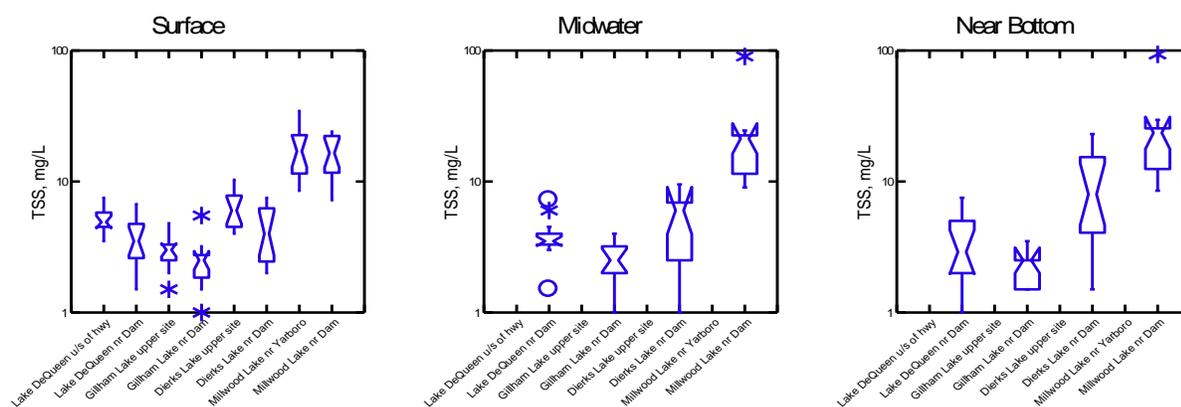


Figure 3.6 TSS data from reservoirs in the Lower Little River watershed 2010 – 2014.

**Suspended Sediment**

The USGS has collected suspended sediment concentrations from a water quality monitoring station on the Cossatot River near Vandervoort (7340300), during the period from 2010 through 2014 (see Figure 3.1 for station location). The average suspended sediment concentration measured at this station during this period was 2.86 mg/L, with a median concentration of 3.0 mg/L, a minimum concentration of <0.5 mg/L and a maximum concentration of 6.0 mg/L. The median suspended sediment concentration measured by the USGS is similar to the median TSS concentration, 2.90 mg/L, at the downstream ADEQ Cossatot River water quality station, RED0022.

**Modeled Sediment**

Prioritization of the Lower Little River 11-digit HUC subwatersheds based on modeled sediment concentrations is shown in Figure 3.7 (Gitau and Chaubey 2007). Higher numbers indicate higher priority, with highest priority shown as the darkest red on Figure 3.7. The subwatersheds with the highest sediment contributions estimated by the model are in the middle and lower watershed, within in the Gulf Coastal Plain.

**Comparison of Measured to Modeled Sediment Parameters**

A comparison of the SWAT model prioritization for sediment to ADEQ impaired waters assessments is shown in Table 3.6. Note that “80-100” in the SWAT sediment priority column indicates highest priority. No stream reaches in the SWAT highest sediment priority subwatersheds are listed as impaired due to turbidity on the ADEQ 2014 303(d) list. The two turbidity impaired stream reaches are in subwatersheds classified by the SWAT results as relatively high priority for sediment.

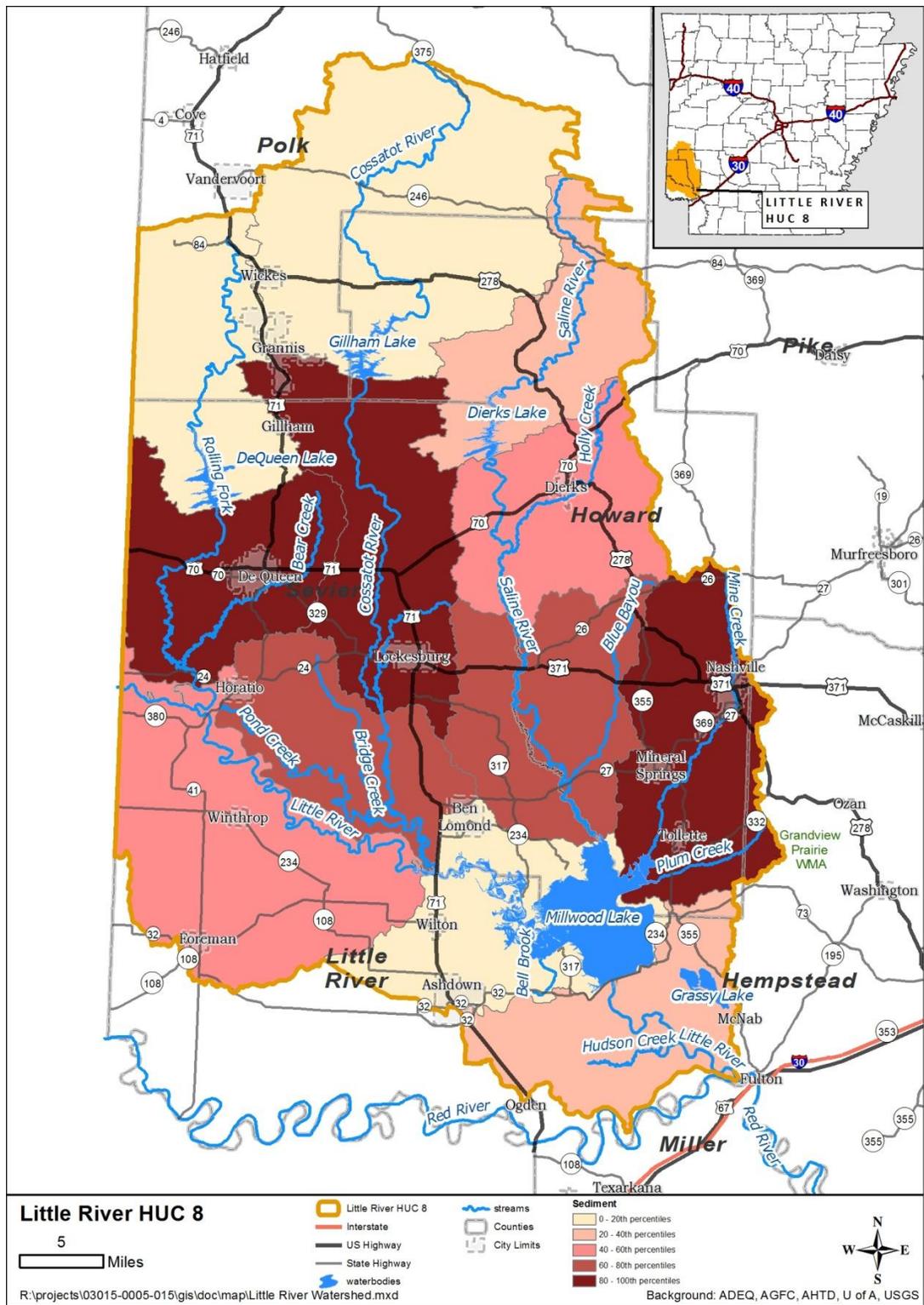


Figure 3.7 Estimates of relative contribution of sediment based on SWAT model results (Gitau and Chaubey 2007).

Table 3.6 Comparison of SWAT model sediment priorities to ADEQ turbidity impairments in the Lower Little River watershed.

| 11-digit HUC subwatershed name (HUC number) | ADEQ reach number                      | SWAT sediment priority | Turbidity impaired ADEQ | ADEQ monitoring                                    |
|---|--|------------------------|-------------------------|--|
| Middle Little River (11140109180)           | 031, 023, 032, 722                     | 40-60                  | 023 yes                 | RED0002 (023)                                      |
| Upper Rolling Fork (11140109190)            | 027 (partial), 028, 029, 919, 927, 928 | 0-20                   | no                      | RED0030 (927)<br>RED0058 (919)                     |
| Lower Rolling Fork (11140109200)            | 024, 025, 026, 027 (partial), 030, 930 | 80-100                 | No                      | RED0033 (025)<br>RED0023A (026)                    |
| Pond Creek Watershed (11140109210)          | 021, 821, 918 (partial)                | 60-80                  | No                      | BRI0001 (821)<br>RED0063 (021)                     |
| Upper Cossatot River (11140109220)          | 018, 019, 020, 818, 921                | 0-20                   | No                      | RED0031 (018)                                      |
| Middle Cossatot River (11140109230)         | 918 (partial)                          | 80-100                 | No                      | RED0022  |
| Lower Cossatot River (11140109240)          | 918, 920, 017                          | 60-80                  | No                      | LCO01 (920)  |
| Lower Little River (11140109250)            | 005, 007, 016, 916                     | 0-20                   | No                      | None   |
| Upper Saline River (11140109260)            | 014 (partial)                          | 20-40                  | No                      | None   |
| Holly Creek (11140109270)                   | 011, 012, 013, 014 (partial), 913      | 40-60                  | No                      | RED0034A (913)<br>RED0034B (013)<br>RED0032 (014)  |
| Blue Sand (11140109280)                     | 009, 010, 905                          | 60-80                  | 010 yes                 | BLB0001 (009)<br>RED0021 (010)                     |
| Mine Creek (11140109290)                    | 033, 933, 934, 935                     | 80-100                 | No                      | RED0018B (033)<br>RED0048B (933)<br>RED0048A (934) |
| Plum Creek (11140109300)                    | 833                                    | 80-100                 | No                      | None   |
| Yellow Creek (11140109310)                  | 003                                    | 20-40                  | No                      | None   |
| Hudson Creek (11140109320)                  | None                                   | 20-40                  | No                      | None   |
| Bois D Arc Creek (11140109330)              | 001- 006                               | 20-40                  | No                      | None   |

#### **3.2.1.4.2. Sediment Parameters Over Time**

There are a number of water quality monitoring stations in the Lower Little River watershed with data records spanning 10 years or more. Below, the data from these long term monitoring stations are examined for signs of changes in sediment water quality over time.

##### **Turbidity**

Turbidity data from ADEQ stream stations with data records of at least 10 years are shown on Figure 3.8. Note that pre-1990 data shown on the plots are USGS data. All of the sites appear to exhibit a dip in turbidity levels between 2010 and 2015. This suggests a basin-wide response that may be related to a regional influence, such as weather and rainfall patterns. Apparent declining trends in turbidity at several stations appear to be the result primarily of this basin-wide response. Therefore, at this point, the determination is that there are no strong long-term trends in turbidity at these monitoring stations.

Period of record surface turbidity data from the reservoir monitoring stations are shown on Figure 3.9. Note that pre-1990 data is USGS data. Because there are few data points prior to 2011, it is difficult to characterize long term trends in turbidity with much confidence. It appears that turbidity levels in DeQueen Lake, Gillham Lake, and the upper Dierks Lake station may not have changed over time. It also appears that turbidity levels in Dierks Lake near the dam, and Millwood Lake may have increased over time.

##### **TSS**

TSS data from ADEQ stream stations with data records of at least 10 years are shown on Figure 3.10. For most of the stations, these data do not exhibit trends over the long term. Slight declining trends are apparent in TSS concentrations from Rolling Fork River station RED30 and Holly Creek station RED34A. TSS concentrations from the Bear Creek station exhibited a rapid decline in the early 1990s, and appear to have remained relatively unchanged since then.

Period of record surface TSS data from the reservoir monitoring stations in the watershed are shown on Figure 3.11. There are few data points prior to 2010, making it difficult to characterize long term trends with much confidence. If the data from prior to 2010 adequately

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represent historical TSS levels, it appears that TSS concentrations at most of the stations have increased over time.

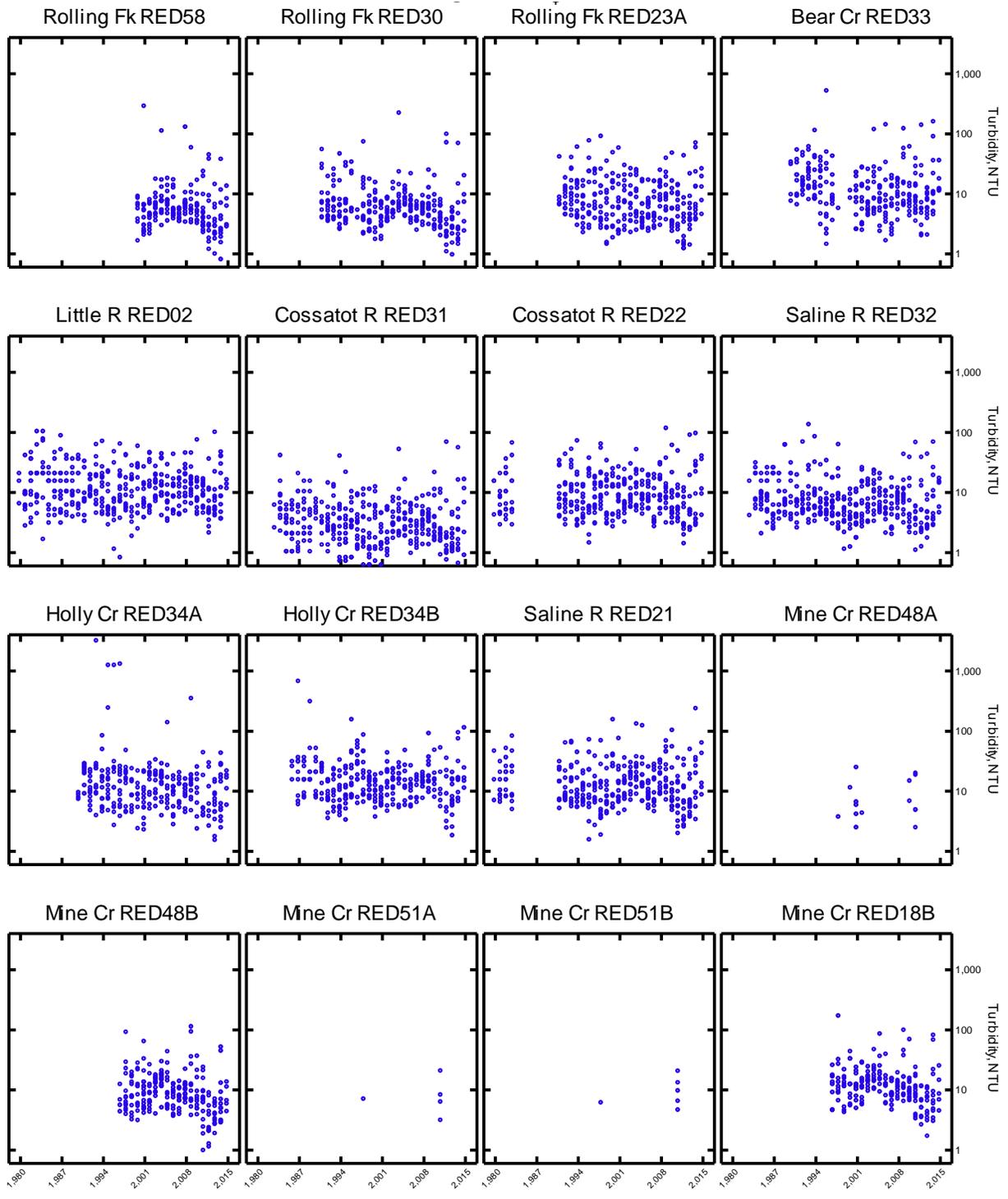


Figure 3.8. Turbidity data from long-term stream monitoring stations in the Lower Little River watershed.

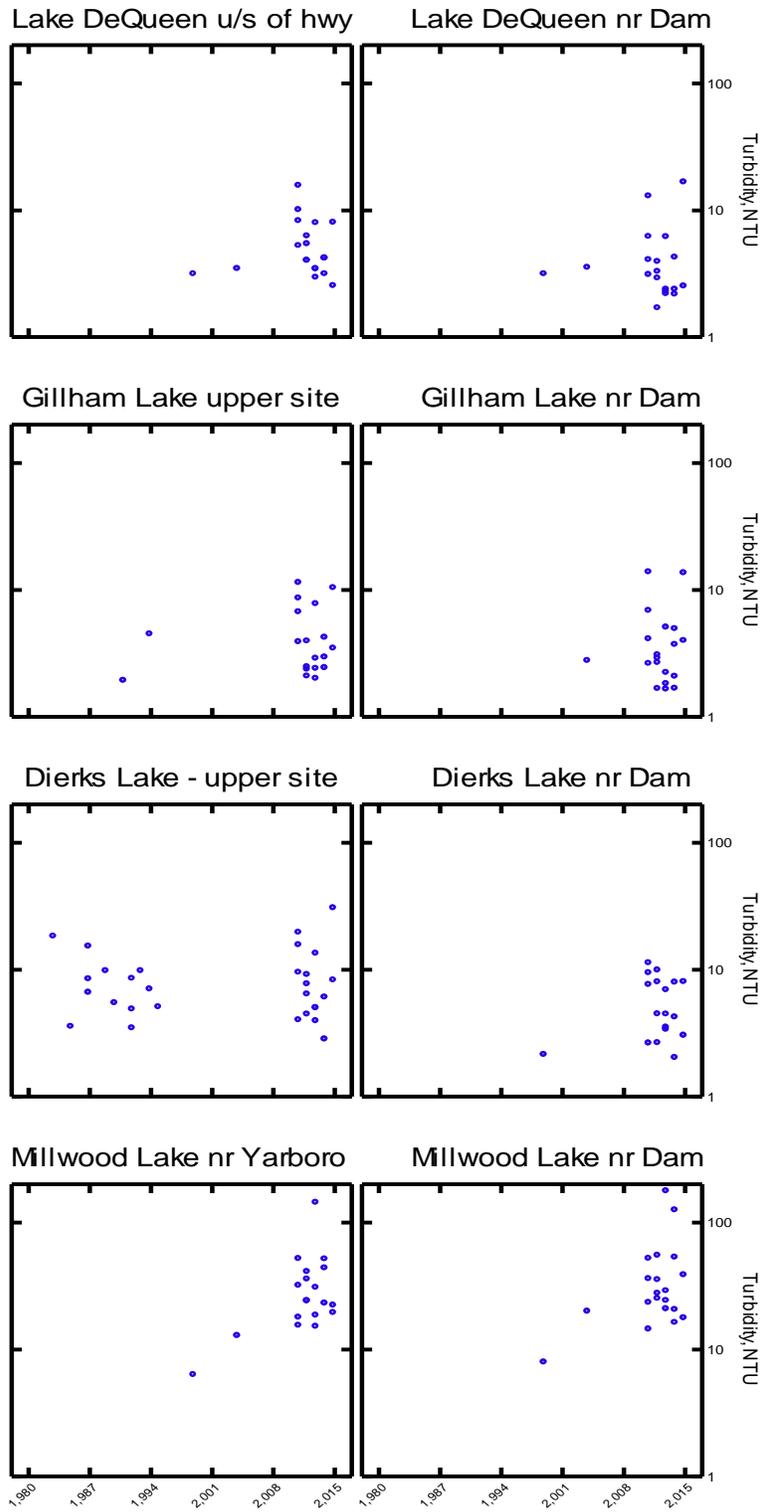


Figure 3.9. Surface turbidity data from long-term reservoir monitoring stations in the Lower Little River watershed.

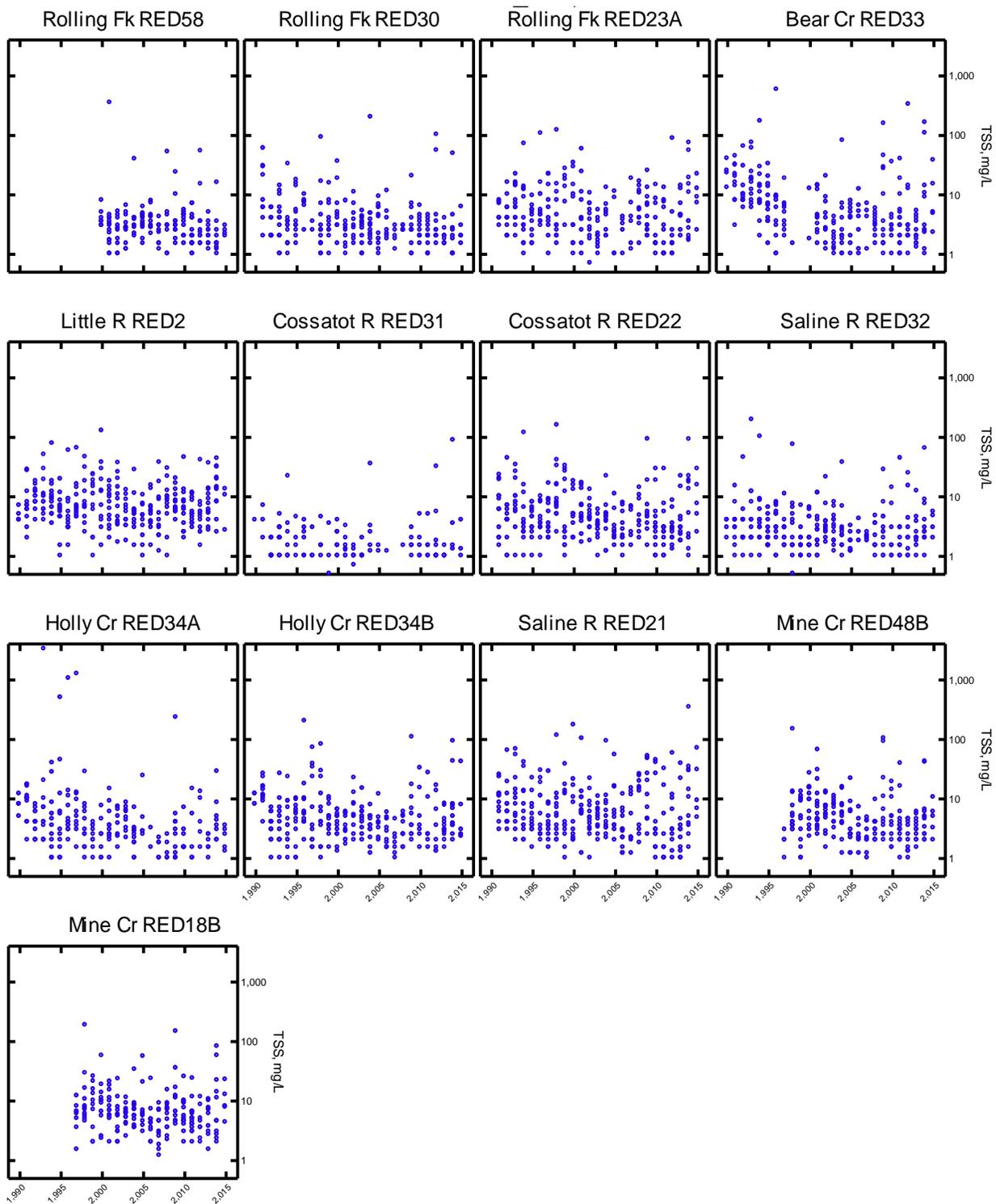


Figure 3.10. TSS data from long-term stream stations in the Lower Little River watershed.

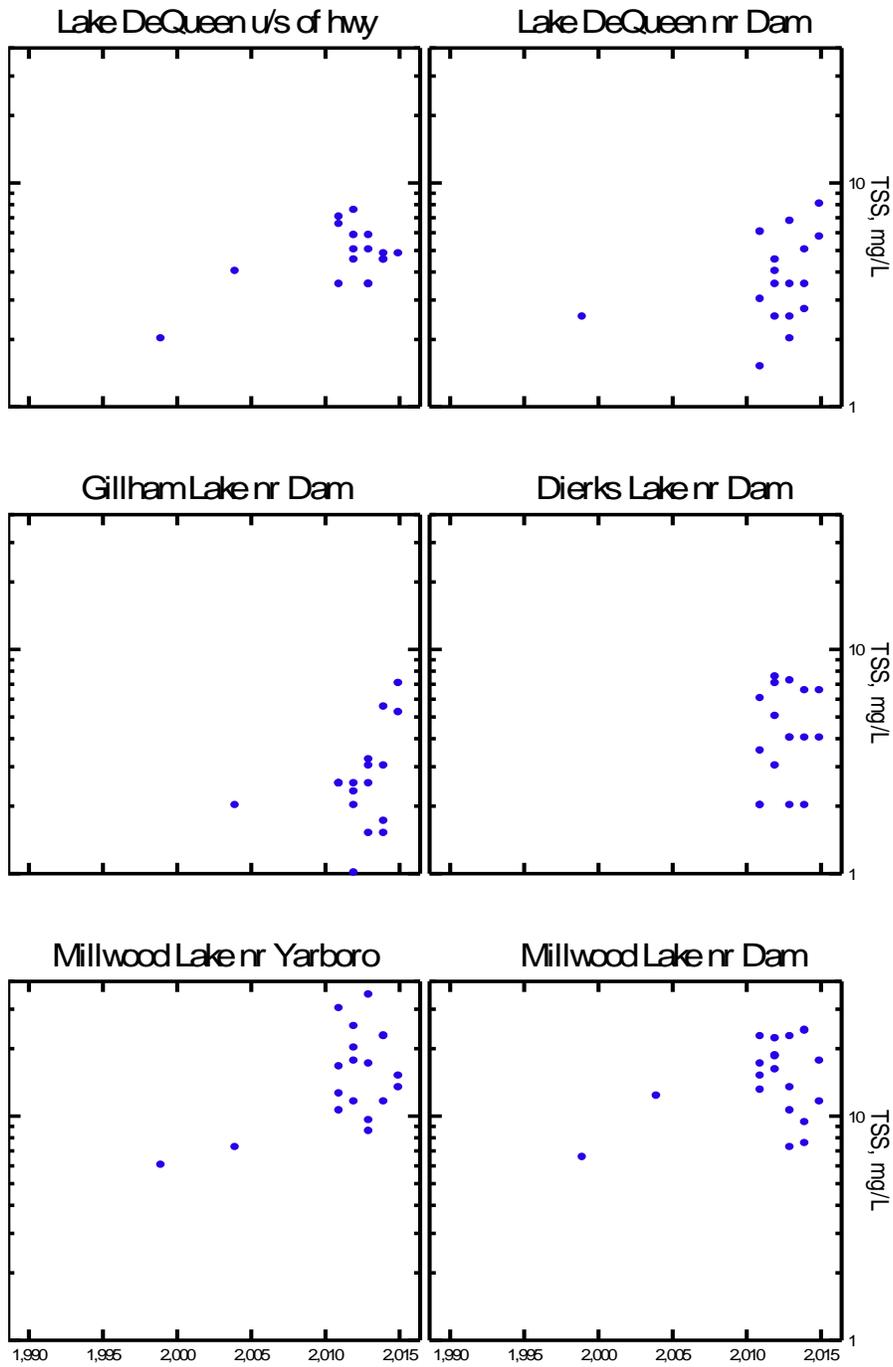


Figure 3.11. Surface TSS data from long term lake monitoring stations in the Lower Little River watershed.

## Suspended Sediment

The period of record suspended sediment concentrations from the USGS water quality monitoring station on the Cossatot River (7340300) is shown on Figure 3.12. This data show a period of higher suspended sediment concentrations between 1995 and 2005. Around 2010, suspended sediment concentrations at this station became lower, and have remained primarily less than 5 mg/L since then.

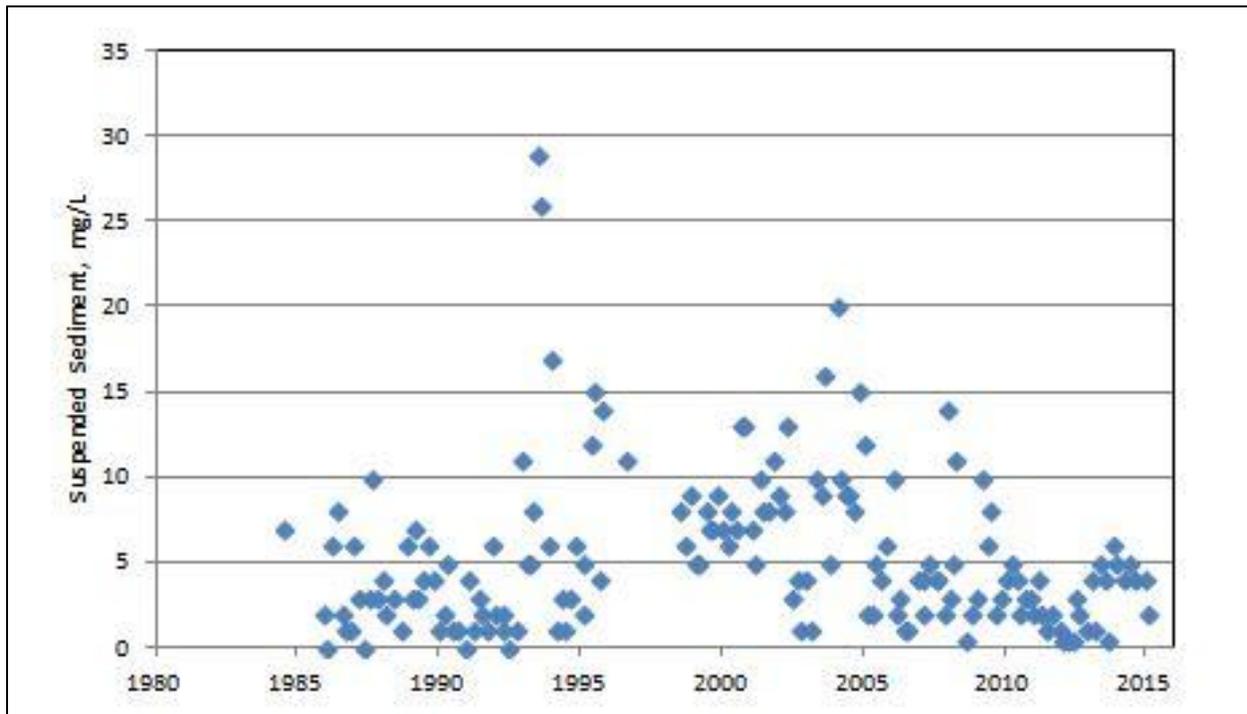


Figure 3.12. Suspended sediment data from long term USGS station on Cossatot River near Vandervoort (7340300).

### 3.2.1.4.3. Sediment Parameters Data Gaps

If the results from the preliminary SWAT model realistically indicate subwatersheds with higher sediment loads, it appears there are several tributaries south of the Little River that should be monitored. Otherwise, monitoring at all of the ambient and roving stations in the watershed needs to continue. In particular, continued monitoring is needed in the reservoirs to develop good long term data sets.

#### **3.2.1.4.4. Sediment Parameters Summary**

- In the majority of the streams in the watershed, median turbidity levels and median TSS concentrations for the period 2010 – 2014 appear to increase downstream.
- The highest median turbidity level for the period 2010 – 2014 was at a Bear Creek water quality monitoring station.
- Overall, median turbidity levels for the period 2010 - 2014 in Little River, Mine Creek, and Saline River are statistically significantly higher than the rest of the monitored streams.
- The highest median TSS concentration for the period 2010 – 2014 was at the ADEQ Little River water quality monitoring station.
- Overall, median TSS levels for the period 2010 – 2014 are statistically significantly higher in the Little River and Mine Creek than the rest of the monitored streams.
- When looking at data from the period 2010 – 2014, median turbidity and TSS levels in Millwood Lake are statistically significantly higher than any of the other reservoirs in the watershed.
- Estimated TSS loads at downstream stations on Rolling Fork River, Cossatot River, and Saline River are higher than the loads at the upstream stations on those rivers.
- The lowest maximum and minimum estimated TSS loads are for Mine Creek and Holly Creek.
- Results from a SWAT model of the watershed estimate that HUC 11 subwatersheds in the lower part of the Little River watershed contribute the most sediment.
- For the most part, there appears to have been little to no change in turbidity and TSS levels at long term stream water quality stations.

#### **3.2.1.5 Pathogens**

ADEQ and USGS have collected fecal pathogen data in the Lower Little River watershed. Fecal and total coliforms, and fecal streptococci were historically monitored as indicators of fecal pathogen contamination of waters. Currently, *E. coli* is the most commonly monitored indicator of fecal pathogen contamination of waters. ADEQ began monitoring *E. coli* around 2000. The last fecal coliform measurements collected by ADEQ in the Lower Little River

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watershed are from 2001 (ADEQ 2015a). The USGS has measured fecal coliforms, fecal streptococci, and *E. coli* in the Cossatot River near Vandervoort since the 1980s (USGS 2015a).

#### **3.2.1.5.1. Pathogens Around the Watershed**

Measurements of *E. coli* have been collected by the USGS from the Cossatot River near Vandervoort during the period from 2010 through 2014. During 2007 through 2009 ADEQ collected *E. coli* measurements from 19 locations in the Lower Little River watershed. These are the most recent pathogen data collected by ADEQ in the watershed.

During the period from 2010 through 2014, the USGS collected 28 measurements of *E. coli* levels in the Cossatot River near Vandervoort. Measured *E. coli* levels during this period ranged from 1 colony forming unit per 100 mL (cfu/100mL) to 210 cfu/100mL. The average fecal coliform measurement during this period was 25.4 cfu/100mL, and the median value was 10.5 cfu/100mL.

A summary plot of the 2007-2009 *E. coli* measurements collected by ADEQ and USGS in the Lower Little River watershed is shown in Figure 3.13. The lowest median *E. coli* level is in the upper Rolling Fork River at station RED0030. However, because *E. coli* levels at this station are so variable, the median value is statistically significantly lower than median values from only two other stations, RED0033B on Bear Creek, and BLB0001 on Blue Bayou. The highest median *E. coli* levels in the watershed are at these two stations, BLB0001, and RED0033B. The median *E. coli* levels at BLB001 and RED0033B are statistically significantly greater than the median levels at several of the other water quality monitoring stations in the Lower Little River watershed (Figure 3.13).

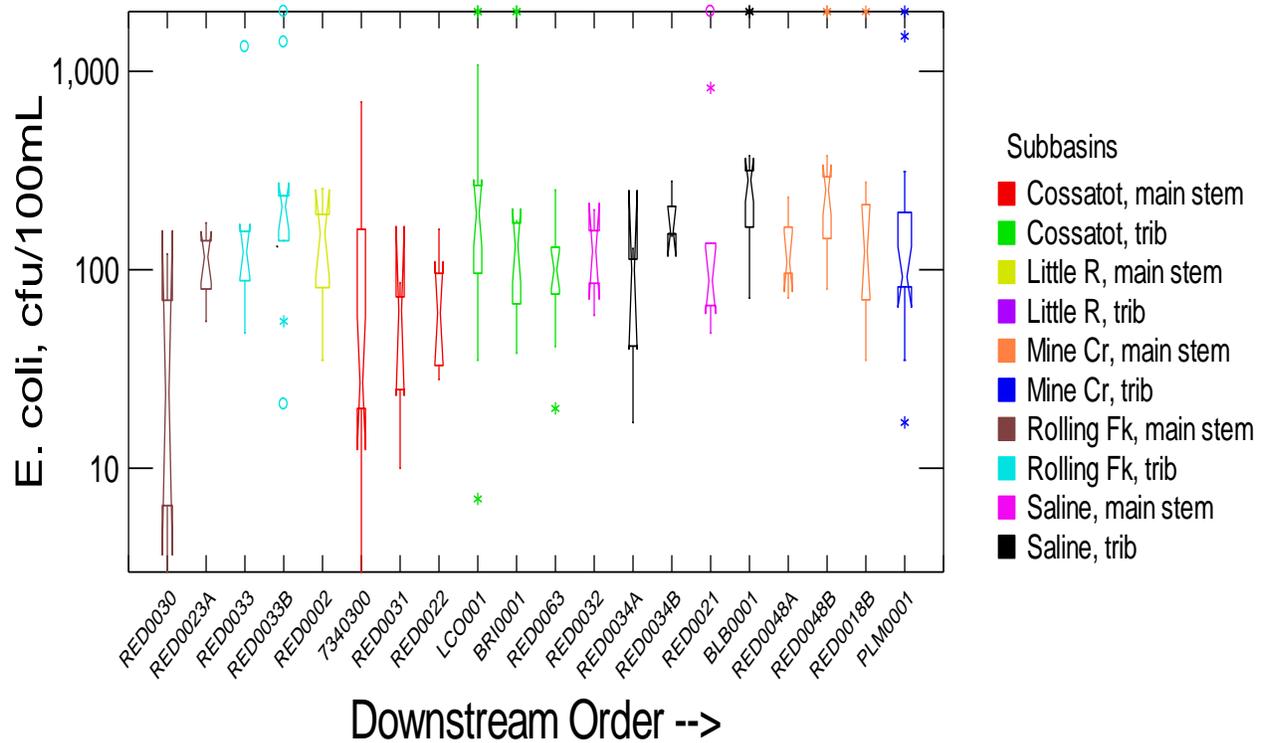


Figure 3.13 Stream *E. coli* data from Lower Little River watershed, 2007-2009.

When data from the main stem monitoring stations are combined, the median *E. coli* level in Mine Creek is statistically significantly greater than the median *E. coli* levels in the Cossatot River and Rolling Fork River. Median *E. coli* levels for all three of these rivers are not statistically significantly different from the median *E. coli* levels in the Little River and Saline River. Note that the medians of *E. coli* levels measured during 2007 - 2009 are all greater than the median *E. coli* level measured by USGS at their Cossatot River station during the period 2010 through 2014.

### 3.2.1.5.2. Pathogens Over Time

Due to the change in monitoring parameters, and the lack of recent data collection, it is not possible to evaluate long-term data records of comparable pathogen data for ADEQ water quality stations in the Lower Little River watershed. However, USGS has been collecting *E. coli* measurements from the Cossatot River near Vandervoort since late 1999, although their analytical methods have changed over the years. These data are graphed in Figure 3.14. Overall, the data from the USGS water quality monitoring station on the Cossatot River appear comparable over time, despite changes in analytical methods. There is no apparent trend in this data.

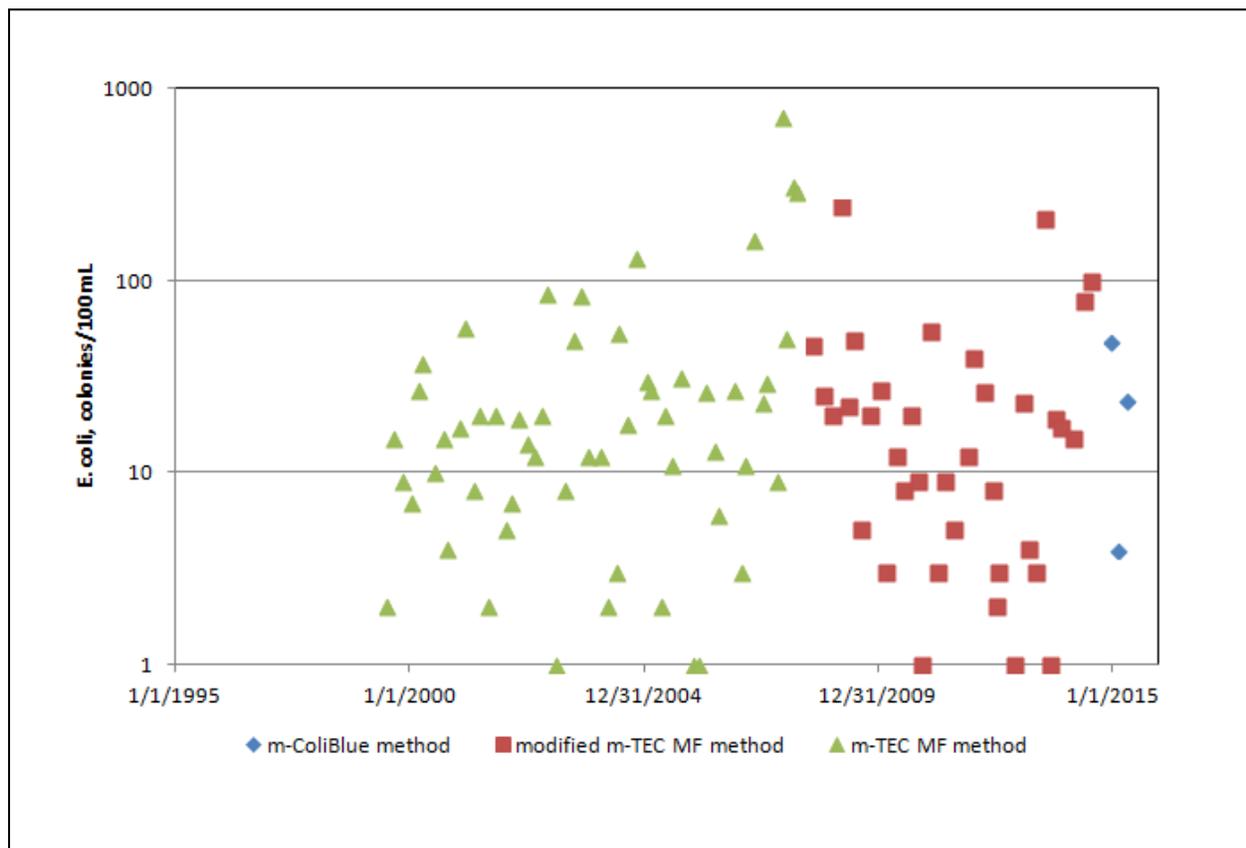


Figure 3.14. *E. coli* data from long term USGS water quality monitoring station on upper Cossatot River.

### **3.2.1.5.3. Pathogen Data Gaps**

Based on the last time the ADEQ roving water quality monitoring stations in the Lower Little River watershed were sampled, ADEQ should be collecting *E. coli* data in the watershed in 2015 or 2016. This data is needed.

### **3.2.1.5.4. Pathogens Summary**

- Bear Creek and Blue Bayou stations had the highest median *E. coli* levels measured by ADEQ during the period 2007 – 2009.
- Of the major rivers in the watershed, Mine creek had the highest median *E. coli* levels measured by ADEQ during the period 2007 – 2009.
- The median *E. coli* level measured by USGS during the period 2010 – 2014 was less than all of the medians of the data measured during the period 2007 – 2009.
- There is no apparent trend in *E. coli* measurements from the USGS long term water quality monitoring station on the Cossatot River.

### **3.2.1.6 Nitrogen**

ADEQ, EPA, and USGS have collected nitrogen measurements in the Lower Little River watershed. ADEQ monitors ammonia nitrogen, inorganic nitrogen (i.e., nitrate plus nitrite), and total Kjeldahl nitrogen. EPA collected total nitrogen measurements for the National Rivers and Streams Assessment; ammonium, inorganic nitrogen, nitrate, and total nitrogen measurements for the National Lakes Assessment; and ammonium, nitrate, and total nitrogen for the Wadeable Streams Assessment. USGS collects total nitrogen, organic nitrogen, ammonia, nitrite, nitrate, total Kjeldahl nitrogen, and inorganic nitrogen measurements from the Cossatot River near Vandervoort. Inorganic nitrogen will be discussed in this section.

#### **3.2.1.6.1. Inorganic Nitrogen Around the Watershed**

Inorganic nitrogen measurements have been collected by ADEQ at over 20 water quality monitoring stations in the Lower Little River watershed during the period from 2010 through 2014. The USGS has measured dissolved inorganic nitrogen at its Cossatot River water quality monitoring station during the same time period.

A summary plot of these data is shown in Figure 3.15. In the Rolling Fork and Saline Rivers, median inorganic nitrogen concentrations appear to decline in the downstream direction. The median inorganic nitrogen concentration at the farthest downstream monitoring station on the Rolling Fork River is statistically significantly lower than the median inorganic nitrogen concentration at the farthest upstream station. In Bear Creek, Cossatot River, and Holly Creek, median inorganic nitrogen concentrations appear to generally increase downstream. Median inorganic nitrogen concentrations at the farthest downstream monitoring stations on Cossatot River, and Holly Creek are statistically significantly higher than the median inorganic nitrogen concentrations at the farthest upstream monitoring stations on these streams. The highest median inorganic nitrogen concentrations from this period occur in Mine Creek (RED0048B and RED0051B).

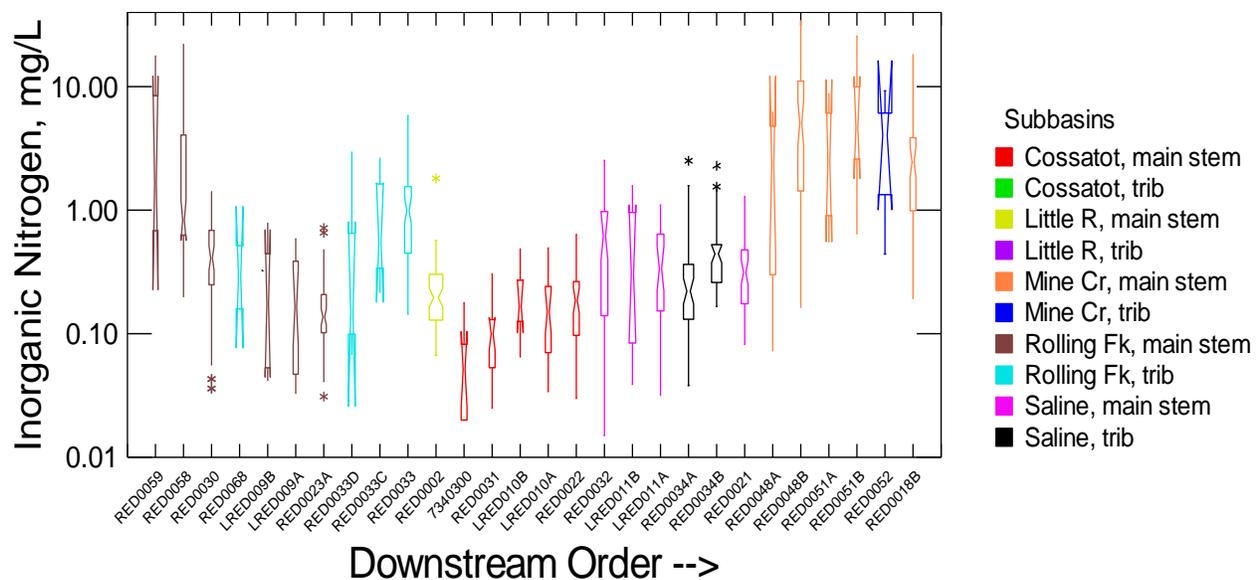


Figure 3.15 Inorganic nitrogen data from streams in the Lower Little River watershed, 2010 – 2014.

When data from the main stem monitoring stations are combined, the median inorganic nitrogen concentration for the Cossatot River is statistically significantly lower than the median inorganic nitrogen concentrations for the other monitored streams. The median inorganic nitrogen concentration for Mine Creek is statistically significantly higher than the median inorganic nitrogen concentrations for the other monitored streams.

Summary plots of inorganic nitrogen measurements collected by ADEQ from the reservoirs in the watershed during the period from 2010 through 2014 are shown on Figure 3.16. The highest median inorganic nitrogen concentrations, at all depths, occur in Dierks Lake. Median inorganic nitrogen concentrations at depth in Millwood Lake tend to be lower than all of the other reservoirs in the watershed.

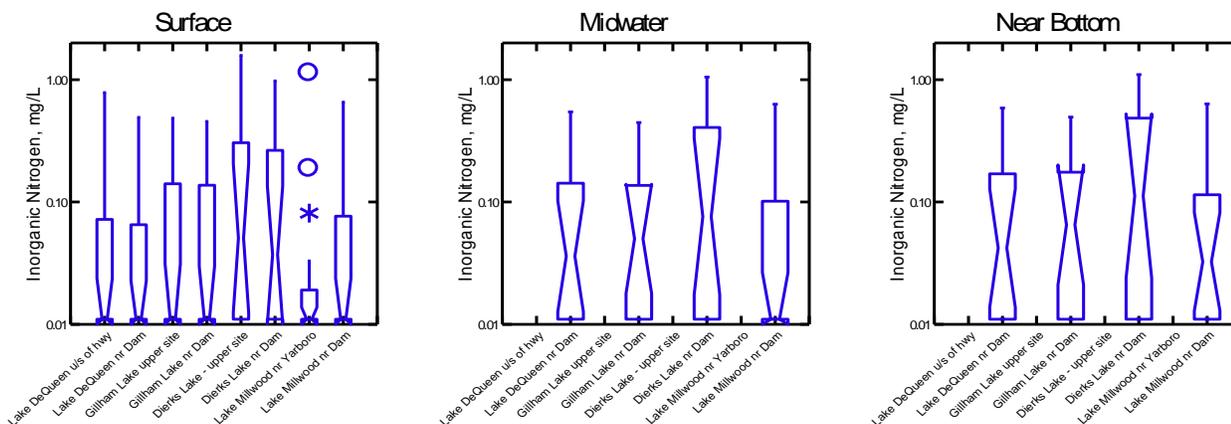


Figure 3.16 Inorganic nitrogen concentrations at ADEQ reservoir water quality stations 2010-2014.

### 3.2.1.6.2. Modeled Nitrogen

Prioritization of the Lower Little River 11-digit HUC subwatersheds based on modeled total nitrogen concentrations is shown in Figure 3.17 (Gitau and Chaubey 2007). Higher percentiles indicate higher priority, with highest priority shown as the darkest red on Figure 3.17. The highest nitrogen contributions estimated by the model are from the Little River, Cossatot River, Mine, and Plum Creeks.

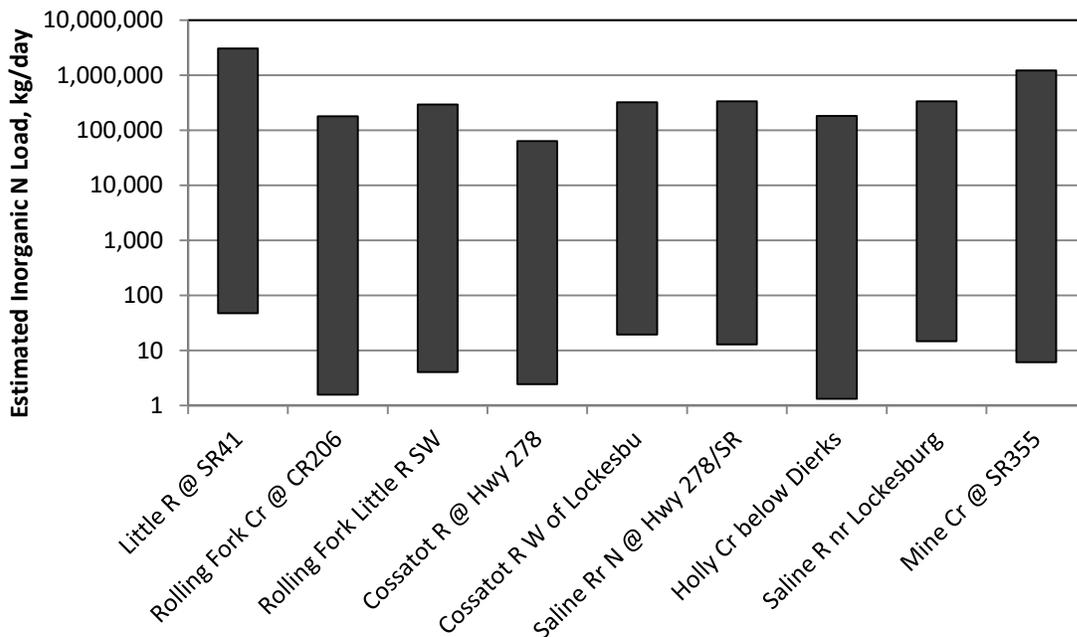


Figure 3.17 Estimated inorganic nitrogen loads for selected locations within the Lower Little River watershed.

### 3.2.1.6.3. Inorganic Nitrogen Over Time

Inorganic nitrogen data have been collected for over 10 years at several ADEQ water quality monitoring stations within the Lower Little River watershed. Inorganic nitrogen data from stream stations with data records of at least 10 years are shown on Figure 3.18. Inorganic nitrogen concentrations in the Rolling Fork River appear to exhibit declines beginning around 2000. This decline is most evident in the data from the upstream-most station, RED0058. The graph of inorganic nitrogen data from Bear Creek exhibits a dramatic decline beginning around 2005, which has resulted in the nitrogen impairment being removed from this stream (see Section 3.2.1.3.2.). Inorganic nitrogen concentrations in the Cossatot and Saline Rivers exhibit variation over their period of record. Inorganic nitrogen data from the upstream Holly Creek water quality monitoring station (RED34A) exhibit variation over time, while inorganic nitrogen concentrations at the downstream station (RED34B) have remained relatively constant. The lack of variation at the downstream Holly Creek station may be the result of the influence of point

source discharges. Inorganic nitrogen data from the water quality stations on Mine Creek all appear to exhibit some degree of increase over time. Inorganic nitrogen concentrations appear to have increased slightly over time at the Little River station, and decreased over time at the Plum Creek station.

Period of record surface inorganic nitrogen data from the reservoir monitoring stations in the watershed are shown on Figure 3.19. There are few data points prior to 2010, making it difficult to characterize long term trends with much confidence. If the data from prior to 2010 adequately represent historical inorganic nitrogen conditions, it appears that inorganic nitrogen concentrations at most of the stations have increased over time.

#### **3.2.1.6.4. Inorganic Nitrogen Data Gaps**

There is a fairly good set of long term and recent inorganic nitrogen data for streams in the Lower Little River watershed. There is a good set of recent, but not long term, data for the ADEQ lake water quality monitoring stations in the Lower Little River watershed. If the results from the SWAT model realistically indicate subwatersheds with higher inorganic nitrogen loads, it appears there are several tributaries south of the Little River that should be monitored. Otherwise, monitoring at all of the ambient and roving stations (stream and reservoir) in the watershed needs to continue.

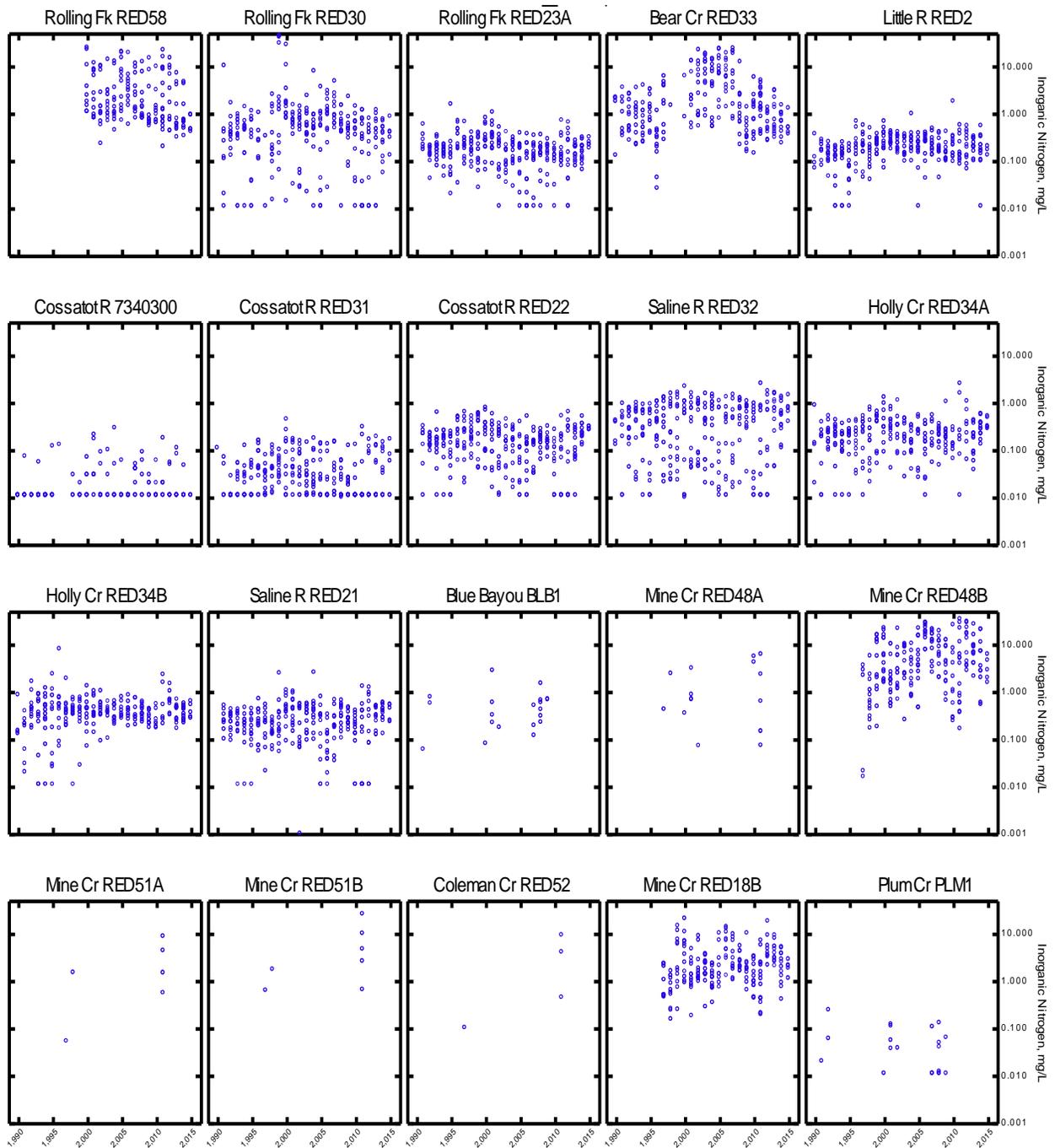


Figure 3.18. Inorganic nitrogen data from long term stream water quality monitoring stations in the Lower Little River watershed.

### **3.2.1.6.5. Inorganic Nitrogen Summary**

- Median inorganic nitrogen concentrations at stream water quality monitoring stations during the period 2010 through 2014 decrease downstream in the Cossatot and Saline Rivers. In the rest of the monitored streams in the watershed, median inorganic nitrogen concentrations for this period increase downstream.
- Overall, median inorganic nitrogen concentrations from the period 2010 through 2014 are lowest in the Cossatot River and highest in Mine Creek.
- Median inorganic nitrogen concentrations at reservoir water quality monitoring stations during the period 2010 through 2014 are highest in Dierks Lake and lowest in Millwood Lake.
- The greatest estimated inorganic nitrogen loads occur at the Little River and Mine Creek water quality monitoring stations.
- The greatest modeled inorganic nitrogen contributions are from Little River, Mine Creek and Plum Creek, and Cossatot River 11-digit watersheds.
- Long term records of inorganic nitrogen from the Rolling Fork River, Bear Creek, and Plum Creek appear to exhibit declining trends.
- Long term records of inorganic nitrogen from Mine Creek appear to exhibit increasing trends.

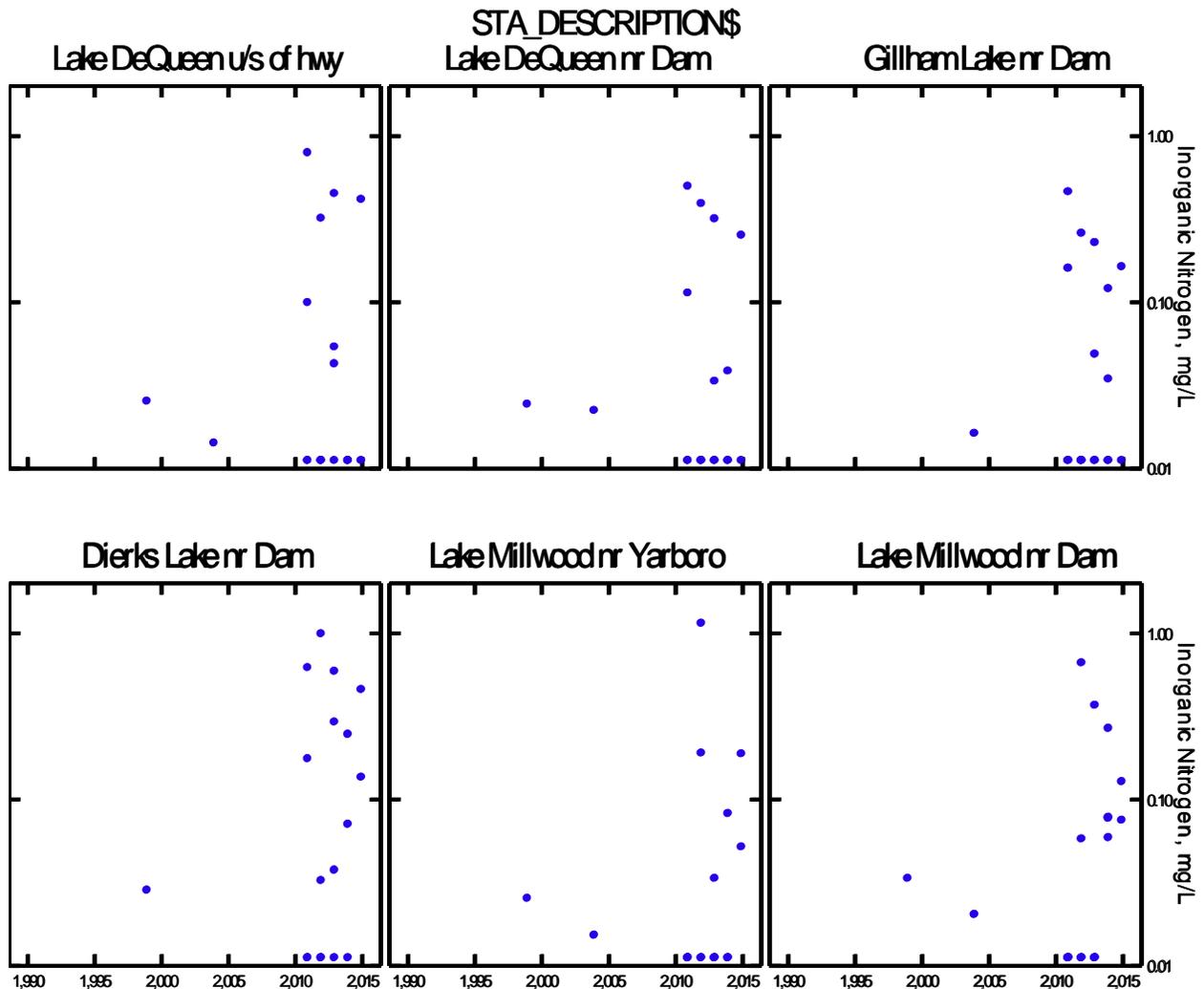


Figure 3.19. Surface inorganic nitrogen data from long term reservoir monitoring stations in the Lower Little River watershed.

### 3.2.1.6.6. Phosphorus

ADEQ, EPA, and USGS have collected phosphorus measurements in the Lower Little River watershed. ADEQ monitors orthophosphate and total phosphorus. EPA collected total phosphorus measurements for the National Rivers and Streams Assessment, National Lakes Assessment, and Wadeable Streams Assessment. USGS has measured total phosphorus, dissolved phosphorus, phosphate, and orthophosphate in the Cossatot River near Vandervoort. Total phosphorus will be discussed in this section.

### **3.2.1.6.7. Phosphorus around the Watershed**

Total phosphorus measurements have been collected by ADEQ at over 20 water quality monitoring stations in the Lower Little River watershed during the period from 2010 through 2014. Total phosphorus data are not available for the USGS water quality monitoring station on the Cossatot River for this time period.

A summary plot of these data is shown in Figure 3.20. Median total phosphorus concentrations in Rolling Fork River decrease downstream. Median total phosphorus concentrations at the upstream and downstream Saline River water quality monitoring stations are very similar. Median total phosphorus concentrations in all other streams with multiple water quality monitoring station increase downstream. In all of these streams, the downstream median total phosphorus concentration is statistically significantly higher than the median total phosphorus concentration at the upstream water quality monitoring station. In Mine Creek, median total phosphorus concentrations both increase and decrease downstream.

The highest median total phosphorus concentrations for the period 2010 through 2014 are in Mine Creek. The median total phosphorus concentration at Mine Creek station RED0048B is statistically significantly greater than the median concentrations for all of the other water quality monitoring stations in the watershed.

The lowest median total phosphorus concentrations for the period 2010 and 2014 are at the upper Bear Creek station (RED0033D), the upper Cossatot River station (RED0031), and Robinson Creek, a tributary of the Rolling Fork River (RED0068). The median total phosphorus concentrations at these stations are statistically significantly lower than the median concentrations at all other monitoring stations in the watershed.

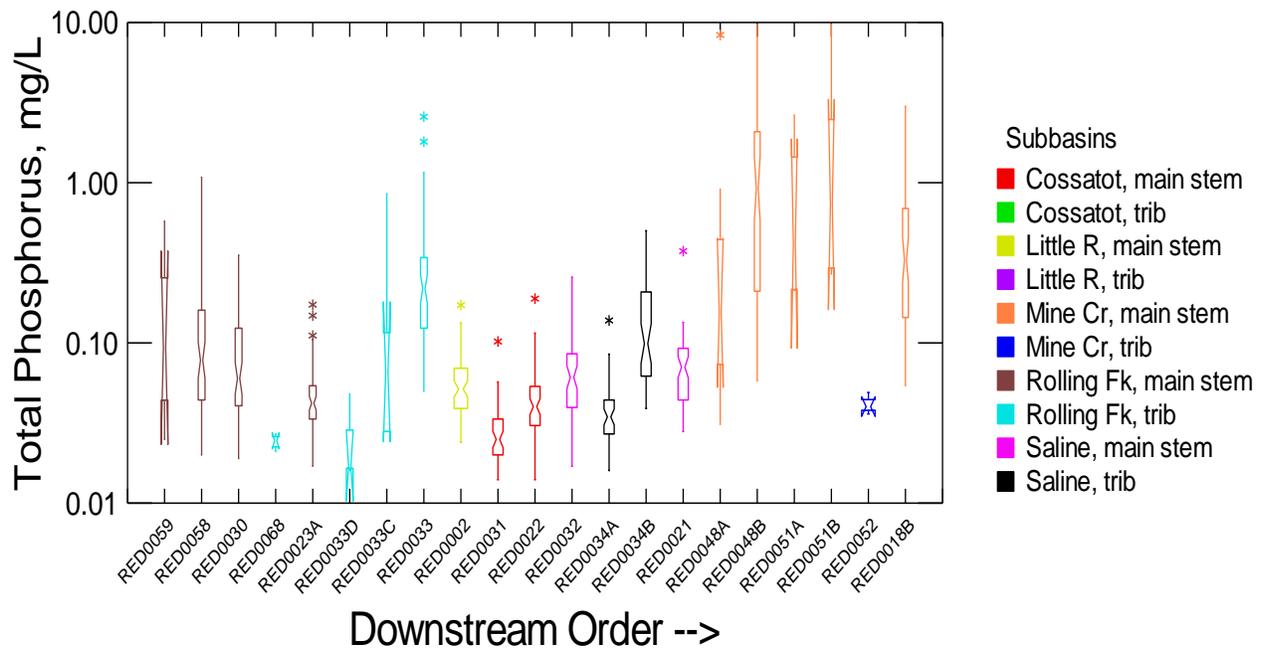


Figure 3.20. Total phosphorus data from streams in the Lower Little River watershed, 2010 - 2014.

Summary plots of total phosphorus measurements collected by ADEQ from the reservoirs in the watershed during the period from 2010 through 2014 are shown on Figure 3.21. Surface and midwater median total phosphorus concentrations in Millwood Lake are statistically significantly higher than median total phosphorus concentrations in the other reservoirs. Surface median total phosphorus concentrations are lower at the stations near the dam in all of the reservoirs. In DeQueen Lake and Gillham Lake, the median total phosphorus concentration near the dam is statistically significantly lower than the median concentration at the upper lake station.

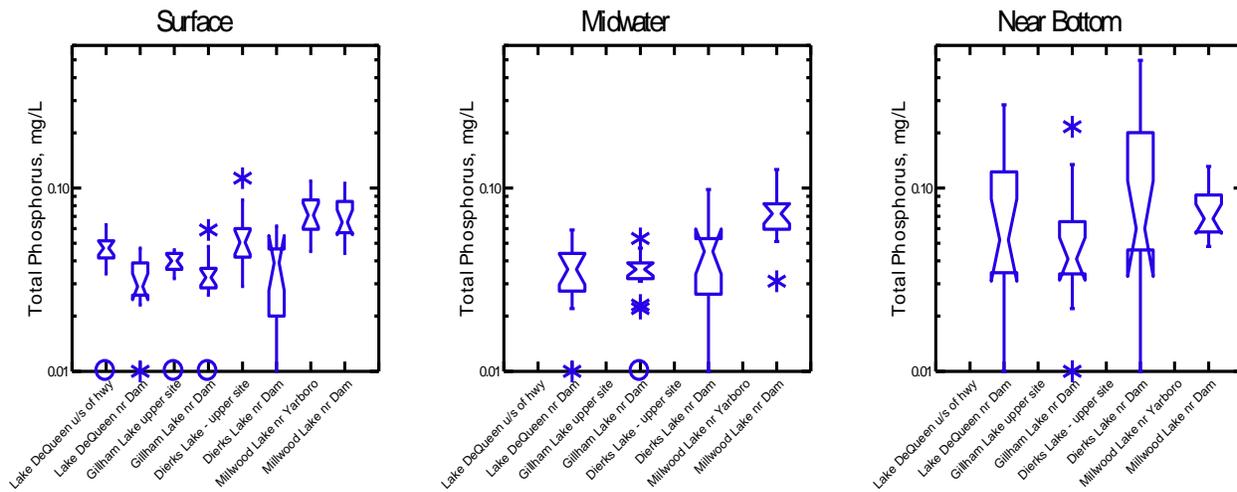


Figure 3.21. Surface total phosphorus data from long term reservoir monitoring stations in the Lower Little River watershed.

### 3.2.1.6.8. Modeled Total Phosphorus

Prioritization of the Lower Little River 11-digit HUC subwatersheds based on modeled total phosphorus concentrations is shown in Figure 3.22 (Gitau and Chaubey 2007). Higher percentiles indicate higher priority, with highest priority shown as the darkest red on Figure 3.22. The highest total phosphorus contributions estimated by the model are from the middle to lower watershed, particularly the Little River, Mine Creek and Plum Creek, and lower Cossatot River 11-digit subwatersheds.

### 3.2.1.6.9. Total Phosphorus Over Time

Total phosphorus data have been collected for over 10 years at several ADEQ water quality monitoring stations in the Lower Little River watershed. Entire periods of record of the total phosphorus data from stream stations with more than 10 years of data through at least 2011 are graphed in Figure 3.23.

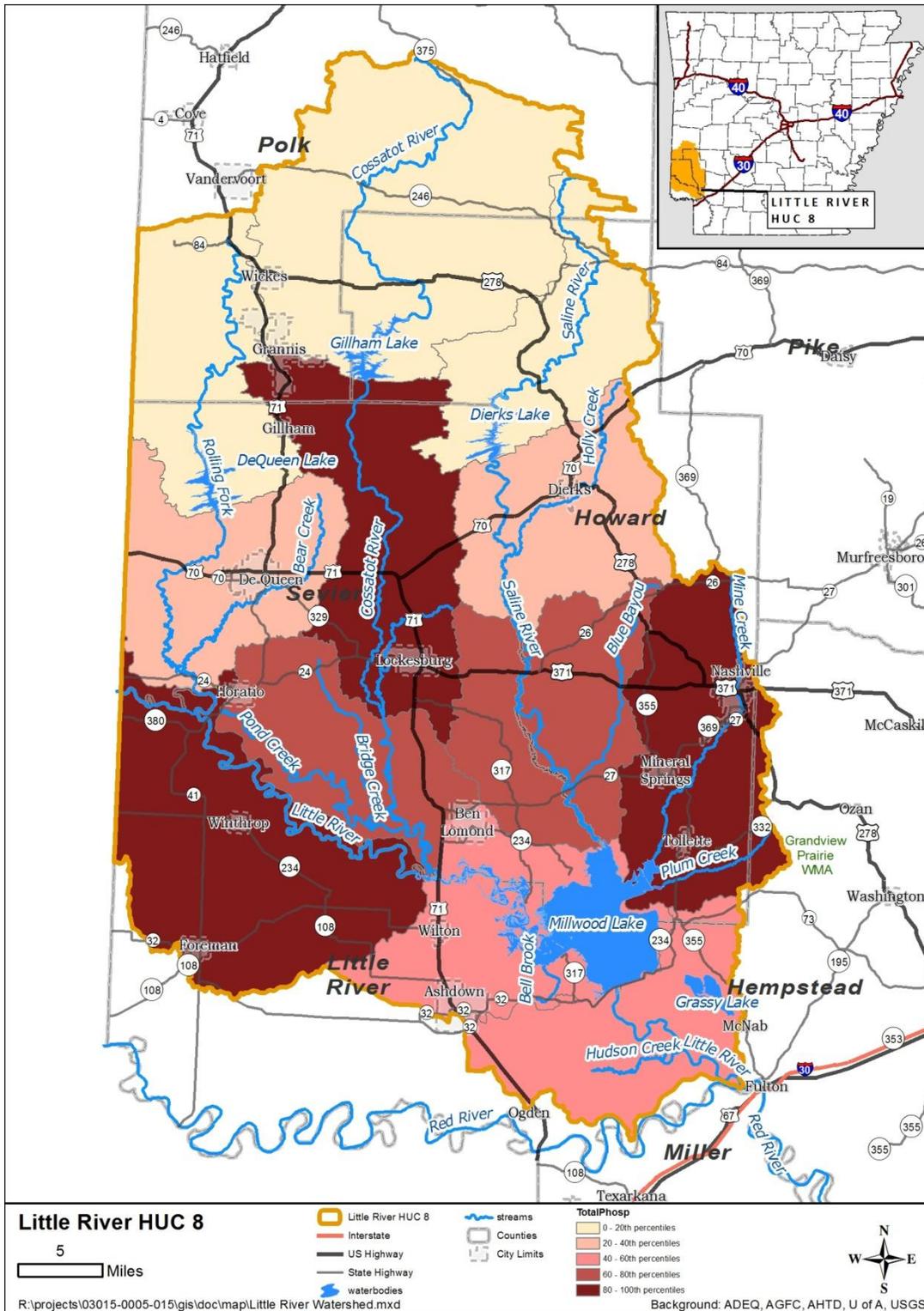


Figure 3.22. Estimates of relative contribution of phosphorus based on SWAT model results (Gitau and Chaubey 2007).

Total phosphorus concentrations appear to have declined over time at many of the stream water quality monitoring stations in the Lower Little River watershed. The most dramatic decline is evident in the total phosphorus data from the Rolling Fork River water quality monitoring stations upstream of DeQueen Lake. The total phosphorus data from the Rolling Fork River monitoring station downstream of DeQueen Lake appears to have a pattern similar to the stations upstream of the lake, though less dramatic. Total phosphorus concentrations in Bear Creek appear to have increased recently. Total phosphorus concentrations appear to have declined at the Holly Creek monitoring station upstream of Dierks, but not at the station downstream of Dierks, suggesting that point source discharges between these two stations may be contributing phosphorus. For the most part, total phosphorus concentrations at the Mine Creek water quality monitoring stations appear to exhibit declining trends over time.

Period of record surface total phosphorus data from the reservoir monitoring stations in the watershed are shown on Figure 3.24. There are few data points prior to 2010, making it difficult to characterize long term trends with much confidence. If the data from prior to 2010 adequately represent historical total phosphorus conditions, it appears that total phosphorus concentrations may have increased over time in Gillham Lake and Millwood Lake.

#### **3.2.1.6.10. Total Phosphorus Data Gaps**

There is a fairly good set of long term and recent total phosphorus data for streams and reservoirs in the Lower Little River watershed. There is a good set of recent, but not long term, data for the ADEQ lake water quality monitoring stations in the Lower Little River watershed. If the results from the SWAT model realistically indicate subwatersheds with higher total phosphorus loads, it appears there are several tributaries south of the Little River that should be monitored. Otherwise, monitoring at all of the ambient and roving stations (stream and reservoir) in the watershed needs to continue.

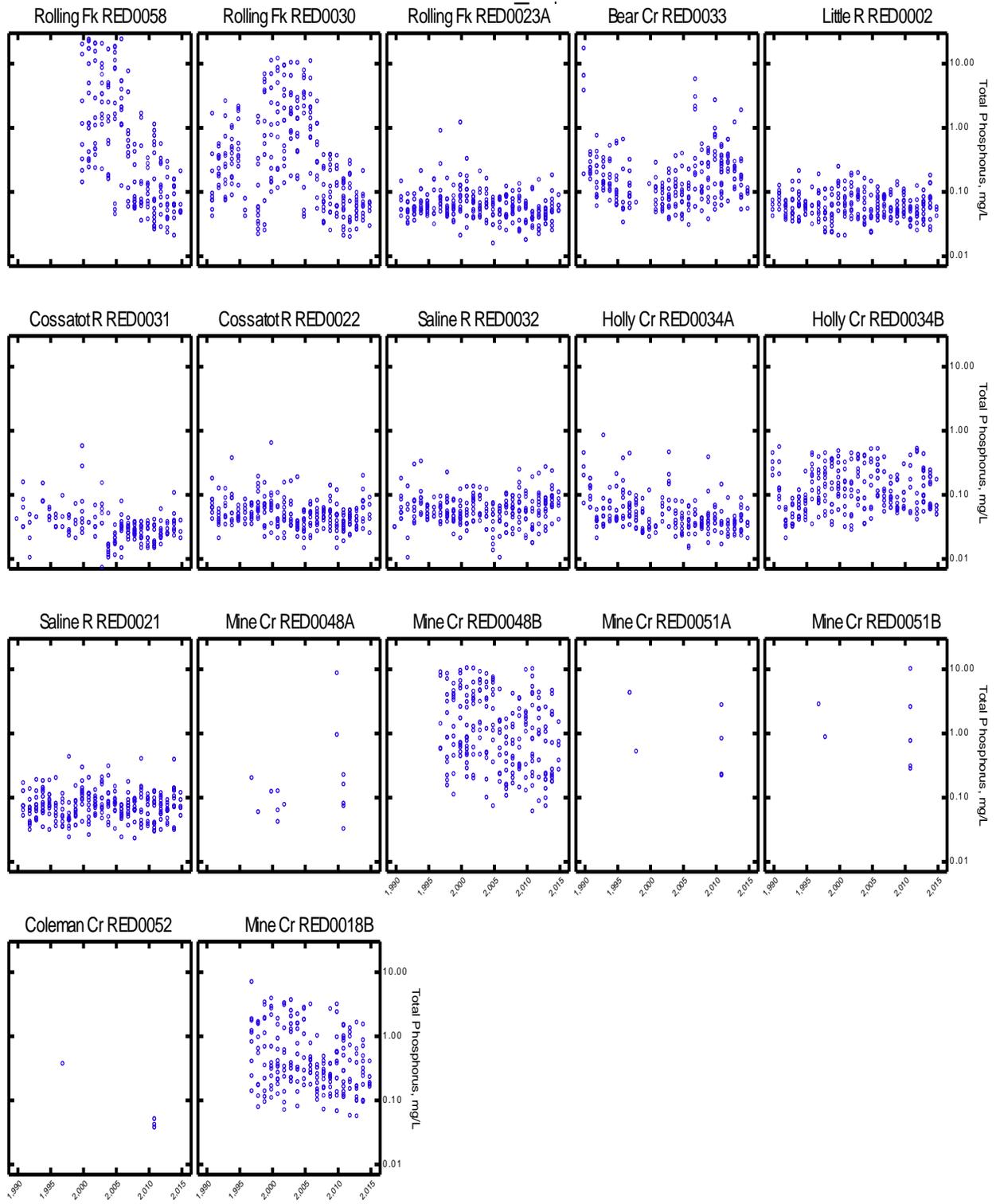


Figure 3.23. Total phosphorus data from long term stream water quality monitoring stations in the Lower Little River watershed.

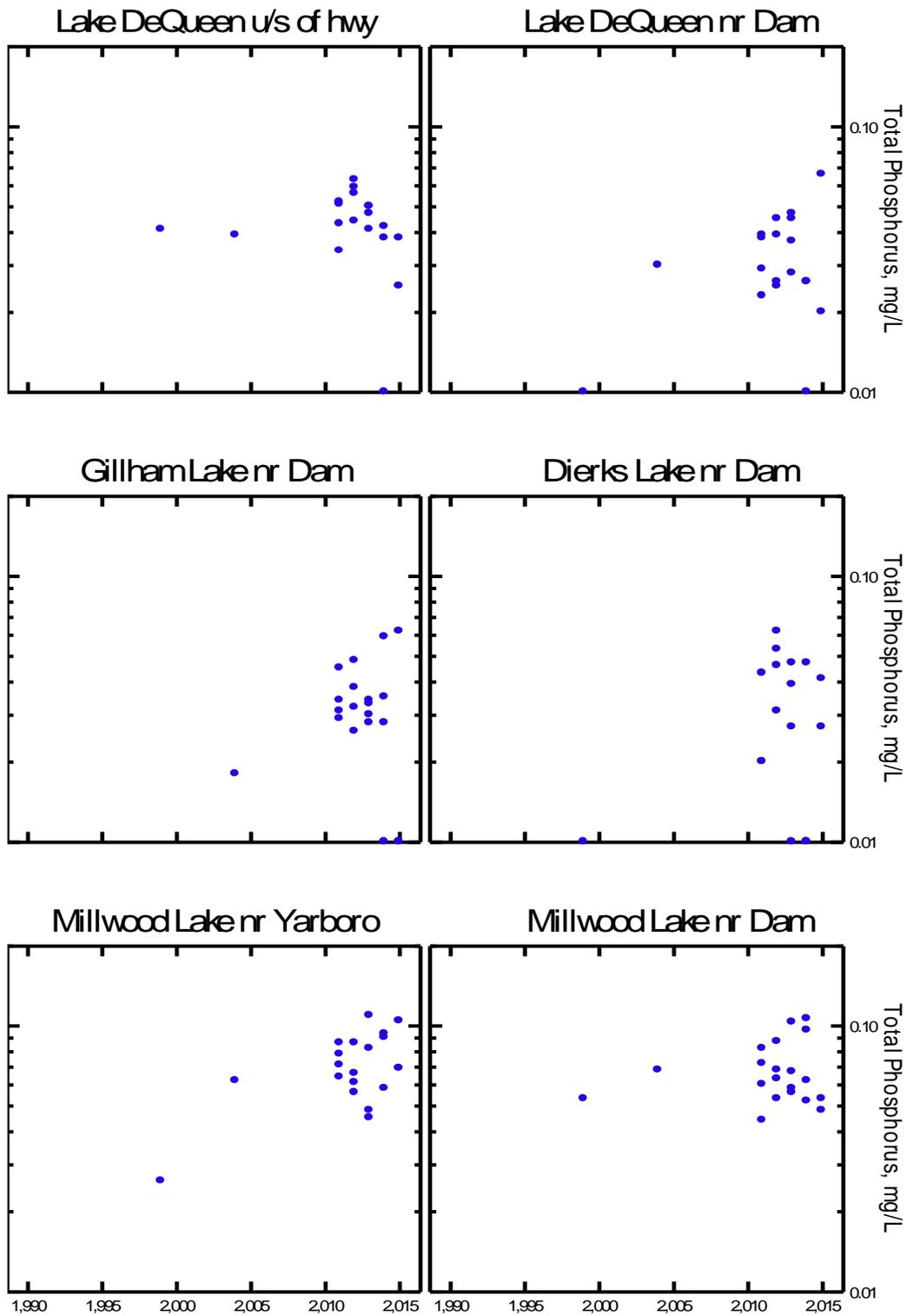


Figure 3.24. Surface total phosphorus data from long term reservoir monitoring stations in the Lower Little River watershed.

### **3.2.1.6.11. Total Phosphorus Summary**

- Median total phosphorus concentrations during the period 2010 through 2014 decrease downstream in the Rolling Fork River.
- In all the other monitored streams with multiple water quality stations, except Mine Creek, the median total phosphorus concentration during the period 2010 through 2014 increases downstream, with the median concentration at the downstream station statistically significantly higher than the median concentration at the upstream station.
- The highest median total phosphorus concentration for the period 2010 through 2014 is at Mine Creek station RED043B.
- The lowest median total phosphorus concentration for the period 2010 through 2014 is at Bear Creek station RED033D.
- Surface and midwater median total phosphorus concentrations at Millwood Lake water quality monitoring stations during the period 2010 through 2014 are statistically significantly higher than the median concentrations from the other reservoirs in the watershed.
- The largest estimated total phosphorus load for the period 2010 through 2014 is from the Little River, primarily because of the high flow rates.
- The smallest estimated total phosphorus load for the period 2010 through 2014 is from the upper Rolling Fork River.
- The largest estimated total phosphorus loads based on SWAT modeling are from the Little River, middle Cossatot River, and Mine Creek and Plum Creek.
- The lowest estimated total phosphorus loads based on SWAT modeling are from the upper Rolling Fork, Cossatot, and Saline Rivers.
- Long term data records indicate declining trends in total phosphorus concentrations at many locations in the watershed, including stations on the Rolling Fork River, Holly Creek, and Mine Creek.
- Total phosphorus concentrations may have increased in Gillham Lake and Millwood Lake over time.

## **3.2.2 Groundwater Quality**

### **3.2.2.1 Monitoring**

Groundwater quality data have been collected in the Lower Little River watershed by ADEQ and USGS. ADEQ administers mandated groundwater monitoring programs at various sites that are regulated by state and federal programs. The purpose of this monitoring is to

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evaluate potential and actual impacts to groundwater resulting from human activities, e.g., solid waste landfills and underground storage tanks, and natural phenomenon (ADEQ 2015a).

ADEQ developed the Arkansas Ambient Ground Water Monitoring Program in 1986, which currently consists of 12 monitoring areas and approximately 250 wells and springs throughout the state (ADEQ 2015a, Kresse, et al. 2014). A portion of the Athens Plateau groundwater quality monitoring area is within the Lower Little River watershed. Monitoring in the Athens Plateau area was initiated in 2004 to increase the amount of baseline water quality data and track the potential for impacts from livestock agriculture on the aquifers. Samples are collected from wells completed in the Paleozoic formations of the southern Ouachita Mountains, and in the Cretaceous and Quaternary deposits of the Gulf Coastal Plain geologic province (ADEQ 2015a). Fifteen wells in the Lower Little River watershed have been sampled as part of this program. All but two of the wells were sampled for the first time in 2004. Four of these wells were sampled only sampled once, in 2004. Two wells were sampled first in 2008. The Athens Plateau wells in the watershed were most recently sampled in 2013 (ADEQ 2015a, EPA 2015a, USGS 2014a).

The USGS collects groundwater quality data at several wells in the Lower Little River watershed. There are four wells within the watershed that have been sampled for water quality by USGS since 2000 (USGS 2014). One of these is the Trinity Group USGS master well located in the watershed (Todd Fugit, personal communication 9/4/2013). Master wells are sampled for water quality every five years (ADEQ 2009).

The periods of record for water quality data from active monitoring wells are listed in Table 3.7. A detailed water quality data inventory, that includes older data, is available in Appendix B.

Table 3.7. Periods of record for active and recent groundwater quality monitoring wells in the Lower Little River watershed (ADEQ 2015a, USGS 2014a).

| Well ID         | Monitoring Agency/<br>Organization | Aquifer          | Date of first<br>sample | Date of most recent<br>sample |
|-----------------|------------------------------------|------------------|-------------------------|-------------------------------|
| ATH003          | ADEQ                               | not given        | 4/5/2004                | 4/5/2004                      |
| ATH004          | ADEQ                               | not given        | 3/10/2008               | 6/3/2013                      |
| ATH005          | ADEQ                               | not given        | 4/5/2004                | 6/3/2013                      |
| ATH006          | ADEQ                               | not given        | 4/5/2004                | 6/3/2013                      |
| ATH007          | ADEQ                               | not given        | 4/5/2004                | 4/5/2004                      |
| ATH008          | ADEQ                               | not given        | 4/5/2004                | 3/10/2008                     |
| ATH009          | ADEQ                               | not given        | 4/5/2004                | 4/5/2004                      |
| ATH015          | ADEQ                               | not given        | 4/6/2004                | 4/6/2004                      |
| ATH016          | ADEQ                               | not given        | 4/6/2004                | 6/25/2013                     |
| ATH017          | ADEQ                               | not given        | 4/6/2004                | 6/25/2013                     |
| ATH018          | ADEQ                               | not given        | 4/6/2004                | 6/10/2013                     |
| ATH019          | ADEQ                               | not given        | 4/6/2004                | 6/10/2013                     |
| ATH020          | ADEQ                               | not given        | 4/6/2004                | 3/11/2008                     |
| ATH021          | ADEQ                               | not given        | 4/6/2004                | 6/10/2013                     |
| ATH027          | ADEQ                               | not given        | 3/11/2008               | 6/10/2013                     |
| 334156094083801 | USGS                               | Terrace deposits | 8/22/2011               | 8/22/2011                     |
| 334203094083701 | USGS                               | Terrace deposits | 8/21/2015               | 8/21/2015                     |
| 334341093390201 | USGS                               | Tokio Formation  | 8/21/2015               | 8/21/2015                     |
| 335806094100102 | USGS                               | Trinity Group    | 6/9/1972                | 6/20/2011                     |

### 3.2.2.2 Groundwater Quality Characteristics

Groundwater quality in the Ouachita Mountains aquifer is good with respect to Federal primary drinking water standards. Water quality and type generally are defined by the two major rock types in the Ouachita Mountains: quartz rocks (sandstone, chert, and novaculite) and shale. Groundwater from quartz formations tends to have low pH values, low dissolved solids concentrations, and is very soft water of a mixed water type representative of precipitation concentrated by evapotranspiration processes. Groundwater from shale rock in the system is characterized as a strongly calcium- to sodium-bicarbonate water type, with varying constituent concentrations defined by residence time along the flow path. Sulfate and chloride concentrations tend to be elevated in some areas for groundwater from shale formations. Groundwater problems in regard to taste, staining, and other aesthetic properties are related to elevated levels of iron, which is a common complaint among domestic users of this aquifer. Iron

is abundant in numerous mineral forms in sedimentary rocks throughout Arkansas, and elevated iron in the Ouachita Mountain aquifer are attributed to microbially mediated processes (Kresse et al. 2013).

For all but the Ozan aquifer, water quality in the aquifers of the Gulf Coastal Plain is good, with regard to Federal primary drinking water standards, where they outcrop and are unconfined. Downgradient of the outcrop areas, salinity levels in the Nacatoch and Tokio aquifers increase to levels that make them unsuitable for many uses. For the most part, chloride levels in the Trinity aquifer are less than 15 mg/L, even as far as 15 miles downgradient of the outcrop. In the Ozan aquifer, chloride and sulfate concentrations that exceed Federal secondary drinking water standards occur in the outcrop area (Kresse, et al. 2014).

#### **3.2.2.2.1. ADEQ**

Parameters measured in the monitoring wells within ADEQ's Athens Plateau Monitoring Area include TDS, chloride, iron, and manganese (ADEQ 2014a). In the wells within the Lower Little River watershed, TDS concentrations range from 68 mg/L to 438 mg/L. All TDS concentrations were below the Secondary Maximum Contaminant Level for drinking water (SMCL). Chloride concentrations ranged from 2 mg/L to 10.5 mg/L and were all well below the SMCL of 250 mg/L. Dissolved iron concentrations ranged from below detection level (15 µg/L) to 4,040 µg/L. Iron concentrations above the SMCL of 300 µg/L were observed in 3 of the 15 wells. Manganese was detected in all but one well with concentrations ranging from 0.81 µg/L to 1,590 µg/L (ADEQ 2014a).

#### **3.2.2.2.2. USGS**

Parameters measured by USGS in wells within the Lower Little River watershed include TDS, chloride, iron, manganese, inorganic nitrogen and sulfate. Data collected over the last 5 years show all TDS concentrations below the SMCL with values ranging from 48 mg/L to 264 mg/L. Chloride and sulfate concentrations were also below the SMCL with values ranging from 6.7 mg/L to 22.5 mg/L and 0.84 mg/L to 16.3 mg/L, respectively. One well had iron and manganese concentrations above the SMCL. Inorganic nitrogen concentrations were well below

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the Maximum Contaminant Level for drinking water (MCL) of 10 mg/L with values ranging from 0.47 mg/L to 0.8 mg/L (USGS 2014).

### **3.2.3 Hydrologic Data**

This section describes monitoring of surface water and groundwater within the Lower Little River watershed.

#### **3.2.3.1 Surface Water Flow Monitoring**

The USGS monitors stream flow in the Lower Little River watershed. Table 3.8 lists active and historical USGS flow gages located in the Lower Little River watershed. There are six active USGS gages within the Lower Little River watershed. These gages are continuous monitoring sites. The Arkansas Department of Parks and Tourism provides support assistance for USGS gage 07340300, on the Cossatot River within the boundaries of the Cossatot River State Park (USGS 2015b).

Table 3.8. Active and historical flow gages located within the Lower Little River watershed (USGS 2015b).

| Gage No. | Stream                      | Continuous dates                       | Daily dates                        | Peak dates             | Measurement Dates      |
|----------|-----------------------------|--|------------------------------------|------------------------|------------------------|
| 07340300 | Cossatot River              | 10/1/2007 – current                    | 6/1/1967 - current                 | 5/6/1961 – 5/30/2013   | 6/21/1967 – current    |
| 07341200 | Saline River                | 10/1/2007 – current                    | 7/1/1963 - current                 | 5/6/1961 – 5/13/2014   | 6/11/1963 - current    |
| 07340000 | Little River                | 10/1/2007 – current                    | 4/1/1931 - current                 | 8/1915 – 5/14/2014     | 12/10/1930 – current   |
| 07339500 | Rolling Fork                | 10/1/2007 – current                    | 8/24/1987 – current (gage ht only) | 8/27/1947 – 9/11/2014  | 2/12/1948 – current    |
| 07340500 | Cossatot River              | 10/1/2007 – current (gage height only) | 4/1/1938 - current                 | 1/24/1938 – 9/11/2014  | 1/19/1938 - current    |
| 07341000 | Saline River                | 10/1/2007 – current (gage height only) | 10/1/1938 – 10/8/2014              | 1920 – 9/11/2014       | 5/13/1938 – current    |
| 07341301 | Little River                | --                                     | 10/1/1966 – 9/30/1980              | 5/9/1967 – 5/7/1984    | --                     |
| 07339800 | Pepper Creek                | --                                     | --                                 | 5/5/1961 – 4/4/1986    | 3/12/1961 – 4/24/1973  |
| 07340200 | West Flat Creek             | --                                     | --                                 | 2/23/2962 – 12/2/1982  | 11/22/1961 – 9/27/1988 |
| 07340530 | Mill Slough Creek tributary | --                                     | --                                 | 6/12/1963 – 12/11/1985 | 4/23/1964 – 5/25/1969  |
| 07341100 | Rock Creek                  | --                                     | --                                 | 7/23/1961 – 5/15/1983  | 7/23/1961 – 9/27/1988  |
| 07341260 | Dillard Creek               | --                                     | --                                 | 7/19/1989 – 4/25/2004  | 2/11/1988 – 11/19/2002 |
| 07339200 | Rolling Fork                | --                                     | --                                 | --                     | 11/19/1963 – 9/27/1988 |
| 07339780 | Rolling Fork                | --                                     | --                                 | --                     | 7/10/1962 – 4/30/2013  |
| 07339790 | Bear Creek                  | --                                     | --                                 | --                     | 9/2/1987 – 10/24/1989  |
| 07339850 | Rolling Fork                | --                                     | --                                 | --                     | 2/13/1975 – 3/26/1975  |
| 07340200 | East Flat Creek             | --                                     | --                                 | --                     | 9/20/1967 – 2/29/1968  |
| 07340220 | Flat Creek                  | --                                     | --                                 | --                     | 9/20/1967 – 2/29/1968  |
| 07340400 | Cossatot River              | --                                     | --                                 | --                     | 11/19/1963 – 9/27/1988 |
| 07340575 | Neal Spring                 | --                                     | --                                 | --                     | 11/1/1968              |
| 07340750 | Lick Creek                  | --                                     | --                                 | --                     | 11/20/1963 – 9/27/1988 |
| 07340945 | Saline River                | --                                     | --                                 | --                     | 9/2/1987 – 10/24/1989  |
| 07341225 | Blue Bayou                  | --                                     | --                                 | --                     | 9/2/1987 – 12/9/1989   |

### 3.2.3.2 Surface Water Level Monitoring

The USACE monitors reservoir pool and river levels in the Lower Little River watershed at 13 real-time gages. Table 3.9 lists information about the USACE water level monitoring gages within the watershed. Five of the USACE gages are at the same locations as USGS gages (USACE 2015c).

Table 3.9. USACE water level gages operating in the Lower Little River watershed (USACE 2015a, USACE 2015c ,USACE Tulsa District 2015).

| Gage No. | Waterbody      | Location               | Start Year |
|----------|----------------|------------------------|------------|
| -        | Little River   | Tailwater Millwood dam | 1911       |
| AHDA4    | Millwood Lake  | Dam                    | 2000       |
| DEQA4*   | Cossatot River | Near DeQueen           | 1911       |
| DIEA4    | Dierks Lake    | No information         | 2000       |
| DIRA4*   | Saline River   | Near Dierks            | 1911       |
| DKTA4    | Saline River   | Tailwater Dierks dam   | 2000       |
| DQDA4    | DeQueen Lake   | Dam                    | 2000       |
| DQNA4*   | Rolling Fork   | Near DeQueen           | 1911       |
| DQTA4    | Rolling Fork   | Tailwater DeQueen dam  | 1911       |
| GLLA4    | Gillham Lake   | Dam                    | 2000       |
| GLTA4    | Cossatot River | Tailwater Gilham Dam   | 1911       |
| HRGA4*   | Little River   | Near Horatio           | 1911       |
| LCKA4*   | Saline River   | Near Lockesburg        | 1911       |

\* Same location as USGS flow gage

### 3.2.3.3 Surface Water Hydrologic Characteristics

Streams in the upper Lower Little River watershed, within the Ouachita Mountains, often go dry during the summer. Streams in the part of the watershed within the Gulf Coastal Plain usually maintain flows during the drier times of the year. The most recent published 7Q10 values for USGS gages in the Lower Little River watershed are shown in Table 3.10.

Table 3.10. 7Q10 values for USGS gages in the Lower Little River watershed (Funkhouser 2008).

| Station ID | Location                        | 7Q10 Flow (cfs) |
|------------|---------------------------------|-----------------|
| 07339200*  | Rolling Fork near Grannis       | 0.04            |
| 07339500   | Rolling Fork near DeQueen       | 0.16            |
| 07340000   | Little River near Horatio       | 3.95            |
| 07340300   | Cossatot River near Vandervoort | 8.37            |
| 07340400*  | Cossatot River near Umpire      | 6.87            |
| 07341000   | Saline River near Dierks        | 0               |
| 07341200   | Saline River near Lockesburg    | 0.32            |

\* Partial record station

The USGS recently analyzed precipitation, flow, reservoir pool elevations, and reservoir releases from the period 1951-2011 at selected locations in Arkansas, Louisiana, and Missouri. The Little River USGS gage near Horatio (07340000) was included in this analysis, along with the four USACE reservoirs located in the Lower Little River watershed (Wagner, Krieger and Merriman 2014). The results of the trend analyses for the locations within the Lower Little River watershed are summarized in Table 3.11

Table 3.11. Results from long term trend analysis of selected surface water indicators at locations in the Lower Little River watershed.

| Indicator                           | Trends Identified*      |                   |                   |              |                   |
|-------------------------------------|-------------------------|-------------------|-------------------|--------------|-------------------|
|                                     | Little River nr Horatio | Millwood Lake     | DeQueen Lake      | Gillham Lake | Dierks Lake       |
| Annual mean daily flow/releases     | Increasing              | Decreasing        | <b>Decreasing</b> | Decreasing   | Decreasing        |
| Annual maximum daily flow/releases  | <b>Decreasing</b>       | Decreasing        | <b>Decreasing</b> | Decreasing   | <b>Decreasing</b> |
| Annual minimum daily flow/releases  | <b>Increasing</b>       | Increasing        | <b>Increasing</b> | Increasing   | <b>Increasing</b> |
| Annual mean daily pool elevation    | --                      | Increasing        | Increasing        | Increasing   | Decreasing        |
| Annual maximum daily pool elevation | --                      | <b>Decreasing</b> | Decreasing        | Increasing   | Decreasing        |
| Annual minimum daily pool elevation | --                      | <b>Increasing</b> | Decreasing        | Increasing   | Decreasing        |

\* **Bold red text** indicates the trend is statistically significant.

One of the purposes of the four USACE reservoirs in the Lower Little River watershed is water supply. These reservoirs are managed by the USACE Little Rock District. The amount of storage allocated to water supply in each of these reservoirs is summarized in Table 3.12.

Table 3.12. Surface water storage in USACE reservoirs in the Lower Little River watershed.

| Reservoir     | Total storage at conservation pool, acre-feet | Water supply storage, acre-feet <sup>a</sup> | Water supply storage currently contracted, acre-feet <sup>a</sup> |
|---------------|---|--|---|
| DeQueen Lake  | 25,000  | 17,885                                       | 17,885  |
| Dierks Lake   | 15,000  | 10,100                                       | 10,100  |
| Gillham Lake  | 23,000  | 20,600                                       | 20,400  |
| Millwood Lake | 188,000 <sup>b</sup>                          | 150,000                                      | 93,118  |

<sup>a</sup> (USACE 2015a)

<sup>b</sup> (Richards and Green 2013)

Millwood Lake was constructed and is operated by USACE for flood-risk reduction, water supply and recreation. The lake was completed in 1966. A sediment survey performed by USGS in 2013 revealed that the capacity of Millwood Lake has been reduced between 32 and 44 percent since construction due to sedimentation (Richards and Green 2013). The Millwood Lake Focus Group states that storage capacity has declined more rapidly than predicted when the USACE designed the reservoir ( Millwood Lake Citizen Focus Committee 2009).

#### 3.2.3.4 Groundwater Levels

The USGS and ANRC have recently been monitoring water levels in the Tokio aquifer, which is located under the Lower Little River watershed (Schrader and Rodgers 2013, ANRC 2015). Wells located within the Lower Little River watershed where water levels have been measured within the last 10 years are listed in table 3.13. Water level data are collected from these wells every three years.

Table 3.13. Periods of record for active groundwater level monitoring wells in the Lower Little River watershed (USGS 2015c).

| Well ID      | Monitoring Agency/<br>Organization | Date of first sample | Date of most recent<br>sample |
|--------------|------------------------------------|----------------------|-------------------------------|
| 12S25W02DDD1 | ANRC                               | 12/9/1998            | 3/20/2014                     |
| 12S27W05AAC1 | USGS                               | 6/30/1976            | 3/18/2014                     |
| 12S27W04BBC1 | USGS                               | 8/8/1996             | 3/18/2014                     |
| 11S29W13CCD1 | USGS                               | 9/4/1996             | 3/18/2014                     |
| 10S28W31DCC1 | USGS                               | 4/21/1999            | 3/18/2014                     |
| 11S26W08BBB1 | USGS                               | 4/29/1999            | 3/13/2014                     |
| 09S28W20DAC1 | USGS                               | 1/25/1957            | 2/20/2008                     |
| 11S30W25DDC1 | USGS                               | 4/29/1999            | 2/19/2008                     |

The geology of the upper part of the Lower Little River watershed, in the Ouachita Mountains, does not have much capacity for groundwater storage. Groundwater in the Lower Little River watershed is largely contained in the Tokio aquifer underlying the Gulf Coastal Plain. From 1980 to 2010, withdrawals from the Tokio aquifer decreased 81%. Groundwater flow in the Tokio Aquifer is generally towards the south or southeast (Schrader and Rodgers 2013).

In 2014, water levels were measured in 10 Tokio aquifer wells in Howard County and three Tokio aquifer wells in Sevier County. Groundwater levels declined between 2011 and 2014 at four of the wells in Howard County. The rest of the wells in Howard County and all of the wells in Sevier County showed groundwater level increases between 2011 and 2014 (ANRC 2015). A cone of depression is evident about one of the wells in southern Howard County, but the cause is unknown (Schrader and Rodgers 2013).

### 3.2.4 Biological Data

#### 3.2.4.1 Sampling

Biological data has been collected in the Lower Little River watershed by ADEQ, EPA, and the USFS. ADEQ has conducted biological assessments at over 25 sites in the watershed. At these sites, the most recent surveys were in 2002 (ADEQ 2015b, ADEQ 2015c). In 2011 ADEQ conducted an inventory of biotic assemblages for Mine Creek and Bear Creek.

Macroinvertebrates and fish were collected at three sites on Mine Creek. Macroinvertebrates were collected at two sites on Bear Creek, and fish were collected at one site (ADEQ 2014a).

In 2006, EPA began the National Aquatic Resources Survey program to conduct probability-based surveys of the condition of the nation's water resources. This program grew out of the earlier National Wadeable Streams Assessment. Biological sampling was conducted at a site on Bell Brook in 2004 as part of the National Wadeable Streams Assessment. Algal surveys were conducted at Millwood Lake and Gillham Lake in 2007 and 2009 as part of National Aquatic Resources Surveys. Biological sampling was conducted at two sites in the Lower Little River watershed during 2009 as part of the National Rivers and Streams Survey (EPA 2013b).

The USFS conducts Basin Area Stream Surveys in the Ouachita National Forest every five years. The most recent survey was conducted in 2011. Populations of selected indicator species of fish are surveyed, along with a number of sensitive species that include crayfish and mussels in addition to fish (USFS 2011). This sampling program includes two sites in the upper Cossatot River watershed (Nuckols 2005). Caney and Brushy Creeks in Cossatot River headwaters are considered water quality reference streams by the USFS (USFS 2011).

Researchers are surveying the extent of Arkansas Fatmucket populations in Arkansas, which includes streams within the Lower Little River watershed. Mussel surveys by USGS, USFWS, and AGFC are ongoing in the Ouachita National Forest (USFS 2013).

#### **3.2.4.2 Condition of Benthic Macroinvertebrate Communities**

EPA surveyed benthic macroinvertebrates in Bell Brook, a tributary of Millwood Lake, in July 2004; and in Opossum Creek, a tributary of Gillham Lake, and Hudson Creek, a tributary of the Little River downstream of Millwood Lake, during the summer of 2009. Based on the multimetric index developed for the 2008-2009 National Rivers and Streams Assessment, the macroinvertebrate community of Opossum Creek was classified as poor and the macroinvertebrate community of Hudson Creek was classified as fair (EPA 2015a) (EPA 2013b). Based on indices used in the Wadeable Streams Assessment, the macroinvertebrate

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community at the Bell Brook site was classified as most disturbed, with 20% to 50% taxa loss (EPA 2014).

Results from the 2011 ADEQ macroinvertebrate surveys of Bear Creek and Mine Creek were not available in the ADEQ online aquatic macroinvertebrate database (ADEQ 2015b). Results from the 2002 surveys are summarized in Table 3.14. The lower values for taxa richness, EPT, and intolerant taxa in the Rolling Fork River downstream of the Tyson plant effluent, compared to values in the Rolling Fork River west of Grannis (upstream of the Tyson plant effluent), suggests that the discharge from the Tyson plant may be impacting the macroinvertebrate community downstream.

Table 3.14. Macroinvertebrate metrics from ADEQ 2002 surveys in the Lower Little River watershed.

| Stream         | Location             | Season | Taxa richness | EPT   | HBI  | Intolerant taxa | Tolerant taxa |
|----------------|----------------------|--------|---------------|-------|------|-----------------|---------------|
| Cossatot R     | 1 mi N of Hwy 278    | Spring | 23            | 47.8% | 3.79 | 11              | 2.7%          |
| Rolling Fork R | Co. rd. W of Grannis | Spring | 26            | 69.8% | 3.28 | 11              | 2.0%          |
| Rolling Fork R | Co. rd. W of Grannis | Spring | 30            | 70.2% | 3.40 | 12              | 1.8%          |
| Rolling Fork R | Co. rd. W of Grannis | Spring | 30            | 70.0% | 3.30 | 10              | 2.9%          |
| Rolling Fork R | Co. rd. W of Grannis | Spring | 32            | 67.7% | 3.30 | 11              | 3.1%          |
| Rolling Fork R | d/s Tyson outfall    | Spring | 25            | 43.7% | 4.71 | 7               | 2.8%          |
| Rolling Fork R | d/s Tyson outfall    | Spring | 24            | 50.8% | 3.95 | 8               | 1.6%          |
| Rolling Fork R | d/s Tyson outfall    | Fall   | 21            | 47.9% | 4.86 | 6               | 9.3%          |
| Rolling Fork R | d/s Tyson outfall    | Fall   | 16            | 35.0% | 5.42 | 5               | 1.9%          |
| Cossatot R     | u/s Cossatot falls   | Fall   | 22            | 32.2% | 4.27 | 5               | 3.9%          |

### 3.2.4.3 Fisheries Condition

EPA surveyed fisheries in Opossum Creek, a tributary of Gillham Lake, and Hudson Creek, a tributary of the Little River downstream of Millwood Lake, during the summer of 2009. There was insufficient information to classify the condition of the fishery at the Opossum Creek site. The fishery at the Hudson Creek site was classified as poor (EPA 2015a).

Results from the 2011 ADEQ fishery surveys of Bear Creek and Mine Creek were not available in the ADEQ online fish collection database (ADEQ 2015c). Results from the most recent previous surveys, in 2002 and 2004, are summarized in Table 3.15.

Table 3.15. Results from ADEQ 2002 and 2004 fishery surveys in the Lower Little River watershed.

| Stream         | Location          | Sample date | No. species | No. sensitive species | % sensitive species | No. fish |
|----------------|-------------------|-------------|-------------|-----------------------|---------------------|----------|
| Rolling Fork R | u/s Tyson outfall | Fall 2002   | 28          | 7                     | 17.4                | 1,272    |
| Rolling Fork R | CR206             | Fall 2002   | 28          | 6                     | 24.1                | 2,588    |
| Cossatot R     | Howard CR         | Fall 2004   | 13          | 5                     | 42.4                | 688      |

Recently, the USFS analyzed diversity and biotic integrity of fisheries at sites monitored for the Ouachita National Forest Basin Area Stream Survey from 1990 through 2011. The Brushy Creek and Caney Creek sites located in the upper Cossatot River watershed were analyzed as part of this study. These analyses indicated overall biodiversity and biotic integrity at these sites is relatively good. The analyses identified a downward trend in diversity scores for Brushy Creek and biotic integrity scores for Caney Creek over time. The number of species present in Brushy Creek was reasonably consistent over time. The declining diversity scores appear to be the result of a sharp increase in numbers of central stonerollers present. This increase could indicate changes in streamside habitat, such as loss of riparian vegetation, and warrants further investigation. The downward trend in biotic integrity scores for Caney Creek appear to be the result of changes in sampling efforts over time, rather than actual changes in fish populations (Roghair and Dolluf 2013).

#### **3.2.4.4 Periphyton Communities**

EPA surveyed periphyton in Opossum Creek, a tributary of Gillham Lake, and Hudson Creek, a tributary of the Little River downstream of Millwood Lake, during the summer of 2009. Based on the multimetric index developed for the National Rivers and Streams Assessment, the periphyton community of Opossum Creek was classified as poor and the periphyton community of Hudson Creek was classified as good (EPA 2013b, EPA 2015a).

#### **3.2.4.5 Algal Communities**

EPA surveyed algal communities in Gillham Lake and Millwood Lake in 2009. Millwood Lake condition was not assessed based on algae. Gillham Lake was classified as least disturbed, with less than 20% taxa loss based on plankton indicators used for the National Lakes Assessment (EPA 2013d). Both Millwood Lake and Gillham Lake were classified as least disturbed based on sediment diatom indicators used for the National Lakes Assessment (EPA 2013e).

#### **3.2.4.6 Monitoring of Threatened and Endangered Aquatic Species**

The USFS monitors populations of threatened Leopard Darters at a permanent monitoring site on the Cossatot River. None have been counted at the Cossatot River monitoring site (USFS 2011, USFS 2013). The Rabbitsfoot, Ouachita Rock-pocketbook, and Winged Mapleleaf are endangered mussel species that have been recently found in the Little River (Harris, et al. 2009, USFS 2013).

#### **3.2.4.7 Aquatic Nuisance Species**

Two state identified ANS have been found in the Lower Little River watershed; Asian clam (*Corbicula fluminea*) and Nutria (*Myocastor coypus*). Three of the aquatic nuisance plant species for Arkansas have been reported in the Lower Little River watershed; Alligator Weed (*Alternanthera philoxeroides*), hydrilla (*Hydrilla verticillata*), and Eurasian water-milfoil (*Myriophyllum spicatum*) (AGFC 2013). Hydrilla, water lily, and alligator weed cover large areas of Millwood Lake, impacting access and water withdrawals, and slowing flow and

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increasing sedimentation Millwood Lake Citizen Focus ( Millwood Lake Citizen Focus Committee 2009) (Millwood Lake Citizen Focus Committee 2010).

#### **3.2.4.8 Migratory Patterns**

The Lower Little River watershed is situated where the Central and Mississippi Flyways overlap (Arkansas Department of Parks and Tourism 2014). Neotropical migrant songbirds arrive early spring and stay until early fall, when they migrate south. Waterfowl begin arriving in late fall. USFWS (US Fish and Wildlife Service 2014b).

#### **3.2.4.9 Biological Data Gaps**

No information was found to indicate that there is routine biological monitoring occurring in the Lower Little River watershed outside of the Ouachita National Forest. Researchers have developed indices of biotic integrity for Ouachita Mountain streams that could be used to track water quality (Dauwalter and Jackson 2004, Roghair and Dollof 2013, Hlass, Fisher and Turton 1998, Davidson and Clem 2003).

### **3.2.5 Stream Habitat Survey Data**

Stream habitat survey data include aspect, channel type, bedload, substrate, streambank stability, slump potential, large woody debris, and riparian vegetation. Stream habitat survey data have been collected in the Lower Little River watershed by ADEQ, EPA, and USFS.

#### **3.2.5.1 ADEQ**

ADEQ collects habitat data during fish and macroinvertebrate surveys. This includes information on channel characteristics, substrate, instream cover, and riparian vegetation (ADEQ 2015b, ADEQ 2015c).

#### **3.2.5.2 EPA**

In 2006, EPA began a program to conduct probability-based surveys of the condition of the nation's water resources (EPA 2013a). As part of this program, stream and riparian habitat

indices were developed for four sites in the Lower Little River watershed in 2007 and 2009 (EPA 2015a). The results for these indices are summarized in Table 3.16.

Table 3.16. Habitat indices results for the Lower Little River watershed (EPA 2009, EPA 2015a).

| Station ID                                   | NLA06608-1288  | FW08AR192                     | FW08AR024                            | NLA06608-0500            |
|--|----------------|-------------------------------|--------------------------------------|--------------------------|
| Station description                          | Millwood Lake  | Opossum Creek,<br>Polk County | Hudson Creek,<br>Little River County | Gillham Lake             |
| Littoral vegetation cover condition          | Not assessed   | Not applicable                | Not applicable                       | Least disturbed          |
| Littoral-riparian vegetation cover condition | Not assessed   | Not applicable                | Not applicable                       | Least disturbed          |
| Riparian disturbance condition               | Not assessed   | Low                           | Low                                  | Least disturbed          |
| Riparian vegetation condition                | Not assessed   | Fair                          | Poor                                 | Intermediate disturbance |
| Instream cover condition                     | Not applicable | Good                          | Fair                                 | Not applicable           |

### 3.2.5.3 US Forest Service

The USFS collects data on stream habitat as part of the Basin Area Stream Surveys in the Ouachita National Forest. Data collected includes channel measurements, substrate composition, bank stability, and instream and riparian cover (Nuckols 2005). A forest-wide Basin Area Stream Survey was completed in 2011. Analysis of the data from that survey was scheduled to begin in 2015 (USFS 2013).

## **4.0 POLLUTANT SOURCE ASSESSMENT**

This section summarizes available information on pollutant sources that are present in the watershed. This includes both nonpoint sources and point sources. The information presented in this section will be used to identify management strategies that can be implemented to improve water quality.

### **4.1 Nonpoint Sources**

Nonpoint source pollution generally results from precipitation, land runoff, infiltration, drainage, seepage, hydrologic modification, or atmospheric deposition. As runoff from rainfall or snowmelt moves, it picks up and transports pollutants resulting from human activity, ultimately depositing them into rivers, lakes, wetlands, coastal waters, and ground water. Potential nonpoint pollution sources that have been identified for the Lower Little River watershed include livestock, cropland, unpaved roads, and streambank erosion. Septic systems and wildlife are other potential nonpoint sources in this watershed.

#### **4.1.1 Livestock**

Livestock production is significant in the Lower Little River watershed. Poultry operations have been identified as a potential source of nonpoint source nutrients in the watershed, with swine and cattle operations also contributing (Lower Little River Watershed Coalition 2004). Manure from livestock operations is also a potential source of pathogens in the watershed.

There are currently 64 active ADEQ permits issued within the watershed for land application of liquid animal waste. Of those permits, 63 are for swine production and the remaining permit is for a dairy farm (ADEQ 2015d). These facilities are required to operate in accordance with a waste management plan approved by ADEQ that specifies allowable waste application rates based on the nutrient uptake of the cover crop. The operator must also observe buffer distances between application areas and potential receiving streams. Dry litter operations in the watershed may or may not operate under a waste management plan since the watershed

has not been designated a “nutrient surplus area” by the Arkansas Natural Resources Commission Title 22.

Allowing cattle unrestricted access to pasture streams for drinking water and summer cooling has been a common practice on farms in the watershed. In addition to allowing pollution of the stream by cattle waste, this practice can damage riparian and stream habitat, and change channel morphometry. These changes can cause changes in the stream sediment regime which can alter stream habitat downstream.

Recent livestock and poultry numbers reported by the USDA National Agricultural Statistics Service for the counties of the Lower Little River watershed are compared to numbers reported for 2002 in Table 4.1. There are no trends applicable to all counties. In aggregate, the inventories have declined slightly between 2012 and 2002, except that layers (poultry) are steady and hogs & pigs have declined by nearly half. For individual counties, production of all livestock has declined in Howard County and increased in Little River County while the other counties have mixed changes.

Table 4.1. Inventories of selected livestock in counties of the Lower Little River watershed (USDA National Agricultural Statistics Service 2014).

| Livestock       | Year | Hempstead number<br>(number/sq mi) | Howard number<br>(number/sq mi) | Little River number<br>(number/sq mi) | Polk number<br>(number/sq mi) | Sevier number<br>(number/sq mi) |
|-----------------|------|------------------------------------|---------------------------------|---------------------------------------|-------------------------------|---------------------------------|
| Cattle & calves | 2002 | 61,211 (84.1)                      | 44,646 (75.9)                   | 31,277 (58.8)                         | 38,751 (45.2)                 | 31,854 (56.4)                   |
|                 | 2012 | 55,935 (76.9)                      | 41,882 (71.2)                   | 34,666 (65.1)                         | 28,675 (33.4)                 | 32,892 (58.2)                   |
| Beef cows       | 2002 | D*                                 | 21,317 (36.2)                   | 13,625 (25.6)                         | D*                            | 20,105 (35.6)                   |
|                 | 2012 | D*                                 | 16,773 (28.5)                   | 14,414 (27.1)                         | D*                            | 19,938 (35.3)                   |
| Hogs & pigs     | 2002 | 3,469 (4.8)                        | 35,758 (60.8)                   | D*                                    | 7,744 (9.0)                   | 13,436 (23.8)                   |
|                 | 2012 | 4,045 (5.6)                        | 21,240 (36.1)                   | D*                                    | 2,925 (3.4)                   | 4,746 (8.4)                     |
| Layers          | 2002 | 591,272<br>(812.7)                 | 557,520<br>(947.3)              | D*                                    | 236,393<br>(275.6)            | 56,031 (99.1)                   |
|                 | 2012 | 676,508<br>(929.9)                 | 367,690<br>(624.7)              | 43,117 (81.0)                         | 269,050<br>(313.7)            | 88,677<br>(156.9)               |
| Broilers        | 2002 | 11,001,979<br>(15,123)             | 7,645,202<br>(12,990)           | 2,213,940<br>(4,160)                  | 4,582,054<br>(5,342)          | 6,799,414<br>(12,032)           |
|                 | 2012 | 8,115,455<br>(11,155)              | 6,665,939<br>(11,326)           | 2,459,790<br>(4,622)                  | 5,938,391<br>(6,924)          | 7,348,254<br>(13,003)           |

\*Data withheld by USDA NASS to avoid disclosing data for individual operations.

The NRCS develops 12-digit HUC subwatershed rankings for a number of resource concerns. One of these resource concerns is the nutrient and pathogen impacts of animal manure on surface water quality. Figure 4.1 is a map of the NRCS relative ranking of the Lower Little River 12-digit HUC subwatersheds in terms of the impacts of animal manure on surface water quality. On this map, green indicates little or no impact, and red indicates a high potential for impact.

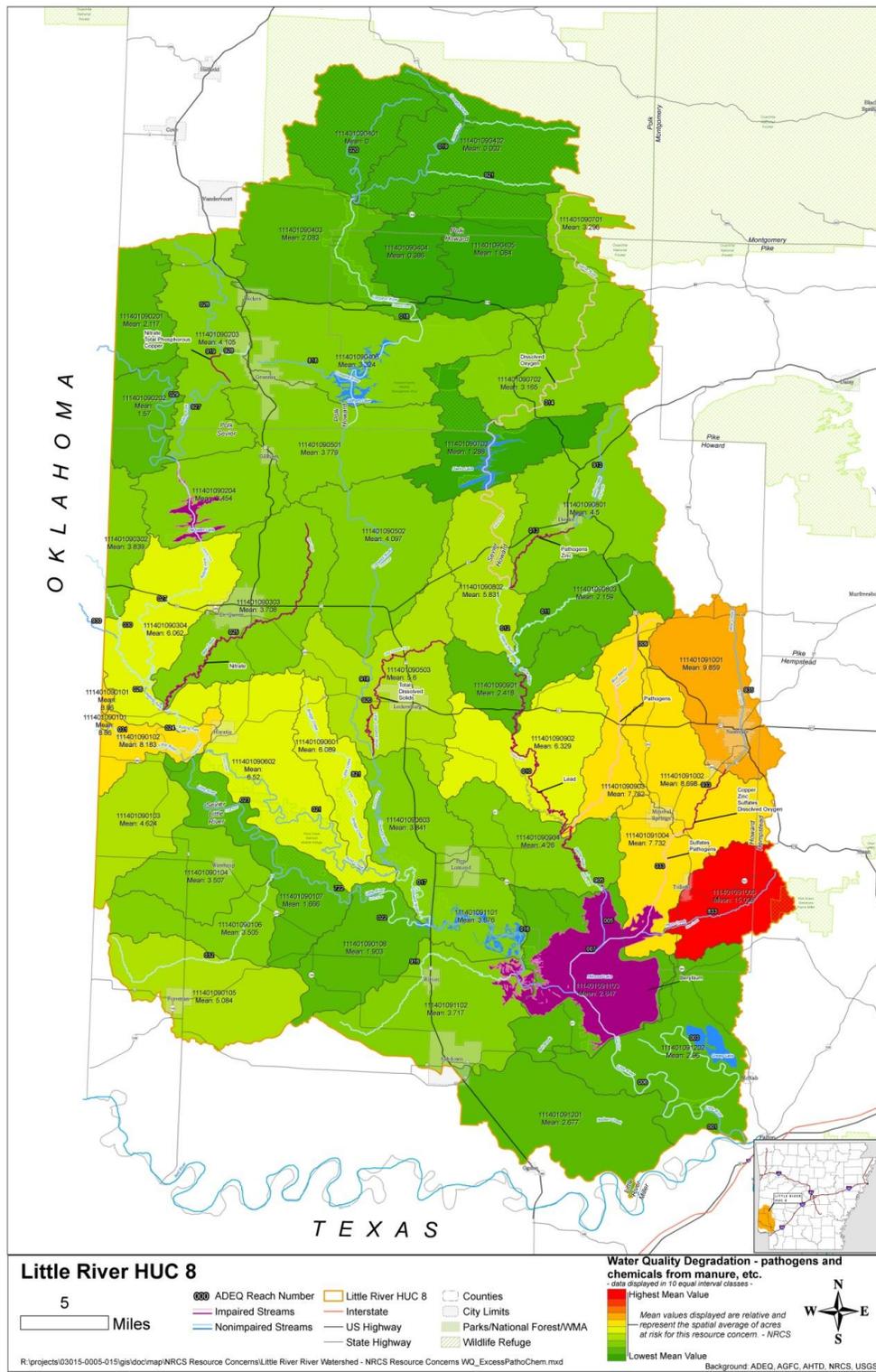


Figure 4.1. NRCS ranking of Lower Little River 12-digit HUC subwatersheds for the resource concern water quality impacts from manure.

### **4.1.2 Pasture**

In 2011, approximately 18% of the land in the Lower Little River watershed was classified as pasture or hay land (Homer, et al. 2015). These lands are generally used for the disposal of manure from nearby livestock operations. Poor quality pasture cover can allow erosion, resulting in sediment being carried to surface waters. Lack of buffers of natural vegetation along pasture streams allows more sediment to enter surface waters, and alters stream habitat and temperature.

Figure 4.1 identifies 12-digit HUC subwatersheds where use of manure on pasture could be impacting surface water quality. Erosion on pasture lands can be sheet or rill erosion, or gullies. Sheet/rill/wind erosion and concentrated flow erosion (i.e., gullies) are resource concerns evaluated by NRCS. Figure 4.2 is a map of the NRCS relative ranking of the Lower Little River 12-digit HUC subwatersheds in terms of the potential for sheet/rill/wind erosion. Figure 4.3 is a map of the NRCS relative ranking of the Lower Little River 12-digit HUC subwatersheds in terms of the potential for concentrated flow (i.e., gully) erosion.

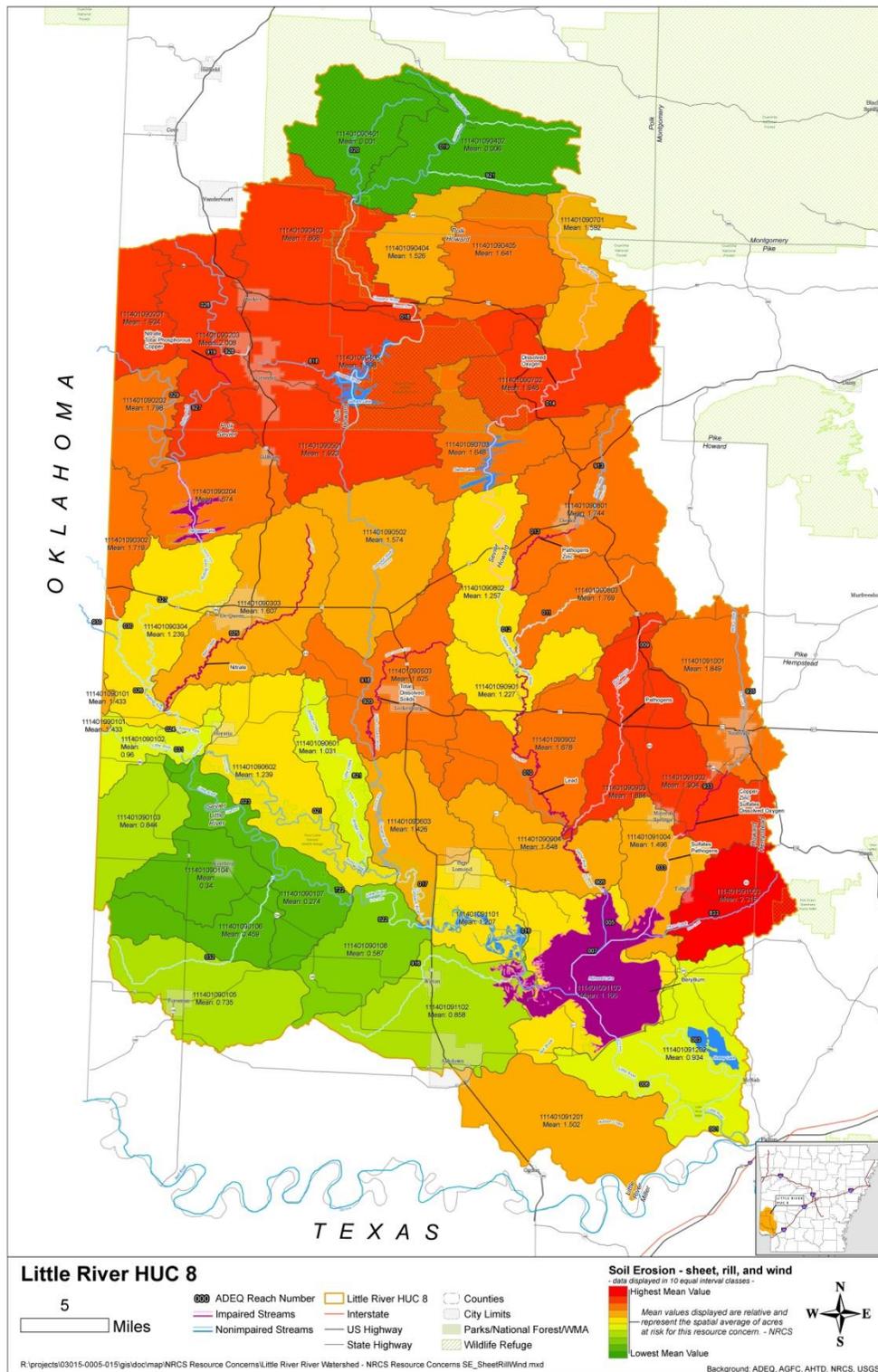


Figure 4.2. NRCS ranking of Lower Little River 12-digit HUC subwatersheds for the resource concern sheet/rill/wind erosion.

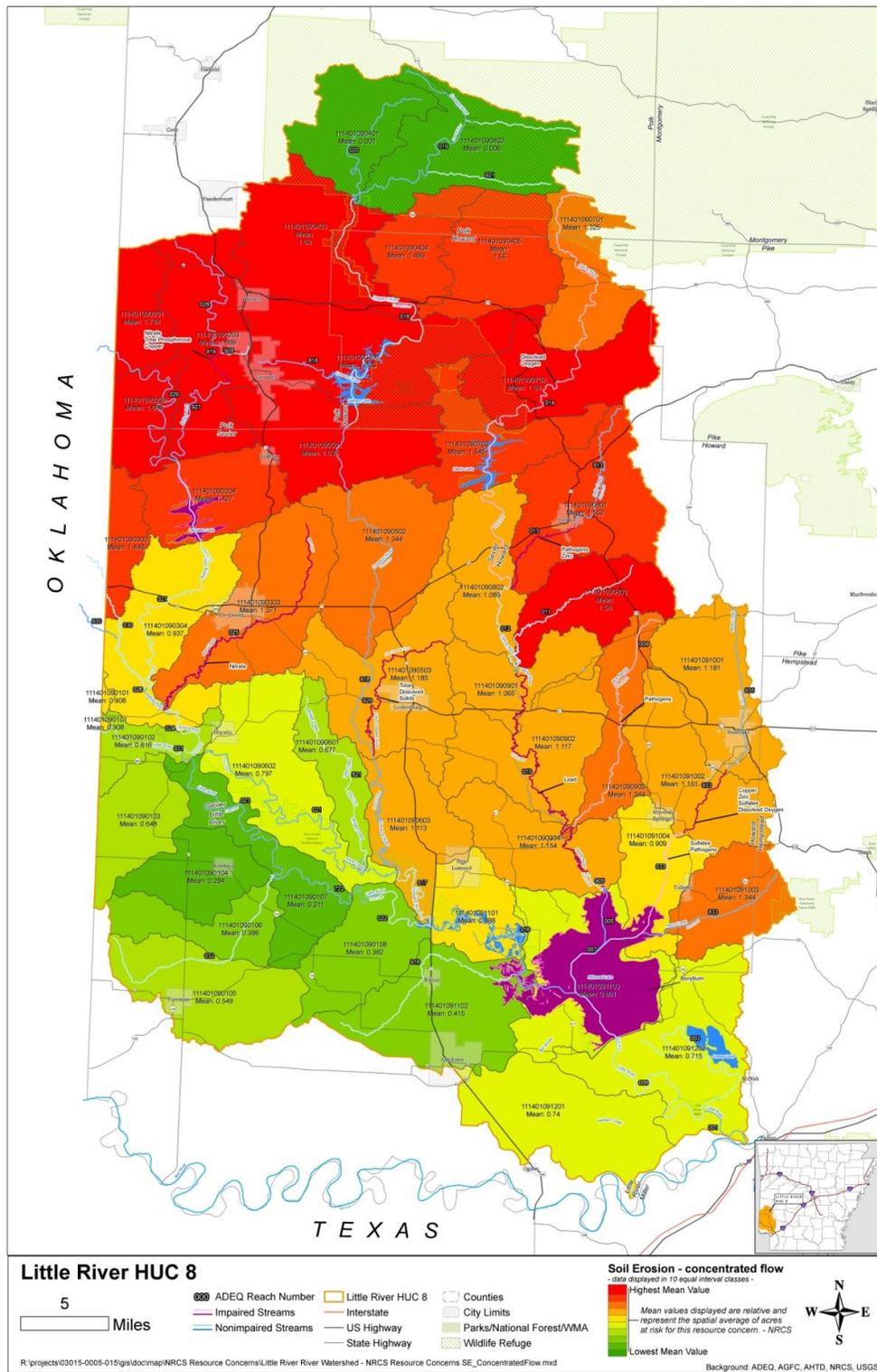


Figure 4.3. NRCS ranking of Lower Little River 12-digit HUC subwatersheds for the resource concern concentrated flow erosion.

### **4.1.3 Streambank Erosion**

There are approximately 4,000 miles of streambanks (i.e., miles of stream multiplied by two) in the Lower Little River watershed (Center for Advanced Spatial Technologies 2006). Stakeholders have identified streambank erosion as an issue in the Lower Little River watershed particularly, along those streams impacted by reservoir operations. Banks along those streams experience longer periods of high water, and when the high water recedes, the banks slough. Streambank erosion has the potential to contribute turbidity and sediment to surface waters, as well as causing loss of property for landowners. Areas of severe bank erosion were identified as a potential source for turbidity in the Gulf Coastal Plain region of the watershed (Lower Little River Watershed Coalition 2004). Along the Cossatot National River, streambank erosion has been associated with areas that receive heavy recreational use (Southeast Aquatic Resources Partnership 2015).

Streambank erosion is another resource concern evaluated by NRCS. Figure 4.4 is a map of the relative ranking of 12-digit HUC subwatersheds of the Lower Little River in terms of the potential for streambank erosion.

### **4.1.4 Cropland**

A very small percentage (0.24%) of the land in the Lower Little River watershed is cultivated cropland (Homer, et al. 2015). Row crop agriculture has not been identified by ADEQ as a likely nonpoint source of pollutants impairing water quality in the Lower Little River watershed. Table 4.2 summarizes information on cropland for the counties that are part of the Lower Little River watershed, from the most recent Census of Agriculture.

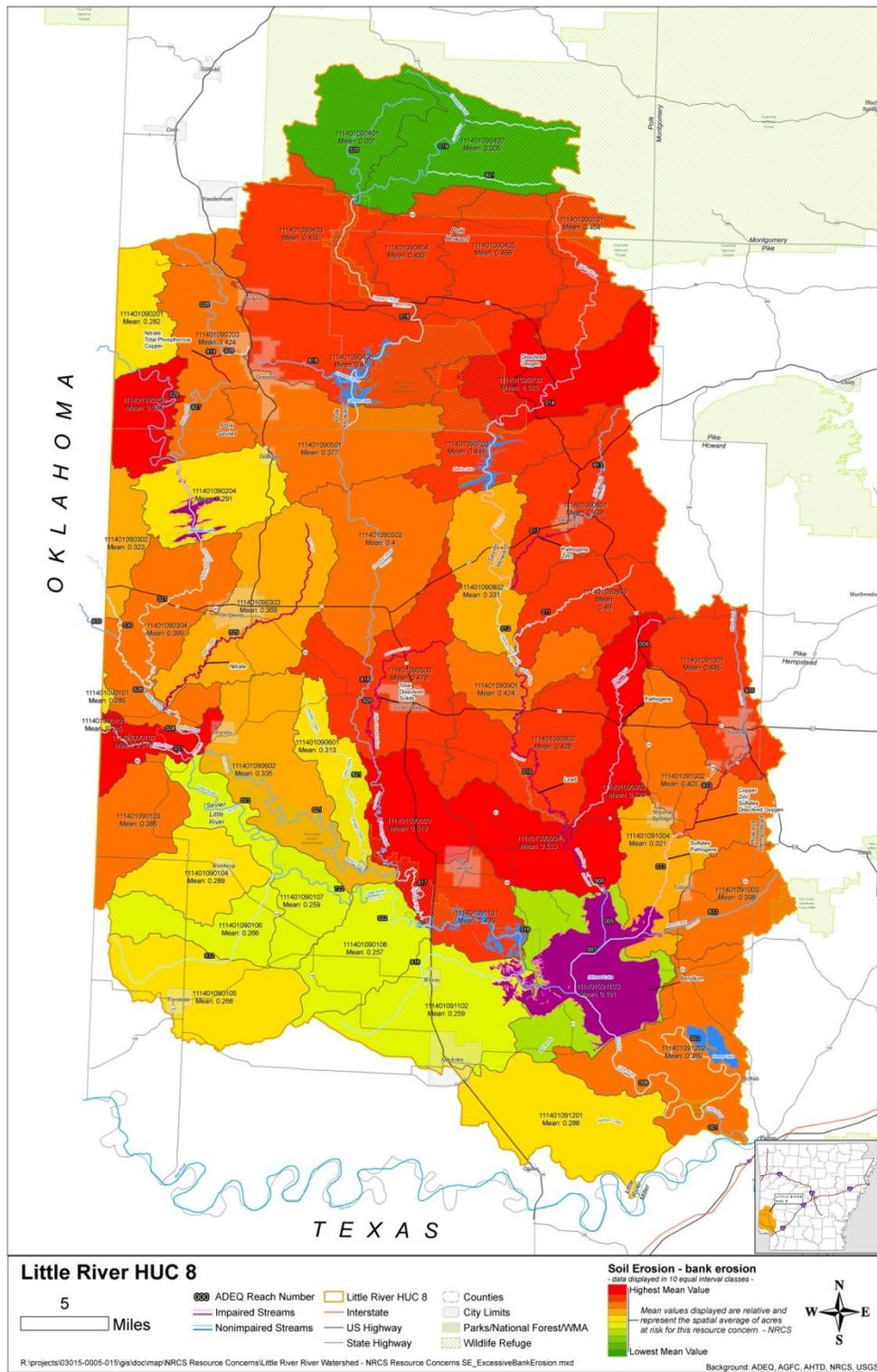


Figure 4.4. NRCS ranking of Lower Little River 12-digit HUC subwatersheds for the resource concern streambank erosion.

Table 4.2. Agricultural statistics for counties in the Lower Little River watershed (USDA National Agricultural Statistics Service 2014).

| 2012 Census    | Polk   | Hempstead | Sevier | Little River | Howard |
|----------------|--------|-----------|--------|--------------|--------|
| Cropland, ac   | 31,927 | 48,947    | 27,381 | 59,895       | 23,156 |
| Soybeans, ac   | 0      | 280       | 0      | 11,321       | 0      |
| Corn, ac       | 0      | 0         | 0      | 5,520        | 0      |
| Wheat, ac      | D*     | 0         | 0      | 5,607        | 0      |
| Forage, ac     | 24,222 | 35,194    | 24,626 | 25,457       | 20,714 |
| Vegetables, ac | 23     | 55        | D*     | 64           | 5      |

\* Data withheld to avoid disclosure of data for individual farms

#### 4.1.5 Septic Systems

Given the rural character of the Lower Little River watershed, it is likely that septic systems are used by many residents. There are some concerns that growth in the area is resulting in increased presence of septic systems that could contribute nutrients to the waterbodies and groundwater in the watershed (USACE Little Rock District 2010).

#### 4.1.6 Wildlife

The large numbers of waterfowl and shorebirds that overwinter in the Lower Little River watershed (primarily around Millwood Lake) and utilize the area during migration could have the potential to impact water quality. However, there are currently no indications that migrating and overwintering waterfowl and shorebirds are impacting water quality in the Lower Little River watershed.

#### 4.1.7 Resource Extraction

There are a number of permitted non-coal mines in the watershed. Information from these permits is summarized in Table 4.3. There are several rock quarries, and a number of open-cut

sand and gravel mining operations. Permitted open-cut mining facilities are required to take precautions to prevent release of sediment to adjacent surface waters.

Table 4.3. Mining facilities in the Lower Little River watershed with active ADEQ permits.

| <b>Permit No.</b> | <b>Facility Name</b>         | <b>County</b> | <b>Material Mined</b> |
|-------------------|------------------------------|---------------|-----------------------|
| 0532-MN-A3        | CertainTeed Gypsum           | Howard        | Gypsum                |
| 0457-MN-A2, A4    | Blue Bayou Sand and Gravel   | Howard        | Sand and gravel       |
| 0673-MN           | James M Goodson Mining       | Howard        | Sand and gravel       |
| 0076-MQ           | Vista Crest Properties, Inc. | Howard        | Rock                  |
| 0458-MN- A4       | Meridian Aggregates, Co.     | Polk          | Sand and gravel       |
| 0031-MQ-A2        | Meridian Aggregates, Co.     | Polk          | Rock                  |
| 0498-MN-A7        | Cossatot Rock, LLC           | Sevier        | Sand and gravel       |
| 0383-MN-A4        | Trinity Materials            | Sevier        | Sand and gravel       |
| 0088-MQ           | Amelia Minerals, LLC         | Sevier        | Rock                  |
| 0160-MN-A6        | Hanson Aggregates West, Inc. | Little River  | Sand and gravel       |
| 0654-MN           | Matteson, Worth              | Little River  | Sand                  |

#### **4.1.8 Unpaved Roads**

Unpaved roads have been identified as a potential source of turbidity in the Lower Little River watershed (Lower Little River Watershed Coalition 2004). These include county roads, National Forest roads and trails, and roads associated with timber management and harvest activities. There are approximately 3,400 miles of unpaved county roads in the Lower Little River watershed (Center for Advanced Spatial Technologies 2006). Table 4.4 lists the miles of unpaved roads for each of the 12-digit HUC subwatersheds of the Lower Little River watershed.

Table 4.4. Miles of unpaved roads in 12-digit HUC subwatersheds of the Lower Little River (Center for Advanced Spatial Technologies 2006).

| <b>12-digit HUC</b> | <b>Subwatershed name</b>         | <b>Unpaved roads,<br/>miles (miles/square miles)</b> |
|---------------------|----------------------------------|--|
| 111401090102        | Red Creek-Little River           | 18.29 (1.19)   |
| 111401090103        | Caney Creek                      | 56.26 (2.06)   |
| 111401090104        | Hurricane Creek-Little River     | 54.87 (2.02)   |
| 111401090105        | Upper Flat Creek                 | 92.74 (2.04)   |
| 111401090106        | Lower Flat Creek                 | 60.68 (2.45)   |
| 111401090107        | Wards Creek-Little River         | 58.92 (1.61)   |
| 111401090108        | Little River-Upper Millwood Lake | 56.45 (1.63)   |
| 111401090201        | Robinson Creek                   | 60.19 (2.98)   |
| 111401090202        | Ash Creek                        | 62.17 (3.04)   |
| 111401090203        | Rolling Fork                     | 136.64 (2.64)  |
| 111401090204        | Dequeen Lake                     | 69.38 (1.98)   |
| 111401090302        | Cane Creek                       | 36.04 (2.50)   |
| 111401090303        | Bear Creek-Rolling Fork          | 115.99 (1.98)  |
| 111401090304        | Two Mile Creek                   | 81.30 (1.57)   |
| 111401090401        | Brushy Creek-Cossatot River      | 40.43 (1.15)   |
| 111401090402        | Headwaters Cossatot River        | 49.92 (0.93)   |
| 111401090403        | Cow Creek-Cossatot River         | 129.81 (2.39)  |
| 111401090404        | Baker Creek-Harris Creek         | 83.82 (3.42)   |
| 111401090405        | Harris Creek-Cossatot River      | 128.40 (3.18)  |
| 111401090406        | Cossatot River-Gillham Lake      | 150.74 (2.29)  |
| 111401090501        | Carters Creek-Cossatot River     | 140.99 (2.74)  |
| 111401090502        | Hale Creek-Cossatot River        | 151.03 (2.80)  |
| 111401090503        | Bellville Creek-Cossatot River   | 102.22 (1.69)  |
| 111401090601        | Bridge Creek-Pond Creek          | 34.37 (1.62)   |

Table 4.4. Miles of unpaved roads in 12-digit HUC subwatersheds of the Lower Little River (continued).

| <b>12-digit HUC</b> | <b>Subwatershed name</b>       | <b>Unpaved roads,<br/>miles (miles/square miles)</b> |
|---------------------|--------------------------------|--|
| 111401090602        | Pond Creek-Cossatot River      | 77.78 (1.44)   |
| 111401090603        | Cossatot River-Millwood Lake   | 47.84 (1.39)   |
| 111401090701        | Headwaters Saline River        | 75.59 (2.37)   |
| 111401090702        | Camp Creek-Saline River        | 143.04 (3.18)  |
| 111401090703        | Caney Creek-Saline River       | 126.48 (3.69)  |
| 111401090801        | Holly Creek                    | 170.71 (3.15)  |
| 111401090802        | Lee Creek-Saline River         | 80.17 (2.33)   |
| 111401090803        | Messor Creek                   | 84.59 (2.57)   |
| 111401090901        | Sand Creek-Saline River        | 48.80 (1.88)   |
| 111401090902        | Starch Creek-Saline River      | 83.91 (1.74)   |
| 111401090903        | Blue Bayou-Saline River        | 37.81 (1.36)   |
| 111401090904        | Saline River-Millwood Lake     | 46.09 (1.23)   |
| 111401091001        | Upper Mine Creek               | 41.43 (0.98)   |
| 111401091002        | Middle Mine Creek              | 45.86 (1.04)   |
| 111401091003        | Plum Creek-Mine Creek          | 29.69 (1.00)   |
| 111401091004        | Lower Mine Creek-Millwood Lake | 17.24 (0.58)   |
| 111401091101        | Blacks Branch-Millwood Lake    | 17.83 (0.71)   |
| 111401091102        | Beaver Creek-Millwood Lake     | 69.41 (1.26)   |
| 111401091103        | Millwood Lake                  | 30.72 (0.48)   |
| 111401091201        | Hudson Creek                   | 121.08 (2.23)  |
| 111401091202        | Little River-Red River         | 86.6 (1.36)  |

#### **4.1.9 Silviculture**

Silviculture is an important industry in the Lower Little River watershed, particularly in Howard, Little River, and Sevier Counties (Association of Arkansas Counties 2015). In Howard County, almost 50% of the land is owned by the timber company Weyerhaeuser (Association of Arkansas Counties 2015a). In 2004, it was estimated that 57% of the forest land in the Lower Little River watershed was owned by forest industries. Silviculture operations, particularly forest roads and clear-cut areas have been identified as potential sources of eroded sediment in the Lower Little River watershed. Fertilizing of timber has also been identified as a potential source of nutrients in the watershed (Lower Little River Watershed Coalition 2004).

#### **4.2 Point Sources**

This section identifies National Pollutant Discharge Elimination System (NPDES) permitted point sources discharging in the Lower Little River watershed, as well as locations with Phase I or Phase II stormwater permits, Resource Conservation and Recovery Act (RCRA) hazardous waste sites, and underground storage tanks. No active Brownfields sites, confined animal feeding operation (CAFO) permits, nor current state priority, nor Comprehensive Environmental Response, Compensation, and Recovery Act (CERCLA) superfund sites were identified within the Lower Little River watershed. ADEQ has identified point sources as the potential source of pollutants impairing water quality in Rolling Fork River, Mine Creek, and Bear Creek (see tables 3.4 and 3.5).

##### **4.2.1 NPDES Permits**

There are 19 NPDES permitted point sources discharging in the Lower Little River watershed (see Table 4.5). The majority of these are individual permits for municipal wastewater treatment plants. ADEQ intends to continue to work to address point source water quality issues in Rolling Fork River and Mine Creek through the NPDES permitting process (ADEQ 2014a).

Table 4.5. NPDES permitted point sources discharging in the Lower Little River watershed.

| Permit No. | Facility Name  | Receiving Reach | Receiving Stream      |
|------------|--|-----------------|-----------------------|
| AR0002909  | Weyerhaeuser NR Company – DeQueen Remediation          | 025             | Bear Creek            |
| AR0002917  | Weyerhaeuser NR Company – Dierks Mill                  | 013             | Holly Creek           |
| AR0003018  | Tyson Foods, Inc. – Grannis Processing Facility        | 919             | Rolling Fork Creek    |
| AR0021261  | City of Mineral Springs WWTP                           | 033             | Mine Creek            |
| AR0021377  | City of Lockesburg                                     | 918             | Little Cossatot River |
| AR0021709  | City of Dierks   | 013             | Holly Creek           |
| AR0021733  | City of DeQueen  | 025             | Bear Creek            |
| AR0021776  | Nashville WW Treatment Plant                           | 033             | Mine Creek            |
| AR0023817  | City of Foreman  | 032             | East Flat Creek       |
| AR0035785  | City of Horatio  | 032             | East Flat Creek       |
| AR0037079  | Arkansas Dept of Parks & Tourism – Millwood State Park | 006             | Buster Creek          |
| AR0040886  | Town of Wilton WWTF                                    | 016             | Lick Creek            |
| AR0041246  | Millwood Water Corp                                    | 006             | Buster Creek          |
| AR0041734  | Tyson Foods, Inc. – Nashville                          | 933             | Mine Creek            |
| AR0045144  | City of Tollette                                       | 033             | Mine Creek            |
| AR0047996  | Gillham Regional Wastewater District                   | 027             | Bellah Creek          |
| AR0048411  | Domtar A.W. Corp                                       | 016             | Lick Creek            |
| AR0048593  | Locksburg PLT #1544                                    | 918             | Mill Slough           |
| AR0049034  | Cossatot Rock, LLC                                     | 918             | Hale Creek            |
| AR0051136  | SWEPCO – John W. Turk, Jr. Power Plant                 | 001             | Little River          |
| ARG640113  | City of Horatio  | --              | Pond Creek            |
| ARG550422  | Jeremy Murchison                                       | --              | Red River             |
| ARG640140  | Sevier County Water Association                        | --              | Rolling Fork River    |
| ARG500007  | Martin Marietta / Hatton Quarry                        | --              | Prior Creek           |
| ARG640129  | Gillham Lake Reg Water Association                     | --              | Carters Creek         |
| ARG640015  | City of Dierks WTP                                     | --              | Saline River          |

#### 4.2.2 Phase I and II Stormwater Permits

Stormwater runoff from developed areas is a potential source of a variety of pollutants that can impact water quality. There are no communities in the watershed with active MS4 stormwater permits. However, there are a number of active construction and industrial stormwater permits for locations within the watershed (Tables 4.6 and 4.7).

Table 4.6. Active construction stormwater permits for locations within the Lower Little River watershed (ADEQ 2015e).

| Permit No. | Facility Name                    | Receiving Stream                                      |
|------------|----------------------------------|---|
| ARR154552  | Lockesburg Water System          | Little Cossatot / Bellville Creek                     |
| ARR154554  | Lockesburg Wastewater System     | Little Cossatot / Bellville Creek                     |
| ARR154415  | City of DeQueen / Raw Water Main | Wilson Creek / Pepper Creek / Bear Creek              |
| ARR153590  | Jacob Hooper Farm                | Cossatot River  |
| ARR154341  | Centerpoint Energy               | Cow Creek   |
| ARR154566  | Centerpoint Energy               | Yellow Creek  |
| ARR154181  | Cotton Shed Water Extension      | Plum Creek / Mine Creek / Ingram Creek / Schaal Creek |
| ARR153966  | Southwestern Bell                | Temperanceville Creek / Blue Bayou                    |
| ARR154482  | Weyerhaeuser NR Company - Dierks | Little Holly Creek                                    |

Table 4.7. Active industrial stormwater permits for facilities within the Lower Little River watershed (ADEQ 2015f).

| Permit No. | Facility Name                        | Receiving Stream      |
|------------|--------------------------------------|-----------------------|
| ARR00B825  | Pilgrim's Pride Processing Plant     | Bear Creek            |
| ARR001113  | Mission Plastics of Arkansas         | Temperanceville Creek |
| ARR00A062  | Tyson Foods – Nashville Feedmill     | Temperanceville Creek |
| ARR00B824  | Pilgrim's Pride – Nashville Feedmill | Mine Creek            |
| ARR000986  | Blue Bayou Sand & Gravel             | Blue Bayou            |
| ARR00A685  | Weyerhaeuser NR Company - Dierks     | Holly Creek           |

### 4.3 Hazardous Waste

There are 30 RCRA facilities within the Lower Little River watershed, identified by EPA and ADEQ (Table 4.8). Two of the facilities in the watershed are also hazardous waste treatment/storage/disposal facilities (ADEQ 2015g). The majority of the RCRA facilities have been classified as conditionally exempt small quantity generators, meaning that they generate 100 kilograms or less per month of hazardous waste, or 1 kilogram or less per month of acutely hazardous waste. Small quantity generators generate between 100 and 1,000 kilograms of hazardous waste per month. Large quantity generators generate over 1,000 kilograms of hazardous waste, or more than 1 kilogram of acutely hazardous waste per month.

Table 4.8. RCRA facilities in the Lower Little River watershed identified by EPA and ADEQ (EPA 2015b, ADEQ 2015g).

| ID           | Facility Name                       | Type <sup>1</sup> | Status <sup>2</sup> | County    |
|--------------|-------------------------------------|-------------------|---------------------|-----------|
| ARD983288705 | Meridian Hatton Quarry              | CESQG             | ND                  | Polk      |
| ARR000015735 | Tyson Foods Wickes Hatchery         | CESQG             | ND                  | Polk      |
| ARD983287731 | Tyson Foods-Grannis                 | CESQG             | ND                  | Polk      |
| ARR000004846 | Holcim (US) Inc                     | CESQG             | ND                  | Hempstead |
| ARR000017764 | John W. Turk Power Plant            | CESQG             | NI                  | Hempstead |
| ARD035590116 | Ayers Cleaners Of Nashville         | CESQG             | ND                  | Howard    |
| ARR000024166 | Dierks School District              | CESQG             | ND                  | Howard    |
| ARD040632671 | Husqvarna Outdoor Products          | CESQG             | ND                  | Howard    |
| ARR000000299 | Husqvarna Outdoor Products          | CESQG             | ND                  | Howard    |
| ARD981155427 | Jan-Eze Plating, Inc.               | Large             | ND                  | Howard    |
| ARR000023952 | Mission Plastics Of Arkansas, Inc.  | CESQG             | ND                  | Howard    |
| ARD983275405 | Turner Body Shop                    | CESQG             | ND                  | Howard    |
| ARD077388502 | Tyson Foods-Nashville               | CESQG             | ND                  | Howard    |
| ARD983288382 | Walmart Supercenter #33             | CESQG             | ND                  | Howard    |
| ARD049662752 | Weyerhaeuser nr Company Dierks Mill | CESQG             | ND                  | Howard    |
| ARR000004069 | Cossatot Tech College               | CESQG             | ND                  | Sevier    |
| ARD981510324 | De Queen & Eastern Railroad         | CESQG             | ND                  | Sevier    |
| ARR000024158 | DeQueen High School                 | CESQG             | ND                  | Sevier    |
| AR0000016683 | Engineered Products Inc-Ar Div      | CESQG             | ND                  | Sevier    |

Table 4.8. RCRA facilities in the Lower Little River watershed identified by EPA and ADEQ (continued).

| ID           | Facility Name                            | Type <sup>1</sup> | Status <sup>2</sup> | County       |
|--------------|--|-------------------|---------------------|--------------|
| ARD004549598 | Husqvarna Outdoor Products - Dequeen     | CESQG             | ND                  | Sevier       |
| ARR000012971 | Leopard Auto Detailing                   | NI                | NI                  | Sevier       |
| ARD053141511 | Suttle Equipment Inc                     | CESQG             | ND                  | Sevier       |
| ARR000024463 | Tractor Supply Co #1649                  | CESQG             | ND                  | Sevier       |
| ARR000009183 | Walmart Supercenter #279                 | Small             | ND                  | Sevier       |
| ARD067671313 | Weyerhaeuser nr Dequeen Remediation Site | Large, TSD        | ND                  | Sevier       |
| ARD981512270 | Ash Grove Cement Company                 | Large, TSD        | ND                  | Little River |
| ARD043192988 | Domtar A.W. Llc                          | Small             | ND                  | Little River |
| ARR000017517 | Mobil Pipeline Company - Foreman Station | CESQG             | ND                  | Little River |
| ARR000009100 | Wal-Mart Store 133                       | CESQG             | ND                  | Little River |
| ARR000016832 | Walmart Supercenter #133                 | CESQG             | ND                  | Little River |

<sup>1</sup> CESQG = conditionally exempt small quantity generator, TSD = treatment/storage/disposal facility, NI = no code given

<sup>2</sup> ND = no separately defined state status, NI = no code given

#### 4.4 Underground Storage Tanks

ADEQ has identified over 100 underground storage tanks within the Lower Little River watershed (Table 4.9). Thirty of these tanks have been confirmed to be leaking. Most of the leaking tanks are located at gas stations. Two of the leaking tanks are temporarily not in use. Leaking underground storage tanks have the potential to impact groundwater quality.

Table 4.9. Underground storage tanks identified in the Lower Little River watershed (ADEQ 2015h).

| County       | Number Underground Tanks | Temporarily out of service | Leaking   |
|--------------|--------------------------|----------------------------|-----------|
| Hempstead    | 4                        | 1                          | 0         |
| Howard       | 33                       | 6                          | 7         |
| Little River | 19                       | 5                          | 7         |
| Polk         | 6                        | 2                          | 1         |
| Sevier       | 29                       | 2                          | 15        |
| <b>Total</b> | <b>101</b>               | <b>16</b>                  | <b>30</b> |

## **5.0 LINK POLLUTANT LOADS TO WATER QUALITY**

This section includes a discussion of pollutant loads for the Lower Little River watershed, along with identification of critical areas of the Lower Little River for nonpoint source management activities. The pollutant loads discussion addresses only the primary pollutants of concern, and includes a summary of previous pollutant load estimation work, along with estimates of current pollutant loads.

### **5.1 Estimation of Pollutant Loads**

This section discusses previous pollutant load estimation work, along with estimates of current pollutant loads.

#### **5.1.1 TSS Loads**

It is not possible to calculate turbidity loads, so TSS load is used as a surrogate. No recent studies were identified where TSS loads have been calculated for the Lower Little River watershed. Because the data was available, estimates of TSS loads were calculated using the average of the TSS data collected from 2010 through 2014 at selected monitoring locations in the Lower Little River watershed (Figure 5.1). Seven-day 10 year low-flow and 100 year peak flood values at each monitoring location were estimated using USGS StreamStats. These flows were estimated using regional regression equations developed by USGS (Funkhouser 2008). The loads shown on Figure 5.1 are cumulative, reflecting loads from the entire watershed upstream of the sampling location.

#### **5.1.2 Suspended Sediment Load**

USGS has reported suspended sediment discharge for the water quality monitoring station on the Cossatot River (7340300) for the period 2010 through 2014. The average suspended sediment discharge at this location during this period was 0.59 tons/day (535 kg/day), with a median discharge of 0.12 tons per day (109 kilograms per day), a minimum discharge of <0.01 tons per day (<9 kilograms per day) and a maximum discharge of 4.70 tons per day (4,264

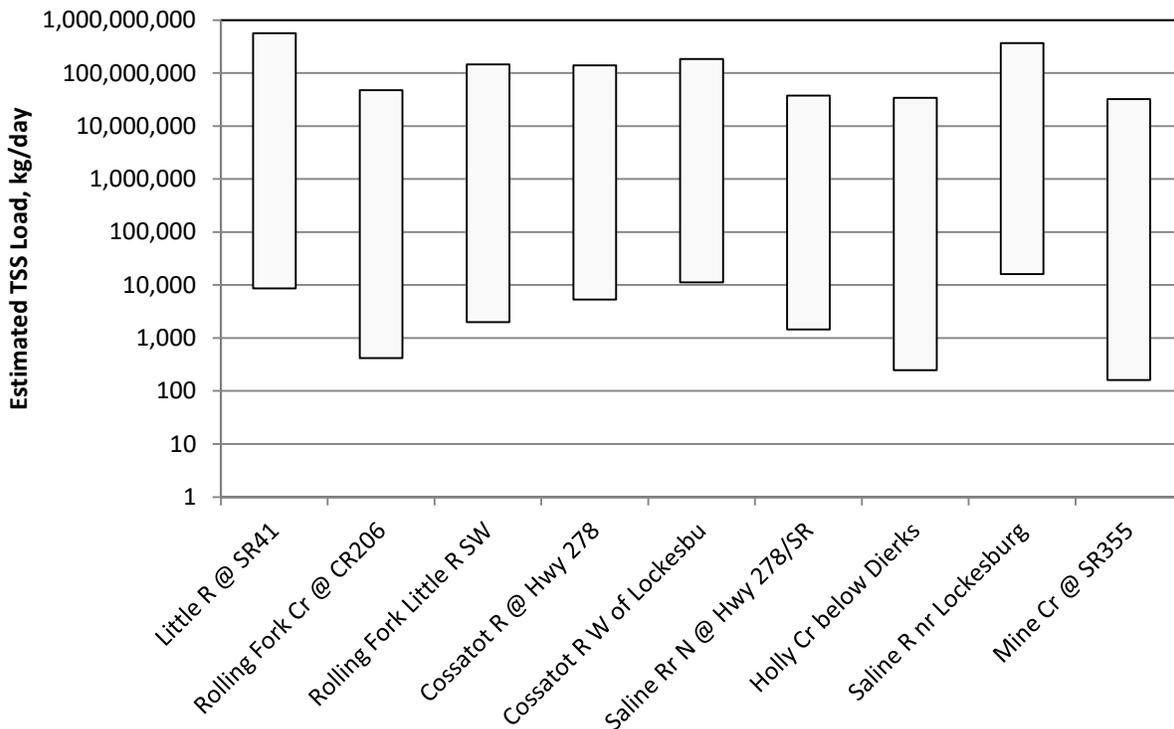


Figure 5.1. Estimated TSS loads for selected locations within the Lower Little River watershed.

kilograms per day). These loads are several orders of magnitude less than the estimated loads shown in Figure 5.1.

### 5.1.3 Pathogen Loads

TMDLs have been completed addressing pathogen impairments in Holly Creek and Mine Creek within the watershed. However, neither existing loads nor percent reductions were included in the TMDL report (EPA Region 6 2008).

## 5.2 Future Conditions and Pollutant Loads

The Little River watershed is experiencing an increase in poultry production, and the number of poultry houses. This is expected to increase the amount of poultry litter produced and applied in the watershed, with the potential for increasing nutrient and pathogen loads. Runoff from poultry house roofs also causes erosion (Stakeholder meeting, 8/26/15, Ashdown).

### 5.3 Identification of Critical Areas

There have been studies and projects in the Lower Little River watershed that evaluated and/or prioritized subwatersheds based on water quality. These studies and projects each used different approaches to evaluate and prioritize. For this plan, critical 12-digit HUC subwatersheds were identified for sediment and pathogen inputs based on: 1) stream segments with water quality impairments; 2) output from a preliminary SWAT model of the watershed; and 3) NRCS 2011 Resource Assessment of subwatersheds. The approaches used to assign ranks to the information considered are discussed below. Table 5.1 summarizes and compares results from the evaluation and prioritization approaches described below.

Table 5.1. Rankings for 12-digit HUC subwatersheds of the Lower Little River watershed, where 1 is the highest rank and 5 is the lowest.

| HUC 12 Name<br>(HUC I.D. number)                   | 2014 Turbidity<br>Impairment | SWAT Sediment<br>Rank | NRCS Excess<br>Sediment<br>Rank | Sediment Load<br>Overall Rank | 2014 Pathogen<br>Impairment | NRCS Manure<br>Pathogen, etc.<br>Rank | Pathogen Load<br>Overall Rank |
|--|------------------------------|-----------------------|---------------------------------|-------------------------------|-----------------------------|---------------------------------------|-------------------------------|
| Red Creek-Little River<br>(111401090102)           | 5                            | 3                     | 1                               | Medium                        | 5                           | 1                                     | Medium                        |
| Caney Creek (111401090103)                         | 5                            | 3                     | 1                               | Medium                        | 5                           | 2                                     | Medium                        |
| Hurricane Creek-Little River<br>(111401090104)     | 5                            | 3                     | 4                               | Low                           | 5                           | 3                                     | Low                           |
| Upper Flat Creek<br>(111401090105)                 | 5                            | 3                     | 4                               | Low                           | 5                           | 2                                     | Medium                        |
| Lower Flat Creek<br>(111401090106)                 | 5                            | 3                     | 3                               | Low                           | 5                           | 3                                     | Low                           |
| Wards Creek-Little River<br>(111401090107)         | 1                            | 3                     | 5                               | Medium                        | 5                           | 5                                     | Low                           |
| Little River-Upper Millwood<br>Lake (111401090108) | 5                            | 3                     | 4                               | Low                           | 5                           | 5                                     | Low                           |
| Robinson Creek<br>(111401090201)                   | 5                            | 5                     | 1                               | Medium                        | 5                           | 4                                     | Low                           |
| Ash Creek (111401090202)                           | 5                            | 5                     | 1                               | Medium                        | 5                           | 5                                     | Low                           |
| Rolling Fork (111401090203)                        | 5                            | 5                     | 1                               | Medium                        | 5                           | 2                                     | Medium                        |
| Dequeen Lake (111401090204)                        | 5                            | 5                     | 3                               | Low                           | 5                           | 3                                     | Low                           |
| Cane Creek (111401090302)                          | 5                            | 1                     | 2                               | Medium                        | 5                           | 3                                     | Low                           |
| Bear Creek-Rolling Fork<br>(111401090303)          | 5                            | 1                     | 2                               | Medium                        | 5                           | 3                                     | Low                           |

Table 5.1. Rankings for 12-digit HUC subwatersheds of the Lower Little River watershed, where 1 is the highest rank and 5 is the lowest (continued).

| HUC 12 Name<br>(HUC I.D. number)                 | 2014 Turbidity<br>Impairment | SWAT Sediment<br>Rank | NRCS Excess<br>Sediment<br>Rank | Sediment Load<br>Overall Rank | 2014 Pathogen<br>Impairment | NRCS Manure<br>Pathogen, etc.<br>Rank | Pathogen Load<br>Overall Rank |
|--|------------------------------|-----------------------|---------------------------------|-------------------------------|-----------------------------|---------------------------------------|-------------------------------|
| Two Mile Creek<br>(111401090304)                 | 5                            | 1                     | 4                               | Medium                        | 5                           | 2                                     | Medium                        |
| Brushy Creek-Cossatot River<br>(111401090401)    | 5                            | 5                     | 5                               | Low                           | 5                           | 5                                     | Low                           |
| Headwaters Cossatot River<br>(111401090402)      | 5                            | 5                     | 5                               | Low                           | 5                           | 5                                     | Low                           |
| Cow Creek-Cossatot River<br>(111401090403)       | 5                            | 5                     | 1                               | Medium                        | 5                           | 5                                     | Low                           |
| Baker Creek-Harris Creek<br>(111401090404)       | 5                            | 5                     | 4                               | Low                           | 5                           | 5                                     | Low                           |
| Harris Creek-Cossatot River<br>(111401090405)    | 5                            | 5                     | 4                               | Low                           | 5                           | 5                                     | Low                           |
| Cossatot River-Gillham Lake<br>(111401090406)    | 5                            | 5                     | 2                               | Medium                        | 5                           | 4                                     | Low                           |
| Carters Creek-Cossatot River<br>(111401090501)   | 5                            | 1                     | 1                               | Medium                        | 5                           | 3                                     | Low                           |
| Hale Creek-Cossatot River<br>(111401090502)      | 5                            | 1                     | 2                               | Medium                        | 5                           | 2                                     | Medium                        |
| Bellville Creek-Cossatot River<br>(111401090503) | 5                            | 1                     | 1                               | Medium                        | 5                           | 2                                     | Medium                        |
| Bridge Creek-Pond Creek<br>(111401090601)        | 5                            | 2                     | 5                               | Medium                        | 5                           | 1                                     | Medium                        |
| Pond Creek-Cossatot River<br>(111401090602)      | 5                            | 2                     | 5                               | Medium                        | 5                           | 1                                     | Medium                        |
| Cossatot River-Millwood Lake<br>(111401090603)   | 5                            | 2                     | 3                               | Medium                        | 5                           | 3                                     | Low                           |
| Headwaters Saline River<br>(111401090701)        | 5                            | 4                     | 4                               | Low                           | 5                           | 4                                     | Low                           |
| Camp Creek-Saline River<br>(111401090702)        | 5                            | 4                     | 2                               | Medium                        | 5                           | 4                                     | Low                           |
| Caney Creek-Saline River<br>(111401090703)       | 5                            | 4                     | 3                               | Low                           | 5                           | 5                                     | Low                           |
| Holly Creek (111401090801)                       | 5                            | 3                     | 2                               | Medium                        | 1                           | 2                                     | High                          |
| Lee Creek-Saline River<br>(111401090802)         | 5                            | 3                     | 3                               | Low                           | 5                           | 2                                     | Medium                        |
| Messor Creek (111401090803)                      | 5                            | 3                     | 2                               | Medium                        | 5                           | 4                                     | Low                           |
| Sand Creek-Saline River<br>(111401090901)        | 1                            | 2                     | 3                               | High                          | 5                           | 4                                     | Low                           |
| Starch Creek-Saline River<br>(111401090902)      | 1                            | 2                     | 3                               | High                          | 5                           | 1                                     | Medium                        |

Table 5.1. Rankings for 12-digit HUC subwatersheds of the Lower Little River watershed, where 1 is the highest rank and 5 is the lowest (continued).

| HUC 12 Name<br>(HUC I.D. number)                 | 2014 Turbidity<br>Impairment | SWAT Sediment<br>Rank | NRCS Excess<br>Sediment Rank | Sediment Load<br>Overall Rank | 2014 Pathogen<br>Impairment | NRCS Manure<br>Pathogen, etc.<br>Rank | Pathogen Load<br>Overall Rank |
|--|------------------------------|-----------------------|------------------------------|-------------------------------|-----------------------------|---------------------------------------|-------------------------------|
| Blue Bayou-Saline River<br>(111401090903)        | 1                            | 2                     | 2                            | High                          | 5                           | 1                                     | Medium                        |
| Saline River-Millwood Lake<br>(111401090904)     | 1                            | 2                     | 3                            | High                          | 5                           | 2                                     | Medium                        |
| Upper Mine Creek<br>(111401091001)               | 5                            | 1                     | 2                            | Medium                        | 5                           | 1                                     | Medium                        |
| Middle Mine Creek<br>(111401091002)              | 5                            | 1                     | 3                            | Medium                        | 5                           | 1                                     | Medium                        |
| Plum Creek-Mine Creek<br>(111401091003)          | 5                            | 1                     | 1                            | Medium                        | 5                           | 1                                     | Medium                        |
| Lower Mine Creek-Millwood<br>Lake (111401091004) | 5                            | 1                     | 4                            | Medium                        | 1                           | 1                                     | High                          |
| Blacks Branch-Millwood Lake<br>(111401091101)    | 5                            | 5                     | 4                            | Low                           | 5                           | 3                                     | Low                           |
| Beaver Creek-Millwood Lake<br>(111401091102)     | 5                            | 5                     | 5                            | Low                           | 5                           | 3                                     | Low                           |
| Millwood Lake<br>(111401091103)                  | 5                            | 5                     | 5                            | Low                           | 5                           | 4                                     | Low                           |
| Hudson Creek (111401091201)                      | 5                            | 4                     | 5                            | Low                           | 5                           | 4                                     | Low                           |
| Little River-Red River<br>(111401091202)         | 5                            | 4                     | 5                            | Low                           | 5                           | 4                                     | Low                           |

### 5.3.1 Impaired Streams

The highest rank was given to 12-digit HUC subwatersheds that contain stream segments listed as impaired on the Arkansas 303(d) list. There are 9 stream segments in the Lower Little River watershed on the final 2008 303(d) list, and 6 stream segments on the 2014 303(d) list (see Tables 3.4 and 3.5). Stream segments on the 2008 303(d) list that do not appear on the 2014 303(d) list are ranked low (i.e., 5). In addition, because the focus of this plan is nonpoint source pollution, stream segments where the suspected pollutant source is point sources are also ranked low (i.e., 5). Twelve-digit HUC subwatersheds that contain impaired stream segments are assigned the highest rank, 1. Those without impaired stream segments are assigned the lowest rank, 5.

### **5.3.2 SWAT Model**

Gitau and Chaubey (2007) prepared and calibrated a SWAT model of the Lower Little River watershed to aid in prioritizing 11-digit HUC subwatersheds for implementation of nonpoint source best management practices (BMPs). The parameters sediment, total phosphorus, and nitrate nitrogen were modeled for the period 1997 through 2003. As shown in Table 5.1, ranks from 1 (highest load) through 5 (lowest load) were assigned to the 12-digit HUC subwatersheds based on the model results for sediment.

### **5.3.3 NRCS Resource Assessment**

NRCS develops 12-digit HUC subwatershed rankings for a number of resource concerns. Resource concerns relevant for identifying critical areas for sediment and pathogens for this plan are ‘excess sediment’, and ‘pathogens and chemicals from manure’. For these resource concerns, relative ranks ranging from 1 to 5 are assigned to the subwatersheds based on the NRCS reported average of the area within the watershed at risk for the resource concern.

### **5.3.4 Recommended Subwatersheds of the Lower Little River for this Plan**

The overall rankings for sediment and pathogen issues are based on the number of high ranks (i.e., ranks of 1 or 2) assigned to the subwatersheds. Twelve-digit HUC subwatersheds with two or more high ranks are classified as highly recommended. Subwatersheds with no high ranks are assigned a low overall rank (low recommendation). Subwatersheds with one high rank are assigned an overall medium rank (recommended). For sediment, subwatersheds with two high ranks, but no impaired waterbody are also assigned a medium overall rank. Overall rankings assigned to the 12-digit HUC subwatersheds for sediment and pathogen issues are shown on Figures 5.2 and 5.3.

This ranking method resulted in six subwatersheds being highly recommended; four for management activities to reduce nonpoint source sediment, and two for management activities to reduce nonpoint source pathogens. These are the subwatersheds recommended for management through this plan. Table 5.2 displays the rankings for the plan recommended 12-digit HUC subwatersheds from each of the prioritization approaches discussed above.

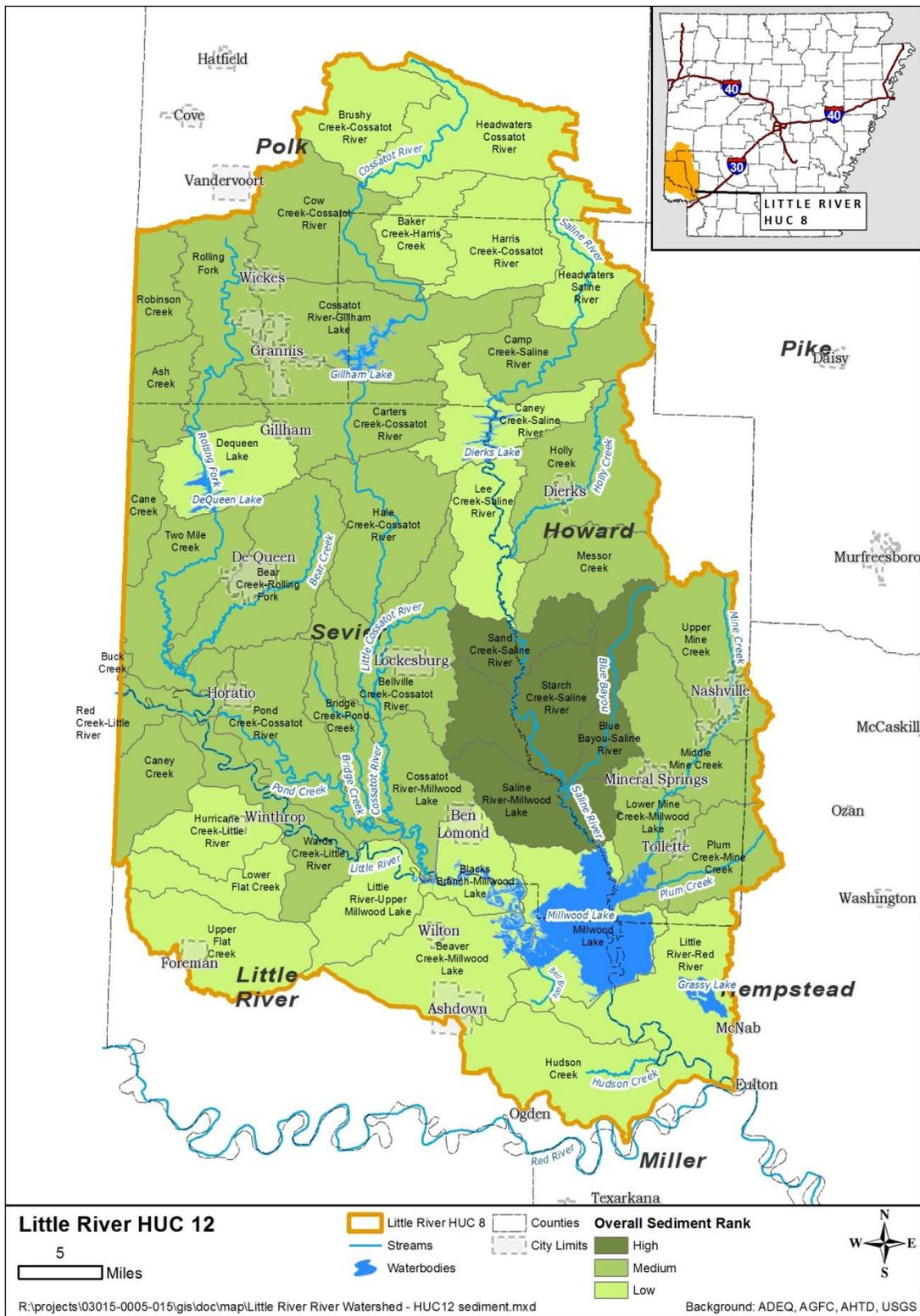


Figure 5.2. Overall ranking of 12-digit HUC subwatersheds for sediment issues.

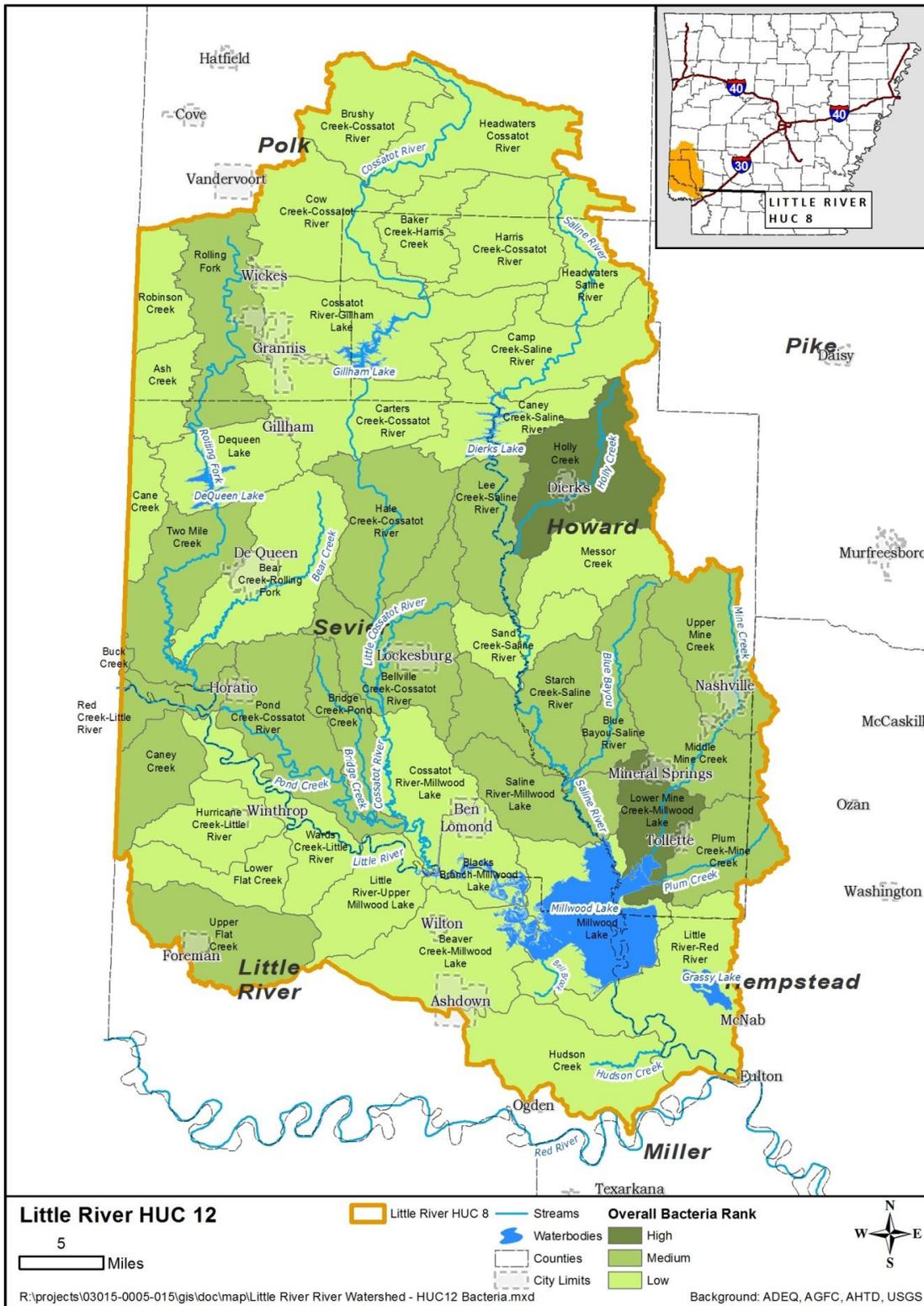


Figure 5.3. Plan ranking of Lower Little River 12-digit HUCs for bacteria issues.

Table 5.2. Rankings from multiple approaches for recommended 12-digit HUC subwatersheds of the Lower Little River watershed.

| HUC 12 Name (HUC I.D. number)                 | 2014 Turbidity Impairment | SWAT Sediment Rank | NRCS Excess Sediment Rank | Sediment Load Overall Rank |  |  | 2014 Pathogen Impairment | NRCS Manure Pathogen, etc. Rank | Pathogen Load Overall Rank |
|---|---------------------------|--------------------|---------------------------|----------------------------|--|--|--------------------------|---------------------------------|----------------------------|
| Holly Creek (111401090801)                    | 5                         | 3                  | 2                         | Medium                     |  |  | 1                        | 2                               | High                       |
| Sand Creek-Saline River (111401090901)        | 1                         | 2                  | 3                         | High                       |  |  | 5                        | 4                               | Low                        |
| Starch Creek-Saline River (111401090902)      | 1                         | 2                  | 3                         | High                       |  |  | 5                        | 1                               | Medium                     |
| Blue Bayou-Saline River (111401090903)        | 1                         | 2                  | 2                         | High                       |  |  | 5                        | 1                               | Medium                     |
| Saline River-Millwood Lake (111401090904)     | 1                         | 2                  | 3                         | High                       |  |  | 5                        | 2                               | Medium                     |
| Lower Mine Creek-Millwood Lake (111401091004) | 5                         | 1                  | 4                         | Medium                     |  |  | 1                        | 1                               | High                       |

### 5.3.5 Nonpoint pollutant sources in recommended 12-digit HUC subwatersheds of the Lower Little River watershed

The priority pollutants in the recommended subwatersheds are sediment/turbidity and pathogens. Table 5.3 summarizes priority pollutants of concern and priority nonpoint sources of these pollutants that are present in each of the recommended 12-digit HUC subwatersheds. Nonpoint sources of sediment/turbidity and pathogens are not identified in the 2008 or 2012 303(d) lists. However, based on available information, several priority nonpoint sources have been identified for these pollutants in the recommended subwatersheds that will be addressed in this plan. These are discussed below.

Table 5.3. Priority pollutants and nonpoint sources for recommended 12-digit HUCs.

| Land use   | % area | Priority Pollutants | Priority Nonpoint Sources  | Land Use Map* |
|--|--------|---------------------|--|---------------|
| <b>Holly Creek, HUC 111401090801</b>                 |        |                     |  |               |
| Developed  | 8.4    | None                | None   |               |
| Hay/pasture  | 9.3    | Pathogens           | Livestock (cattle in streams, animal feeding operations, manure storage), pasture runoff |               |
| Forest   | 51.6   | None                | None   |               |
| <b>Sand Creek – Saline River, HUC 111401090901</b>   |        |                     |  |               |
| Developed  | 4.4    | None                | None   |               |
| Hay/pasture  | 8.1    | Sediment/Turbidity  | Streambank erosion   |               |
| Forest   | 55.6   | Sediment/Turbidity  | Streambank erosion, silviculture   |               |
| <b>Starch Creek – Saline River, HUC 111401090902</b> |        |                     |  |               |
| Developed  | 4.2    | None                | None   |               |
| Hay/pasture  | 32.4   | Sediment/Turbidity  | Streambank erosion, sheet/rill erosion   |               |
| Forest   | 40.8   | Sediment/Turbidity  | Streambank erosion, silviculture   |               |

\*green = forest, gray = barren, yellow = hay/pasture, blue = stream or lake, red = developed, pink = impaired stream reach

Table 5.3. Priority pollutants and nonpoint sources for recommended 12-digit HUCs (continued).

| Land use  | % area | Priority Pollutants | Priority Nonpoint Sources  | Land Use Map* |
|---|--------|---------------------|--|---------------|
| <b>Blue Bayou – Saline River, HUC 111401090904</b>        |        |                     |  |               |
| Developed   | 4.9    | None                | None   |               |
| Hay/pasture   | 40.0   | Sediment/Turbidity  | Streambank erosion, sheet/rill erosion, gully erosion                                    |               |
| Forest  | 41.5   | Sediment/Turbidity  | Streambank erosion, gully erosion, silviculture  |               |
| <b>Saline River – Millwood Lake, HUC 111401090904</b>     |        |                     |  |               |
| Developed   | 3.7    | None                | None   |               |
| Hay/pasture   | 16.8   | Sediment/Turbidity  | Streambank erosion   |               |
| Forest  | 44.5   | Sediment/Turbidity  | Streambank erosion, silviculture   |               |
| <b>Lower Mine Creek – Millwood Lake, HUC 111401091004</b> |        |                     |  |               |
| Developed   | 4.7    | None                | None   |               |
| Hay/pasture   | 36.8   | Pathogens           | Livestock (cattle in streams, animal feeding operations, manure storage), pasture runoff |               |
| Forest  | 30.5   | None                | None   |               |

\*green = forest, gray = barren, yellow = hay/pasture, blue = stream or lake, red = developed, pink = impaired stream reach

### 5.3.5.1 Sediment/Turbidity

Sediment/turbidity is the priority pollutant in the four Saline River recommended subwatersheds because the baseflow turbidity water quality criterion is not being met. Table 5.4 shows NRCS rankings for erosion resource concerns for the Saline River recommended 12-digit HUC subwatersheds. In this table, a rank of 1 indicates a high potential for the erosion source to contribute to water quality issues, and a rank of 5 indicates a very low potential for this erosion source to contribute to water quality issues.

Based on the NRCS resource concern ranks for streambank erosion shown in Table 5.4, for this plan streambank erosion is a priority nonpoint source of sediment/turbidity in all four of the Saline River recommended 12-digit HUC subwatersheds. Landowners at our public meetings noted that reservoir management contributes to streambank erosion. In the 2014 state water quality assessment and draft impaired waters list, ADEQ identifies hydropower as a source of turbidity for the impaired reach of the Saline River (ADEQ 2014a). Based on the high pool boundary of Millwood Lake, streambanks in the Starch Creek, Sand Creek, Blue Bayou, and Saline River-Millwood Lake recommended subwatersheds could be impacted by the management of water levels in the reservoir. Streambank erosion can be associated with any land use in the subwatersheds.

Table 5.4. NRCS rankings for erosion resource concerns in recommended subwatersheds.

| HUC 12 Name (HUC I.D. number)             | NRCS sheet/rill/wind erosion rank | NRCS concentrated flow erosion rank | NRCS streambank erosion rank |
|---|-----------------------------------|-------------------------------------|------------------------------|
| Sand Creek-Saline River (111401090901)    | 4                                 | 3                                   | 2                            |
| Starch Creek-Saline River (111401090902)  | 2                                 | 3                                   | 2                            |
| Blue Bayou-Saline River (111401090903)    | 1                                 | 2                                   | 1                            |
| Saline River-Millwood Lake (111401090904) | 3                                 | 3                                   | 1                            |

Hay and pasture land accounts for one-third or more of the land cover in two of the four Saline River recommended subwatersheds, making this a priority nonpoint source in these subwatersheds. Erosion of pasture can be a source of sediment/turbidity. For the Starch Creek subwatershed, where 32% of the area is hay or pasture, sheet/rill/wind erosion is highly ranked as a natural resource concern, suggesting that erosion from pasture is a priority nonpoint source of sediment for this subwatershed. For the Blue Bayou subwatershed, where 40% of the area is hay or pasture, sheet/rill/wind erosion and concentrated flow (i.e., gully) erosion are highly ranked natural resource concerns. Therefore, we conclude that erosion of pasture is a priority nonpoint source of sediment in the Blue Bayou subwatershed.

Forty to fifty percent of the Saline River recommended subwatersheds is forest. In Howard and Sevier counties, the majority of forest is in silviculture, managed by large corporations, small timber companies, or private landowners. Unpaved roads on timberlands are a source of sediment/turbidity. Timber harvesting activities are also a nonpoint source of sediment/turbidity. As a result, silviculture is considered a priority nonpoint source of sediment/turbidity in these subwatersheds.

#### **5.3.5.2 Pathogens**

Pathogens are the priority pollutant in the Holly Creek and Lower Mine Creek recommended subwatersheds because the pathogen water quality criteria are not being met. Livestock are a recognized source of pathogens in these two recommended subwatersheds. The NRCS has identified manure as a high ranking natural resource concern in these recommended subwatersheds (see Table 5.2). The recommended subwatersheds are located in Howard County, which have some of the highest livestock densities of the five counties within the Millwood Lake watershed (see Table 4.1). All of this indicates that livestock are a priority nonpoint source of pathogens in the Holly Creek and Lower Mine Creek recommended subwatersheds.

## **6.0 WATERSHED GOALS AND OBJECTIVES**

The overall objective of this watershed-based management plan is to restore and sustain the natural resources of the Lower Little River watershed so that the vision of its citizens can be achieved. The vision for the Lower Little River for this plan is: Water serves as the nexus for bringing landowners, businesses, organizations, and agencies together to attain and sustain stream, lake, and wetland uses to improve the way of life and quality of life in the lower Little River basin.

The primary focus of this plan is to address surface water quality. However, the intention is to manage the Lower Little River watershed holistically, so that addressing surface water quality does not adversely affect other management efforts (e.g., groundwater and wildlife habitat management), or give rise to, or exacerbate, other issues. To this end, the visions and goals of other organizations for the Lower River watershed are discussed.

### **6.1 Visions and Goals of Organizations Working in the Lower Little River Watershed**

There are a number of agencies and other organizations that work within the Lower Little River watershed to manage natural resources. Several of them have developed plans that address their visions and goals in the watershed. These are discussed by organization below.

#### **6.1.1 US Fish and Wildlife Service**

USFWS activities in the Lower Little River watershed are guided by a number of management plans. These include the North American Waterfowl Management Plan, the Bird Conservation Plan for the West Gulf Coastal Plain, US Shorebird Conservation Plan for the Lower Mississippi/Western Gulf Coast, and the Southeast United States Regional Waterbird Conservation Plan. In the habitat management plan for the Pond Creek National Wildlife Refuge, the vision for the refuge is stated: “Pond Creek National Wildlife Refuge is a model refuge that protects and manages biological diversity for the enjoyment and benefit of present and future generations.” (USFWS 2014a).

### **6.1.2 US Forest Service**

A portion of the Ouachita National Forest is located in the northern Lower Little River watershed. The US Forest Service vision for the Ouachita National Forest is “A forest that is healthy, beautiful and useful with the full complement of native plants and animals, high quality lakes and streams, and intact productive soils.” USFS (US Forest Service 2015b).

### **6.1.3 Arkansas Department of Parks and Tourism**

The Cossatot River State Park and Natural Area is managed jointly by the Arkansas Department of Parks and Tourism, and the Arkansas Natural Heritage Commission. The mission of the State Park and Natural Area is “to maintain the natural and scenic quality of the Cossatot River corridor and provide natural resource education opportunities.” (Arkansas Department of Parks and Tourism, Arkansas Natural Heritage Commission 2014).

## **6.2 Management Objectives**

The overall management objective of this plan is to implement management practices so the designated uses of the waterbodies within the Lower Little River watershed recommended subwatersheds are attained. Stream segments in the recommended subwatersheds of the Lower Little River are not meeting numeric water quality criteria for turbidity and pathogens from nonpoint sources (see Tables 3.4 and 3.5). Management practices can reduce the pollutants identified on the 303(d) list as the causes of impairment of the designated uses, so that Arkansas water quality criteria are met and the designated uses of the streams are attained. The surface water pollutants that will be the primary target for management measures in the recommended 12-digit HUC subwatersheds are turbidity (sediment), and pathogens (*E. coli*).

## **6.3 Load Reduction Targets**

The primary load reduction targets to be addressed by this plan are for TSS (as a surrogate for turbidity) and pathogens. Temperature impairment is being addressed through an on-going Use Attainability Analysis study. Metals, sulfate, and nutrient pollution causing impairment in the watershed is from point sources that are permitted and managed through the

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Arkansas NPDES program of ADEQ, and are being addressed through that program (ADEQ 2014a).

### 6.3.1 Pathogens

TMDLs addressing pathogens in the Lower Little River watershed have been completed. Percent load reduction targets were not specified with the pathogen TMDLs. The target TMDL pathogen loads, total and nonpoint source load allocation, that apply in the recommended subwatersheds are listed in Table 6.1.

Table 6.1. Pathogen TMDLs for recommended subwatersheds.

| Subwatershed | Parameter      | Criterion* | TMDL<br>cfu/day | NPS LA<br>cfu/day |
|--------------|----------------|------------|-----------------|-------------------|
| Holly Creek  | <i>E. coli</i> | PCR-S      | 4.32E+13        | 3.89E+13          |
|              | <i>E. coli</i> | PCR-W/SCR  | 2.16E+14        | 1.94E+14          |
| Mine Creek   | <i>E. coli</i> | PCR-S      | 7.52E+13        | 6.76E+13          |
|              |                | PCR-W/SCR  | 3.76E+14        | 3.38E+14          |

\*PCR-S = summer primary contact recreation; PCR-W = winter primary contact recreation; SCR = secondary contact recreation

Table 6.2 lists the most recent *E. coli* data collected from the ADEQ water quality monitoring stations associated with the impaired reaches, along with the results of a comparison of these measurements to the single measurement criteria (see Table 3.2). It appears that reevaluation of the *E. coli* impairment for these stream reaches is warranted, as only one of the measurements at each station exceed the single measurement criteria. Therefore, there is no pathogen load reduction target for this plan, and pathogens will not be addressed through implementation of management practices. Rather, the pathogen impairment will be addressed through collection of *E. coli* measurements to determine if the pathogen impairment listing of Holly Creek and Mine Creek is still valid.

Table 6.2. Most recent available *E. coli* data from pathogen impaired stream reaches.

| Subwatershed | ADEQ Station | Sample date | <i>E. coli</i><br>(cfu/100ml) | Exceed criteria |
|--------------|--------------|-------------|-------------------------------|-----------------|
| Holly Creek  | RED0034B     | 6/1/2005    | 128                           | N               |
| Holly Creek  | RED0034B     | 6/14/2005   | 31                            | N               |
| Holly Creek  | RED0034B     | 7/6/2005    | 7                             | N               |
| Holly Creek  | RED0034B     | 7/25/2005   | 1680                          | Y               |
| Holly Creek  | RED0034B     | 8/10/2005   | 24                            | N               |
| Holly Creek  | RED0034B     | 8/23/2005   | 31                            | N               |
| Holly Creek  | RED0034B     | 9/6/2005    | 59                            | N               |
| Holly Creek  | RED0034B     | 9/12/2005   | 52                            | N               |
| Holly Creek  | RED0034B     | 7/24/2008   | 148                           | N               |
| Holly Creek  | RED0034B     | 8/6/2008    | U                             | N               |
| Holly Creek  | RED0034B     | 8/27/2008   | 156                           | N               |
| Holly Creek  | RED0034B     | 9/16/2008   | 279                           | N               |
| Mine Creek   | RED0018B     | 6/1/2005    | 320                           | N               |
| Mine Creek   | RED0018B     | 6/14/2005   | 144                           | N               |
| Mine Creek   | RED0018B     | 7/6/2005    | 62                            | N               |
| Mine Creek   | RED0018B     | 7/25/2005   | 260                           | N               |
| Mine Creek   | RED0018B     | 8/10/2005   | 175                           | N               |
| Mine Creek   | RED0018B     | 8/23/2005   | 192                           | N               |
| Mine Creek   | RED0018B     | 9/6/2005    | 55                            | N               |
| Mine Creek   | RED0018B     | 9/12/2005   | 52                            | N               |
| Mine Creek   | RED0018B     | 5/30/2007   | U*                            | N               |
| Mine Creek   | RED0018B     | 6/21/2007   | 2000                          | Y               |
| Mine Creek   | RED0018B     | 7/17/2007   | U                             | N               |
| Mine Creek   | RED0018B     | 8/1/2007    | 160                           | N               |
| Mine Creek   | RED0018B     | 8/7/2007    | 59                            | N               |
| Mine Creek   | RED0018B     | 8/21/2007   | 35                            | N               |
| Mine Creek   | RED0018B     | 9/6/2007    | 236                           | N               |
| Mine Creek   | RED0018B     | 9/11/2007   | U                             | N               |
| Mine Creek   | RED0018B     | 9/25/2007   | 124                           | N               |
| Mine Creek   | RED0018B     | 6/24/2008   | 192                           | N               |
| Mine Creek   | RED0018B     | 7/21/2008   | 72                            | N               |
| Mine Creek   | RED0018B     | 8/25/2008   | 112                           | N               |
| Mine Creek   | RED0018B     | 10/13/2008  | U                             | N               |
| Mine Creek   | RED0018B     | 12/8/2008   | 69                            | N               |
| Mine Creek   | RED0018B     | 2/23/2009   | 276                           | N               |
| Mine Creek   | RED0018B     | 3/16/2009   | U                             | N               |

\*Not detected

### 6.3.2 Turbidity

There has been no TMDL study addressing turbidity impairment in the watershed, so percent load reduction targets for turbidity have not been determined. A simple analysis of the data from 2010 through 2013 was used to develop a load reduction target for this plan (Appendix C). In this analysis, TSS was used as a surrogate for turbidity because turbidity cannot be expressed as a load and suspended sediment is not monitored in the recommended subwatersheds. TSS concentration targets were developed from the turbidity water quality criteria using a conversion equation developed from linear regression analysis comparing TSS and turbidity data for the period 2010 through 2014 (Appendix C). The regression analysis showed a strong relationship between these two parameters ( $P = 0.000$ ) that accounted for 90% of turbidity variation ( $R^2 = 0.90$ ). Only the base flow turbidity criterion was exceeded in the sediment recommended subwatersheds (i.e., ADEQ station RED0021), so only the base flow target was used in the analysis. The TSS base flow concentration target calculated from the turbidity base flow criterion was 19.1 mg/L. In 2010, 2013, and 2014, twenty percent (i.e., one of five measurements) of base flow TSS concentrations exceeded the target value. Using an iterative process, it was determined that all measured TSS concentrations would be less than the target concentration if they were reduced by 53%. Based on this analysis, the sediment load reduction target for this plan is 55%. The interim target for turbidity is that the percentage of measurements from the impaired stream reach in the recommended subwatersheds that exceed the base flow numeric water quality criterion declines from the 2014 assessment percentage of 28%.

## **7.0 IDENTIFICATION OF MANAGEMENT STRATEGIES**

This section discusses nonpoint source management strategies for the recommended 12-digit HUC subwatersheds of the Lower Little River watershed. The proposed management units are identified. Management strategies that have been used in the watershed are identified, along with management strategies that are planned for the future. Structural and non structural management strategies are discussed separately. In addition, management strategies identified by stakeholders are identified. Discussion of the management strategies is organized by pollutant and pollutant source to be addressed.

### **7.1 Management Units**

The 12-digit HUC subwatersheds of the Lower Little River watershed are used to define management areas for this plan. There are 46 12-digit HUC subwatersheds in the Lower Little River watershed of which all or part are in Arkansas. Six of these 12-digit HUC subwatersheds are recommended for management through this plan (see Section 5.3). The 12-digit HUC is a recommended sized unit for water quality improvement because: 1) it is small enough that improvements in water quality associated with implementing management practices can be observed within a reasonable time frame; 2) it is large enough that significant reductions in targeted pollutants can occur through management; and 3) it provides a sense of place and community involvement for stakeholders (EPA 2014).

### **7.2 Management Strategies for Streambank Erosion**

Streambank erosion has been identified as a priority nonpoint source of excess sediment/turbidity in all four of the recommended subwatersheds of the Lower Little River watershed (see Table 5.3) where sediment/turbidity is the priority pollutant, as well as other areas of the watershed (see Figure 4.4). Streambank erosion occurs in pasture and forest streams, and can be associated with silviculture activities, including timber harvest, road drainage, and stream crossings. Reducing streambank erosion reduces stream turbidity and TSS load to meet state water quality criteria. Reduced turbidity and TSS means improved visibility for predatory sport

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fish such as bass, and reduced sedimentation in stream channels, which also supports desirable sport fish and their prey.

Table 7.1 summarizes structural controls that reduce streambank erosion that have been implemented, are planned, or have the potential to be implemented in the recommended subwatersheds of the Lower Little River watershed. Table 7.2 summarizes nonstructural controls that can reduce streambank erosion that have been implemented, are planned, or have the potential to be implemented in the recommended subwatersheds of the Lower Little River watershed.

Table 7.1. Structural controls to reduce streambank erosion in the recommended subwatersheds of the Lower Little River watershed.

| <b>Project/program<br/>(Agency/organization)</b>   | <b>Pollutants<br/>(source)</b>                      | <b>Practices</b>   | <b>Land Use</b>                     | <b>Status</b> |
|--|---|--|-------------------------------------|---------------|
| Controlled Access and Livestock Fencing (CALF) Initiative (Arkansas Association of County Conservation Districts, USFWS) | Sediment and pathogens (livestock)                  | Eligible practices include stream fencing, stream crossings, alternative water supplies (pipe and pumps), and controlled access points | Pasture                             | On-going      |
| Partners for Fish and Wildlife (US Fish and Wildlife Service)  | Sediment (erosion, livestock)                       | Eligible practices include riparian fencing, streambank stabilization, stream restoration  | Pasture and forest                  | On-going      |
| Forestry road BMPS (Arkansas Forestry Commission, Forest Products Industry)  | Sediment (erosion)                                  | Stream crossings   | Private and commercial forest lands | On-going      |
| EQIP General (NRCS)  | Sediment, nutrients (erosion, livestock)            | Practices include stream fencing, alternative water supplies, streambank protection, water control structures, stream crossing         | Pasture                             | On-going      |
| Arkansas Nonpoint Source Pollution Program (ANRC)  | Sediment, nutrients, pathogens (erosion, livestock) | Eligible practices include stream fencing, alternative water supplies, streambank protection, water control structures                 | Pasture and forest                  | On-going      |

Table 7.2. Nonstructural controls to reduce streambank erosion in the recommended subwatersheds of the Lower Little River watershed.

| <b>Project/program<br/>(Agency/organization)</b>                                     | <b>Pollutants (source)</b>  | <b>Practices</b>   | <b>Land Use</b>                            | <b>Status</b> |
|--|---|--|--|---------------|
| Forestry road BMPS<br>(Arkansas Forestry<br>Commission, Forest<br>Products Industry) | Sediment/turbidity<br>(erosion)                                     | Streamside management<br>zones   | Private and<br>commercial<br>forest lands  | On-going      |
| Partners for Fish and<br>Wildlife<br>(USFWS)   | Sediment/turbidity<br>(erosion, livestock)                          | Eligible practices include<br>riparian buffers and<br>revegetation   | Pasture and<br>forest                      | On-going      |
| EQIP General<br>(NRCS)   | Sediment/turbidity,<br>nutrients<br>(erosion, livestock)            | Practices include<br>conservation plans, riparian<br>buffers, prescribed grazing   | Pasture                                    | On-going      |
| Agricultural Conservation<br>Easement Program<br>(NRCS)                              | Sediment/turbidity,<br>nutrients (erosion)                          | Wetland reserve easements  | Pasture wetlands                           | On-going      |
| Conservation Reserve<br>Program (Farm Services<br>Agency)                            | Sediment/turbidity,<br>nutrients<br>(erosion, livestock)            | Riparian easements   | Streamside<br>pasture, pasture<br>wetlands | On-going      |
| Arkansas Nonpoint<br>Source Pollution Program<br>(ANRC)                              | Sediment/turbidity,<br>nutrients, pathogens<br>(erosion, livestock) | Eligible practice include<br>conservation plans, riparian<br>buffers, prescribed grazing,<br>and planting forage, trees, or<br>native plants | Pasture and<br>forest                      | On-going      |
| Corps of Engineers Public<br>Relations (Corps of<br>Engineers)                       | Sediment/turbidity<br>(erosion)                                     | Alert Corps of Engineers<br>project managers about<br>erosion related to reservoir<br>operation  | Pasture and<br>forest                      | On-going      |

### 7.2.1 Past Management Strategies

Work that has been done in areas of the Lower Little River watershed to reduce streambank erosion is described below.

#### 7.2.1.1 Structural Controls

Based on comments from stakeholders at the public meetings held as part of the process of developing this plan, pasture stream fencing, and stream crossings on unpaved forestry roads have been installed in the Lower Little River watershed. Information on the amount of stream fencing or number of stream crossings was not provided.

Stream exclusion (i.e., stream fencing with alternative water supply) can be a very effective BMP for reducing streambank erosion. However, comments were made during the public meetings for this plan to the effect that this BMP is not effective in some areas of the watershed, particularly, along those streams impacted by reservoir operations. Banks along those streams experience longer periods of high water, and when the high water recedes, the banks slough. In these areas, streambank stabilization, though expensive, would likely be more effective in reducing streambank erosion.

In addition, fencing along streams can be destroyed during flooding. Therefore, when designing stream exclusion BMPs, it would be helpful to consider the extent of the floodplain, and try to locate the fence outside of the main flood hazard area (see Figure 2.3).

Forestry road BMPs, which include stream crossings, were in place at 89% of surveyed sites in the Ouachita Arkansas forestry region, and 80% of surveyed sites in the Southwest Arkansas forestry region. Statewide, forestry road BMPs were utilized most at surveyed federal forest sites (94%), and least frequently on surveyed privately-owned forest lands (79%) (ANRC 2011). Data is not available on any other types of structural controls installed, nor the amount or number of structural controls that have been installed in the watershed.

### **7.2.1.2 Nonstructural Controls**

Based on comments from stakeholders at the public meetings held as part of the process of developing this plan, conservation plans have been developed for farms in the Lower Little River watershed. Streamside Management Zones were in place at 85% of surveyed sites in the Ouachita Arkansas forestry region, and 82% of surveyed sites in the Southwest Arkansas forestry region. Statewide, Streamside Management Zones are present at 100% of surveyed federally-owned forest sites, and least frequently on surveyed privately-owned forest sites (70%) (Arkansas Forestry Commission 2011). Data is not available on any other types of nonstructural controls installed, nor the amount or number of nonstructural controls that have been installed in the watershed.

At the public meetings held while developing this plan, at least one stakeholder stated that management of Corps of Engineers reservoirs was contributing to severe erosion of

streambanks. A Corps of Engineers representative at the public meetings asked that landowners contact the Corps of Engineers project (reservoir) managers with any such complaints.

### **7.2.1.3 Effectiveness**

At this time there is no information available to track the effectiveness of the implemented nonpoint source management practices in the Lower Little River watershed.

## **7.2.2 Ongoing and Planned Activities**

All of the programs listed in Tables 7.1 and 7.2 are on-going. These include programs of the USFWS, NRCS, Farm Service Agency, Arkansas Forestry Commission, Arkansas Association of Conservation Districts, and ANRC.

Management practices that reduce streambank erosion are implemented in the recommended subwatersheds of the Lower Little River watershed through the NRCS Environmental Quality Incentive Program (EQIP) and the Agricultural Conservation Easements Program. The EQIP general program is available in the recommended subwatersheds and provides technical and financial assistance for implementation of management practices on agricultural lands to improve water quality (NRCS 2015 a). The Agricultural Conservation Easements Program has replaced the former Wetlands Reserve Easements program.

The Farm Service Agency (FSA) Conservation Reserve Program (CRP) is similar to the NRCS Agricultural Conservation Easements Program. However, non-wetlands are eligible for the FSA program. Marginal pasture land that is suitable for use as a riparian buffer, or similar water quality use, is eligible for CRP (FSA n.d.).

Management practices that reduce streambank erosion are also implemented in the recommended subwatershed through several USFWS programs. Partners for Fish and Wildlife is a USFWS program that provides technical and financial assistance to landowners. The USFWS has partnered with the Arkansas Association of Conservation Districts for an initiative focused on assisting landowners in restricting livestock access to streams; Controlled Access and Livestock Fencing (CALF). Assistance is available through this program for primarily structural

controls, including fencing, water transfer, alternative watering facilities, stream crossings, and controlled access points.

In addition, both structural and nonstructural management practices that reduce streambank erosion can be implemented in the recommended subwatersheds through the Arkansas Nonpoint Source Pollution Program.

### **7.2.3 Management Programs Outside of Recommended Subwatersheds**

All of the programs listed in Tables 7.1 and 7.2 are active throughout the Lower Little River watershed, not just in the recommended subwatersheds. In addition, there are two programs that implement management practices in selected areas of the Lower Little River watershed that are outside of the recommended subwatersheds.

The Western Arkansas Woodland Restoration Project is an NRCS partnership with the USFS aimed at doubling conservation activity on private lands in selected counties and in the Ouachita National Forest, over a 3-year period. The goal of this program is to improve the health and resiliency of forest ecosystems. It is available in portions of Howard, Pike, and Polk Counties within the Lower Little River watershed (NRCS 2014).

There is also a planned project to restore and protect streambanks along the Cossatot River within the state park. The Southeast Aquatic Resources Partnership, which includes the USFWS and AGFC, initiated this project in 2012.

## **7.3 Management Strategies for Reduction of Sheet/Rill/Wind and Gully Erosion in the Lower Little River Watershed**

Sheet/rill/wind erosion has been identified as a priority nonpoint source of sediment/turbidity in two of the recommended subwatersheds of the Lower Little River watershed (see Table 5.4), as well as other areas of the watershed (see Figure 4.2). Gully erosion has been identified as a priority nonpoint source of sediment/turbidity in one of the recommended subwatersheds (Table 5.4), as well as other areas of the watershed (see Figure 4.3). Sheet/ rill/wind, and gully erosion are associated with pasture and unpaved roads. Reducing sheet/rill/wind, and gully erosion reduces stream turbidity and TSS load to meet state water quality criteria. Reduced turbidity and TSS means improved visibility for predatory sport fish

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such as bass, and reduced sedimentation in stream channels, which also supports desirable sport fish and their prey.

Table 7.3 summarizes structural controls that reduce sheet/rill/wind and gully erosion that have been implemented, are planned, or have the potential to be implemented in the recommended subwatersheds of the Lower Little River watershed. Table 7.4 summarizes nonstructural controls that reduce sheet/rill/wind and gully erosion that have been implemented, are planned, or have the potential to be implemented in the recommended subwatersheds of the Lower Little River watershed.

Table 7.3 Structural controls for sheet/rill/wind and gully erosion in the recommended subwatersheds of the Lower Little River watershed.

| <b>Project/program<br/>(Agency/organization)</b>                            | <b>Pollutants (source)</b>                                    | <b>Practices</b>  | <b>Land Use</b>                     | <b>Status</b> |
|---|---|---|-------------------------------------|---------------|
| Partners for Fish and Wildlife (USFWS)                                      | Sediment/Turbidity (erosion, livestock)                       | Eligible practices include water control structures   | Pasture and forest                  | On-going      |
| Forestry road BMPS (Arkansas Forestry Commission, Forest Products Industry) | Sediment/Turbidity (erosion)                                  | Broad-base dips, rolling dips, wing ditches   | Private and commercial forest lands | On-going      |
| EQIP General (NRCS)   | Sediment/Turbidity, nutrients (erosion, livestock)            | Practices include water control structures, water bars, dips, dikes, ponds, grade stabilization structures, lined waterway, fencing | Pasture and forest                  | On-going      |
| Arkansas Nonpoint Source Pollution Program (ANRC)                           | Sediment/Turbidity, nutrients, pathogens (erosion, livestock) | Eligible practices include water control structures and fencing   | Pasture and forest                  | On-going      |

Table 7.4. Nonstructural controls for sheet/rill/wind and gully erosion in the recommended subwatersheds of the Lower Little River watershed.

| <b>Project/program<br/>(Agency/organization)</b>                            | <b>Pollutants (source)</b>                                    | <b>Practices</b>   | <b>Land Use</b>                     | <b>Status</b> |
|---|---|--|-------------------------------------|---------------|
| Partners for Fish and Wildlife (USFWS)                                      | Sediment/Turbidity (erosion, livestock)                       | Eligible practices include revegetation  | Pasture and forest                  | On-going      |
| Forestry road BMPS (Arkansas Forestry Commission, Forest Products Industry) | Sediment/Turbidity (erosion)                                  | Revegetation   | Private and commercial forest lands | On-going      |
| EQIP General (NRCS)   | Sediment/Turbidity, nutrients (erosion, livestock)            | Practices include conservation plans, prescribed grazing, filter strips, grassed waterways, critical area planting, conservation cover, buffer strips, forage and biomass planting, silvopasture | Pasture                             | On-going      |
| Arkansas Nonpoint Source Pollution Program (ANRC)                           | Sediment/Turbidity, nutrients, pathogens (erosion, livestock) | Eligible practice include conservation plans, prescribed grazing, and planting forage, trees, or native plants   | Pasture and forest                  | On-going      |

### 7.3.1 Past Management Strategies

Work that has been done in areas of the Lower Little River watershed to reduce surface erosion is described below.

#### 7.3.1.1 Structural Controls

Based on comments from stakeholders at the public meetings held as part of the process of developing this plan, pasture cross fencing is implemented in the Lower Little River watershed. Cross fencing can be used to control cattle access to eroding areas. Information on the amount of cross fencing that has been installed in the watershed was not available.

Forestry road BMPs were in place at 89% of surveyed sites in the Ouachita forestry region, and 80% of surveyed sites in the Southwest forestry region. Statewide, forestry road BMPs were utilized most at surveyed federal forest sites (94%), and least frequently on surveyed privately-owned forest lands (79%) (Arkansas Forestry Commission 2011). Data is not available on any other types of structural controls installed, nor the amount or number of structural controls that have been installed in the watershed.

### **7.3.1.2 Nonstructural Controls**

Based on comments from stakeholders at the public meetings held as part of the process of developing this plan, conservation plans have been developed for farms in the Lower Little River watershed. Data is not available on any other types of nonstructural controls installed, nor the amount or number of nonstructural controls that have been installed in the watershed.

### **7.3.1.3 Effectiveness**

At this time there is no information available to track the effectiveness of the implemented nonpoint source management practices in the Lower Little River watershed.

## **7.3.2 Ongoing and Planned Activities**

All of the programs listed in Tables 7.3 and 7.4 are on-going. These include programs of the USFWS, NRCS, FSA, and Arkansas Forestry Commission.

Management practices that reduce surface erosion are implemented in the Lower Little River watershed through NRCS EQIP. The EQIP general program provides technical and financial assistance for implementation of management practices on agricultural lands to improve water quality (NRCS 2015a).

Management practices that reduce surface erosion are also implemented in the Lower Little River watershed through the USFWS Partners for Fish and Wildlife program. This program provides technical and financial assistance to landowners for practices that improve water quality and wildlife habitat (USFWS 2015b).

In addition, both structural and nonstructural management practices that reduce surface erosion can be implemented in the Lower Little River watershed through the Arkansas Nonpoint Source Pollution Program.

## **7.3.3 Management Programs Outside of Recommended Subwatersheds**

All of the programs listed in Tables 7.3 and 7.4 are active throughout the Lower Little River watershed, not just in the recommended subwatersheds. In addition, there is a program that implements management practices in selected areas of the Lower Little River watershed that are

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outside of the recommended subwatersheds. The Western Arkansas Woodland Restoration Project is an NRCS partnership with the USFS aimed at doubling the conservation activity on private lands in selected counties and in the Ouachita National Forest, over a 3-year period. The goal of this program is to improve the health and resiliency of forest ecosystems. It is available in portions of Howard, Pike, and Polk Counties within the Lower Little River watershed (NRCS 2014).

#### **7.4 Management Strategies to Reduce Pathogens**

Manure produced by animal feeding operations and other livestock has been identified as a priority nonpoint source of pathogens (*E. coli*) in the two recommended 12-digit HUC subwatersheds where pathogens are a priority pollutant, as well as several other subwatersheds of the Lower Little River (see Figure 4.1). Proper manure storage, treatment, and disposal remove or reduce this source of pathogens. Maintaining good vegetative cover traps bacteria before they reach streams. Reducing access of pastured livestock to streams, while providing alternate water sources, reduces pathogen inputs from livestock standing in the streams. All of these management strategies reduce the pathogen load to surface waters to meet state *E. coli* water quality standards. When *E. coli* water quality standards are met, the water is safe for human contact.

Table 7.5 is a summary of structural controls that can reduce pathogen loads that may have been implemented in the recommended subwatersheds of the Lower Little River watershed through active implementation programs. Table 7.6 is a summary of nonstructural controls that can reduce pathogen loads that may have been implemented in the recommended subwatersheds through active implementation programs. Because some practices can address both erosion and pathogens, practices from Tables 7.1 through 7.4 are also shown in Tables 7.5 and 7.6.

Table 7.5. Structural controls to reduce pathogens in surface waters of the recommended subwatersheds of the Lower Little River watershed.

| <b>Project/program<br/>(Agency/organization)</b>  | <b>Pollutants<br/>(source)</b>                                | <b>Practices</b>  | <b>Land use</b> | <b>Status</b> |
|---|---|---|-----------------|---------------|
| Controlled Access and Livestock Fencing (CALF) Initiative<br>(Arkansas Association of County Conservation Districts, USFWS) | Sediment/Turbidity and pathogens (livestock)                  | Eligible practices include fencing, stream crossings, alternative water supplies (pipe and pumps), and controlled access points | Pasture         | On-going      |
| Partners for Fish and Wildlife (USFWS)  | Sediment/Turbidity, pathogens, nutrients (erosion, livestock) | Eligible practices include riparian fencing   | Pasture         | On-going      |
| EQIP General (NRCS)   | Sediment/Turbidity, pathogens, nutrients (erosion, livestock) | Practices include fencing, alternative water supplies, stream crossing, stacking sheds  | Pasture         | On-going      |
| Arkansas Nonpoint Source Pollution Program (ANRC)   | Sediment/Turbidity, nutrients, pathogens (erosion, livestock) | Eligible practices include fencing, alternative water supplies  | Pasture         | On-going      |

Table 7.6. Nonstructural controls to reduce pathogens in surface waters of the recommended subwatersheds of the Lower Little River watershed.

| <b>Project/program<br/>(Agency/organization)</b>  | <b>Pollutants<br/>(source)</b>                                | <b>Practices</b>  | <b>Land use</b>     | <b>Status</b> |
|---|---|---|---------------------|---------------|
| Partners for Fish and Wildlife (USFWS)            | Sediment/Turbidity, pathogens (erosion, livestock)            | Eligible practices include riparian buffers   | Stream-side pasture | On-going      |
| EQIP General (NRCS)                               | Sediment/Turbidity, nutrients, pathogens (erosion, livestock) | Practices include conservation plans, riparian buffers, prescribed grazing, filter strips, buffer strips, forage and biomass planting | Pasture             | On-going      |
| Conservation Reserve Program (FSA)                | Sediment/Turbidity, nutrients (erosion, livestock)            | Land easements  | Stream-side pasture | On-going      |
| Arkansas Nonpoint Source Pollution Program (ANRC) | Sediment/Turbidity, nutrients, pathogens (erosion, livestock) | Eligible practice include conservation plans, riparian buffers, prescribed grazing, and planting forage, trees, or native plants      | Pasture             | On-going      |

### **7.4.1 Past Management Strategies**

Work that has been done in areas of the Lower Little River watershed to reduce pathogens in surface waters is described below.

#### **7.4.1.1 Structural Controls**

Based on comments from stakeholders at the public meetings held as part of the process of developing this plan, riparian fencing, stacking sheds, and cross fencing have been installed in the Lower Little River watershed. Data is not available on any other types of pathogen structural controls installed, nor the amount or number of structural controls that have been installed in the watershed.

#### **7.4.1.2 Nonstructural Controls**

Based on comments from stakeholders at the public meetings held as part of the process of developing this plan, buffer strips and prescribed grazing have been implemented in the Lower Little River watershed, but not extensively. Data is not available on any other types of nonstructural controls installed, nor the amount or number of nonstructural controls that have been installed in the watershed.

#### **7.4.1.3 Effectiveness**

At this time there is no information available to track the effectiveness of the implemented nonpoint source management practices in the Lower Little River watershed.

### **7.4.2 Ongoing and Planned Activities**

All of the programs listed in Tables 7.5 and 7.6 are on-going. These include programs of the USFWS, NRCS, Farm Service Agency, and Arkansas Association of Conservation Districts. These programs are described in Sections 7.2.2 and 7.3.2.

## **7.5 Stakeholder Recommendations**

Stakeholder meetings were held to receive input on what management strategies are preferred and work in the Lower Little River watershed. Management strategies identified by the stakeholders are listed in Table 7.7, along with information and comments from stakeholders.

Table 7.7. Management strategies recommended by Lower Little River watershed stakeholders.

| Practice                                   | Comments  |
|--|---|
| Stream crossings for livestock             | Stream crossings have been effective in reducing erosion along pasture streambanks.   |
| Forestry BMPs                              | Streamside Management Zones, stream crossings, and unpaved road BMPs are used in the watershed.   |
| Buffer zones                               | Not spreading litter within a certain distance of surface waters. There has not been much interest in this practice in the past. If buffers are wide enough, they can be enrolled in CRP. |
| Little control and/or export               | Similar to programs active in the Illinois River watershed. These are associated with state declared Nutrient Surplus Areas. Lower Little River watershed is not a Nutrient Surplus Area. |
| Fencing and alternate water supply         | This is a popular BMP in the watershed. Cross fencing is more popular than riparian fencing.  |
| Land leveling                              | There has been some land leveling on the cropland in the watershed.   |
| Erosion control training for unpaved roads | Erosion control methods need to be applicable for mountain roads, not just flat land roads.   |

## 7.6 Estimated Load Reductions

For a number of the management strategies identified above, information on the effectiveness in reducing selected pollutants has been published. This information is summarized in Table 7.8.

### 7.6.1 Supporting Information for Load Reductions

Studies have shown that excluding livestock from streams can improve streambank stability, thus reducing sediment (TSS) loads from an area (Agouridis, et al. 2005). In a decision tool for selecting BMPs for Arkansas, sediment (TSS) reduction of 83% is assigned to use exclusion, with a 38% reduction assumed for use of just alternative watering facilities (Merriman, Gitau and Chaubey 2009).

Table 7.8. Summary of available information on reduction efficiencies of management practices for plan target pollutants (TSS and pathogens).

| Practice  | TSS reduction   | Pathogen reduction      |
|---|---|-------------------------|
| Stream exclusion (Fencing + alternative water supply)                   | 83% <sup>a</sup>  | 30% - 95%               |
| Alternative water supply  | 38% <sup>a</sup> , 89% <sup>b</sup>                                 | 57% <sup>b</sup>        |
| Heavy use area treatment  | No information  | Not applicable          |
| Prescribed/rotational grazing   | 60% <sup>b</sup>  | 60% - 72%               |
| Controlled stream access  | No information  | No information          |
| Forested riparian buffer  | 76% <sup>a</sup> , 94% <sup>b</sup>                                 | 30% <sup>b</sup>        |
| Streambank stabilization/restoration                                    | Up to 100% <sup>c</sup>   | Not applicable          |
| Forestry BMPs (streamside management zones, stream crossing, road BMPs) | See Forested riparian buffer, and erosion control for unpaved roads | Not applicable          |
| Pasture planting  | 59% <sup>a</sup>  | No information          |
| Filter strips   | 53% - 91% <sup>a</sup> , 31% - 98% <sup>b</sup>                     | 30% - 100% <sup>b</sup> |
| Stacking sheds  | Not applicable  | No information          |
| Conservation plans  | See other practices   | See other practices     |
| Nutrient management plans   | See other practices   | See other practices     |
| Vegetated riparian buffer   | See filter strips   | 41% <sup>b</sup>        |

<sup>a</sup> (Merriman, Gitau and Chaubey 2009)

<sup>b</sup>VT database

<sup>c</sup> Kings River bank restoration report

<sup>d</sup> (TNC 2014)

While there has not been much study of the impact of livestock exclusion from streams on stream pathogen concentrations (Agouridis et al. 2005), at least one study concluded that keeping cattle at least 2.5 meters from streams could reduce bacterial loads by 95% (Larsen et al. 1994). Other sources report fecal coliform reductions ranging from 30% to 94% (Peterson et al. 2011a, 2011b; Osmond et al. 2002; Line 2003).

Rotational grazing has been shown to reduce sediment (TSS) and pathogen loads (Sovell et al. 2000, Pennington et al. 2009). A paired watershed study in northwest Arkansas found that sediment levels in runoff from rotationally grazed pastures were at least half the levels from overgrazed pastures (Pennington et al. 2009). Peterson, Redmon and McFarland (2011c) reported that prescribed grazing has been shown to reduce fecal coliform loads by 90% to 96%, and *E. coli* loads by 66% to 72%. Prescribed grazing practices can also include alternative water sources and livestock exclusion. Load reductions for these practices are discussed above.

Forested riparian buffers have been shown to reduce pathogens in runoff from pastures (Doyle et al. 1975, NRCS 2012). Grassed riparian buffers have been shown to reduce pathogens in pasture runoff by 70% to 95% (Coyne and Blevins 1995, Young et al. 1980, Larsen et al. 1994). An Arkansas agricultural BMP effectiveness tool uses a total sediment (TSS) reduction of 76% for forested riparian buffer. Filter strips, or field borders, which would be equivalent to grassed buffers, are expected to reduce sediment (TSS) loads by around 34% (Merriman, Gitau and Chaubey 2009).

Several streambank restoration projects have been implemented in northwest Arkansas. Sediment (TSS) load reductions of almost 100% have been achieved with these natural channel design restoration projects (Van Epps 2014).

An Arkansas agricultural BMP effectiveness tool uses a total sediment (TSS) reduction of 59% for pasture planting. No studies were found researching the impacts of this practice on pathogen levels in runoff. However, it has been shown that runoff volumes tend to be lower from pastures with good condition vegetative cover, which would reduce the amount of pathogens carried to streams (Agouridis et al. 2005).

There have been a number of studies researching the ability of vegetated filter strips to remove pathogens from runoff. Removal rates of up to 100% have been reported (Lim, et al. 1998). An Arkansas agricultural BMP effectiveness tool uses a total sediment (TSS) reduction of 34% for field borders.

### **7.6.2 Load Reduction Estimates for Recommended Subwatersheds**

The TSS load reduction target for this plan is 55%. Examples of the extent of management practices that would be required to achieve a 55% reduction of TSS load for the recommended 12-digit HUC subwatersheds are listed in Table 7.9. The practices included in Table 7.9 are practices that have been implemented and/or have been recommended for implementation in the recommended subwatersheds. These examples are provided for informational purposes only. For these estimates, we assumed that, in each subwatershed, 15% of streambanks and pasture were eroding and contributing TSS to the Saline River. All pasture streams in the highly recommended subwatersheds were assumed to contribute sediment to the

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Saline River. These assumptions were made based on professional judgement. A detailed study of sediment sources is recommended prior to implementing management practices in these, or any, 12-digit HUC subwatersheds of the Lower Little River watershed, to guide the selection of management practices and the locations where they are implemented (see Section 8).

Table 7.9. Estimates of the amount of selected management practices to implement in recommended 12-digit HUC subwatersheds to reduce TSS load by 55%.

|  | <b>Sand Creek –<br/>Saline River</b> | <b>Starch Creek –<br/>Saline River</b> | <b>Blue Bayou –<br/>Saline River</b> | <b>Saline River –<br/>Millwood Lake</b> |
|--|--------------------------------------|--|--------------------------------------|---|
| Feet of stream in subwatershed <sup>a</sup>  | 244,147                              | 532,805                                | 250,589                              | 395,366                                 |
| Assume 15% of streambank contributing TSS, ft  | 73,244                               | 159,841                                | 75,177                               | 118,610                                 |
| Estimated feet of stream in pasture <sup>b</sup>   | 19,776                               | 172,629                                | 100,236                              | 66,422                                  |
| Acres pasture in subwatershed <sup>c</sup>   | 1,359                                | 10,137                                 | 7,179                                | 4,070                                   |
| Assume 15% of pasture contributing TSS, ac   | 204                                  | 1,520                                  | 1,080                                | 610                                     |
| Feet bank stabilization and/or riparian buffer /streamside management zone (80% reduction) | 50,000                               | 60,000                                 | 52,000                               | 82,000                                  |
| Feet pasture stream exclusion (80% reduction)  | 20,000                               | 130,000                                | 140,000                              | 91,000                                  |
| Number of watering facilities <sup>d</sup>   | 20                                   | 130                                    | 140                                  | 91                                      |
| Acres pasture planting (59% reduction)   | 140                                  | 770                                    | 1,000                                | 570                                     |
| Acres prescribed grazing (60% reduction)   | 130                                  | 760                                    | 990                                  | 560                                     |
| Acres 30 ft filter strips (65% reduction)  | 16                                   | 110                                    | 120                                  | 76                                      |

<sup>a</sup> from (Center for Advanced Spatial Technologies 2006)

<sup>b</sup> calculated as feet of stream \* 2010 percent pasture land use

<sup>c</sup> calculated as watershed area \* 2010 percent pasture land use

<sup>d</sup> Assume one watering facility per 1,000 ft of stream exclusion.

Because it appears the *E. coli* water quality standard may be being met in the Holly Creek and Mine Creek recommended 12-digit HUC subwatersheds, no target load reduction has been set in this plan. The pathogen impairments in these recommended subwatersheds are being dealt with in this plan through monitoring/data collection to determine whether or not the stream reaches in these subwatersheds are still impaired (see Section 8). The information in Table 7.8 can be used to guide selection of management practices to reduce pathogen loads in the recommended subwatersheds, if it is determined reduction of pathogen loads is required.

## **8.0 IMPLEMENTATION PROGRAM**

### **8.1 Schedule and Milestones**

As shown in Chapter 7, there are ongoing activities in the Lower Little River watershed that are contributing to achieving the goals of this plan. Table 8.1 summarizes the schedules and milestones and planned activities in the watershed, that are known as of December 2015. It is anticipated that additional projects and activities that contribute to the plan goals will be initiated in the Lower Little River watershed over the next five years. After five years, implementation progress and water quality conditions in the watershed will be reviewed, and adjustments made to the schedule and milestones.

### **8.2 TMDL**

The Clean Water Act requires that States develop Total Maximum Daily Loads (TMDL) for all waterbodies on their impaired waters list. Portions of the Saline River and Little River are included on the draft 2014 Arkansas impaired waters list due to high turbidity levels. ADEQ has assigned development of a TMDL for these stream reaches a low priority. ADH, ANRC, and the Millwood Lake Focus Committee will contact ADEQ about preparing a turbidity TMDL for Saline River and Little River to address the impairments identified there.

### **8.3 Monitoring**

Monitoring is an essential element of adaptive watershed management. The objectives of monitoring in the Lower Little River watershed include:

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

Table 8.1. Implementation schedule.

| Activity   | Action (lead)  | Start | End  | Milestones (3-5 yrs)   | Indicator  | Long Term Goal  |
|------------|--|-------|------|--|--|---|
| TMDL       | Turbidity TMDL (ADEQ)  | 2020  | 2020 | ADH, ANRC, Millwood Lake Focus Committee request turbidity TMDL  | EPA approved TMDL  | Turbidity water quality standards met in impaired stream reaches listed in the 2014 303(d) list               |
| Monitoring | <i>E. coli</i> data collection for removal of Holly Creek and Mine Creek from state impaired waters list (ADEQ)  | 2017  | 2022 | Biennial 305(b) assessments, 303(d) lists  | Attainment or nonattainment classification   | Determine if Holly Creek and Mine Creek meet state <i>E. coli</i> standards                                   |
|            | Synoptic surveys in recommended subwatersheds to characterize TSS/sediment loads (Millwood Lake Focus Committee) | 2018  | 2020 | Survey completed<br>Data analyzed<br>Target areas identified   | Critical areas designated for TSS loading  | Identify target areas for erosion control management strategies to achieve state turbidity standards          |
|            | Annual ambient water quality monitoring (ADEQ, USGS)   | 2017  | 2050 | Four years of water quality data collected   | Number of long term water quality stations<br>Number of sampling events              | Identify and track changes in water quality over time   |
|            | Install automated water samplers on Little River, Saline River, and Mine Creek (Millwood Lake Focus Committee)   | 2017  | 2020 | Automated water samplers obtained and installed<br>Arrangements made for retrieval and analysis of samples<br>At least 3 years of data collected | Number of samplers installed and working<br>Number of samples collected and analyzed | Characterize and track sediment and nutrient loads to Millwood Lake   |
|            | Basin Area Stream Survey in the Ouachita National Forest (USFS)  | 2017  | 2020 | 1 water quality and fishery survey at sites on Bushy Creek and Caney Creek   | Number of sampling events<br>Number of samples                                       | Characterize and track fishery conditions in the Ouachita National Forest                                     |
|            | Fish survey in the Lower Little River watershed (AGFC, UofA Pine Bluff)  | 2018  | 2020 | Two-year fish survey initiated   | Number of survey sites<br>Number of surveys  | Characterize distribution, status, and abundance of selected fish species in the Lower Little River watershed |

Table 8.1. Implementation schedule (Continued).

| Activity                | Action (lead)   | Start | End  | Milestones (3-5 yrs)   | Indicator  | Long Term Goal  |
|-------------------------|---|-------|------|--|--|---|
|                         | Establish Stream Team(s) (stakeholders, AGFC)   | 2017  | 2018 | At least one Stream Team established   | Number of Stream Teams<br>Number of streams monitored by teams           | Identify and track changes in water quality over time   |
| Information & Education | Public meeting to discuss nonpoint source pollution in Lower Little River watershed (Cooperative Extension Service) | 2018  | 2018 | Meeting scheduled<br>Meeting advertised<br>Meeting held<br>Meeting summary published | Meeting held<br>Number of attendees                                      | Engage local stakeholders in nonpoint source pollution management                                       |
|                         | Informational booth at County fairs (Millwood Lake Focus Committee)   | 2018  | 2050 | Booths at 10 county fairs in counties of the Lower Little River watershed            | Number of fairs attended<br>Number of people visiting booths             | Increase awareness of water quality issues in Lower Little River watershed                              |
|                         | Arkansas grazing lands conference (Arkansas Grazing Lands Coalition)  | 2012  | 2030 | 3 to 5 conferences held  | Number of conference attendees from Lower Little River watershed         | Increased awareness and adoptions of pasture BMPs in Lower Little River Watershed                       |
|                         | Annual Forestry and Land Judging Contest (Howard & Pike County Conservation Districts)                              | 2016  | 2030 | 3 to 5 contests held   | Number of contestants from Lower Little River watershed                  | Increased awareness and adoption of silviculture BMPs by private timber owners/managers                 |
|                         | Field Days (Conservation Districts)   | 2016  | 2030 | 1 to 3 field days held in recommended 12-digit HUC subwatersheds                     | Number of field days in recommended subwatersheds<br>Number of attendees | Increase acceptance and use of BMPs that protect and improve water quality                              |
|                         | Water bill brochures (water utilities)  | 2018  | 2022 | Three annual brochures sent out  | Number of brochures distributed  | Increase awareness of connection between watershed activities and drinking water quality and water cost |

Table 8.1. Implementation schedule (Continued).

| Activity                                    | Action (lead)  | Start | End  | Milestones (3-5 yrs)   | Indicator   | Long Term Goal   |
|---|--|-------|------|--|---|--|
|   | Presentations to interest groups (Millwood Lake Focus Committee)   | 2017  | 2022 | Five presentations   | Number of presentations<br>Number of interest groups<br>Number of attendees | Increase awareness of water quality issues in Lower Little River watershed   |
| Supplemental Watershed Implementation Plans | Prepare and implement supplemental watershed implementation plans in recommended 12-digit HUC subwatersheds with turbidity impairments (Millwood Lake Focus Committee) | 2017  | 2022 | Supplemental watershed implementation plan developed for one recommended 12-digit HUC subwatershed | Number of implementation plans accepted                                     | All water quality criteria met in impaired stream reaches listed in final 303(d) list within recommended subwatersheds |
| Implement Management Strategies             | Controlled Access and Livestock Fencing (CALF) Initiative (Arkansas Association of County Conservation Districts, USFWS)   | 2015  | 2022 | Contract for management practices in at least one recommended 12-digit HUC subwatershed            | Miles of fenced streambank in recommended subwatersheds                     | Reduced streambank erosion, improved stream habitat, turbidity and pathogen water quality criteria met                 |
|   | EQIP General (NRCS)  | 2015  | 2022 | Contract for management practices in at least one recommended 12-digit HUC subwatershed            | Number of practices   | Turbidity and pathogen water quality criteria met  |
|   | Management practices in recommended 12-digit HUC subwatersheds (County Conservation Districts)   | 2018  | 2022 | Begin implementation of management practices identified in watershed implementation plan           | Implementation goals outlined in watershed implementation plan              | All water quality criteria met in impaired stream reaches listed in final 2008 and/or 2014 303(d) lists                |

Table 8.1. Implementation schedule (Continued).

| Activity  | Action (lead)   | Start | End  | Milestones (3-5 yrs)  | Indicator  | Long Term Goal   |
|---|---|-------|------|---|--|--|
| Evaluate  | Annual voluntary forestry BMP assessment (Arkansas Forestry Commission) | 2002  | 2050 | Two biennial surveys completed (2017 and 2020)                        | Published assessment reports   | Estimate and document extent of forestry BMP implementation, and identify areas to focus BMP education efforts   |
|   | Biennial water quality assessment (ADEQ)                                | 2016  | 2022 | EPA approved final 303(d) list post 2008                              | Attaining and nonattaining stream reaches in Lower Little River watershed  | All water quality criteria met in Lower Little River impaired stream reaches listed in final 2008 and/or 2014 303(d) lists   |
|   | Track implementation of BMPs in Lower Little River watershed (ANRC)     | 2017  | 2022 | Biennial report of implementation activities in watershed             | Linear feet/acres of BMPs implemented<br>Water quality improvement   | All water quality criteria met in Lower Little River impaired stream reaches listed in final 2008 and/or 2014 303(d) lists   |
| Update Lower Little River Watershed Management Plan | Public Meetings (Millwood Lake Focus Committee)                         | 2023  | 2023 | Organize public meetings  | Number of attendees  | Stakeholder input to watershed management planning   |
|   | Update Watershed Management Plan (Millwood Lake Focus Committee)        | 2023  | 2023 | Obtain implementation data from ANRC<br>Conduct evaluation activities | Updated watershed management plan completed<br>Recommended 12-digit HUC subwatersheds identified<br>Stakeholder relationships continued/improved | Maintain watershed management plan as a living document that reflects stakeholder interest and concerns related to improving water quality in the Lower Little River watershed |

### 8.3.1 Existing Surface Water Quality Monitoring Programs

ADEQ and USGS have active water quality monitoring programs in the Lower Little River watershed. These monitoring programs are described in Section 3.2.1.1. Table 8.2 lists water quality parameters monitored through these programs, which include the indicator parameters identified in Section 8.7. These programs will be continued.

The turbidity impaired Saline River stream segment that runs through the recommended subwatersheds (Starch Creek, Sand Creek, Blue Bayou, and Saline River – Millwood Lake) is monitored by ADEQ at station RED0021, located near the upper end of the segment. Station RED0021 is part of the ADEQ ambient monitoring network, and is sampled monthly.

Table 8.2. Water quality parameters being monitored in the Lower Little River watershed.

| Parameters           | ADEQ ambient | ADEQ lakes | ADEQ roving | USGS |
|----------------------|--------------|------------|-------------|------|
| Metals               | X            |            | X           |      |
| Dissolved Oxygen     | X            | X          | X           | X    |
| Turbidity            | X            |            | X           |      |
| Nutrients            | X            |            | X           | X    |
| TSS                  | X            | X          | X           |      |
| <i>E. coli</i>       |              |            | X           | X    |
| Alkalinity           | X            |            | X           |      |
| Minerals             | X            | X          | X           | X    |
| Temperature          | X            | X          | X           | X    |
| Conductivity         | X            | X          | X           | X    |
| pH                   | X            | X          | X           | X    |
| Hardness             | X            |            | X           | X    |
| Total organic carbon | X            |            | X           |      |

The pathogen impaired stream segments in the recommended subwatersheds Holly Creek and lower Mine Creek, are monitored by ADEQ at stations that are part of the ambient monitoring network. However, *E. coli* sampling is not included in the ADEQ ambient water quality monitoring program. Currently, ADEQ has no plans for *E. coli* sampling in the Lower Little River watershed (J. Wise, ADEQ, personal communication, 3/31/2016). *E. coli* sampling could be conducted through special studies or other programs discussed below.

### **8.3.2 Other surface Water Quality Monitoring Opportunities**

There are opportunities for expanding surface water quality monitoring in the Lower Little River watershed and recommended 12-digit HUC subwatersheds. Possibilities for additional water quality monitoring include special studies, sampling by volunteer stakeholders, and recommended supplemental watershed implementation plans.

#### **8.3.2.1 ADEQ Roving Monitoring Network**

ADEQ will be requested to assign at least one monitoring site in each HUC12 priority watershed during the next round of their roving monitoring network in the Lower Little River watershed. These data will assist in confirming which pollutants are contributing to water quality impairments and potential sources of these pollutants. For example, point source pollutants would be expected to have an inverse relationship with flow, particularly during the July – September low flow period. Although septic systems are not considered point sources, failing septic systems would also be expected to sustain pathogen loads during low flow periods. However, this is also expected if cattle have direct access to streams, particularly during low flow periods. Nonpoint source pollutants, particularly TSS and turbidity, would be expected to have a positive correlation with flow. Pathogen loads typically increase during and following storm events.

#### **8.3.2.2 Special Studies**

Synoptic surveys will be conducted with in-situ measurements of temperature, DO, conductivity and turbidity taken at the outlet of each of the recommended 12-digit HUC subwatersheds in the Lower Little River watershed. In addition, duplicate E.coli samples will be collected at these same sites. These surveys will be conducted once during elevated flow in the winter and during low flow in the summer. These synoptic surveys will help identify critical subareas within the watershed where sediment (turbidity) and pathogen loads are greater than would be expected on a strictly areal basis. These synoptic surveys can be conducted with volunteers from the subwatersheds as members of an AG&FC Stream Team, or contracted with a

local community college or university using students. Each 12-digit HUC subwatershed can easily be sampled within a day.

The Millwood Lake Focus Committee is considering a project to install automated water samplers on the Little River, Saline River, and Mine Creek (J. Stanton, Millwood Lake Focus Committee, personal communication 12/22/15).

### **8.3.2.3 Volunteer Monitoring**

The agencies that traditionally have conducted water quality monitoring in Arkansas face budgetary constraints that make it difficult to expand, or even maintain existing, water quality monitoring networks. Trained stakeholder volunteers are one option for expanding water quality monitoring while working within budgetary constraints. The Arkansas Game and Fish Commission Stream Team program trains and guides volunteers in water quality monitoring of streams. Volunteer water quality monitoring programs have been able to effectively contribute to evaluation of water quality in Northwest Arkansas (Massey and Haggard 2009). There is currently no southwest regional Stream Team coordinator, however, there is stakeholder interest in establishing stream teams in the Lower Little River watershed (Stakeholder meeting, 8/26/15, Ashdown).

### **8.3.2.4 Supplemental Watershed Implementation Plans**

Ultimately, monitoring is the only approach that can document load reductions and support of designated uses and water quality standards. ANRC will coordinate with ADEQ and other agencies, such as the Arkansas Game and Fish Commissions Stream Team, to monitor water quality as part of supplemental watershed implementation planning. A minimal in situ monitoring program for temperature, DO, conductivity, and turbidity will be established at a site downstream from areas where management practices are to be implemented. When possible, at least one year of monitoring data will be collected prior to implementing management practices. Monitoring will be established as soon as an implementation site has been identified, even if one full year of monitoring is not achievable. Monitoring will be re-initiated one year following completed implementation of the management practices and continued for 2 consecutive years.

Construction and transient effects have been observed up to a year following initiation of restoration, which confounds the analysis of practice effectiveness and efficiency. Monitoring will be discontinued for 2 consecutive years and then re-initiated during the 6<sup>th</sup> year after the completion of the management practices (Table 8.3). Where possible, an ADEQ roving monitoring site will be established downstream from the implementation site where a full suite of water quality constituents, including TSS and *E.coli* can be monitored and used to evaluate practice effectiveness and efficiency. Relationships among constituents, such as TSS and turbidity will be evaluated for use at similar sites where only in-situ monitoring might be feasible. For sites where recreational designated uses are impaired because of pathogens, at a minimum, duplicate *E. coli* samples will be collected each week for four consecutive weeks from mid-July to mid-August during the recreation season at each site monitored during each of the years noted above.

Table 8.3. Proposed schedule for BMP effectiveness monitoring.

| <b>Activity</b>                                       | <b>Duration</b> | <b>Overall time period</b> |
|---|-----------------|----------------------------|
| Pre-implementation monitoring                         | 1 year          | 1                          |
| BMP construction/<br>implementation                   | Variable        | 1+x                        |
| Transient effects from<br>construction/implementation | 1 year          | 2+x                        |
| Water quality monitoring                              | 2 years         | 4+x                        |
| No water quality monitoring                           | 2 years         | 6+x                        |
| Resume water quality monitoring                       | 1 year          | 7+x                        |

If funds are available, in-situ monitoring can be continuous throughout the 5 year period. Significant lag times can occur following implementation of BMPs before improvements are observed (Meals et al., 2010). The main components of lag time include the time required for an installed practice to produce an effect, the time required for the effect to be delivered to the water resource, the time required for the water body to respond to the effect, and the effectiveness of the monitoring program to measure the response (Meals et al., 2010). The magnitude of lag time is highly site and pollutant specific, but may range from months to years for relatively short-lived contaminants such as indicator bacteria, years to decades for excessive P levels in agricultural soils, and decades or more for sediment accumulated in river systems (Meals et al., 2010).

### **8.3.3 Existing Biological Monitoring Programs**

Existing biological monitoring occurring in the Lower Little River watershed is described in Section 3.2.3.1. The majority of biological monitoring in the watershed is occurring within the Ouachita National Forest.

### **8.3.4 Other Biological Monitoring Opportunities**

State universities have proposed biological surveys of streams in the Lower Little River watershed as recently as 2015 (AGFC 2015b). In addition, surveys of species of concern have been conducted on streams in the Lower Little River watershed by state and federal agencies and universities. There is the potential for these kinds of biological surveys to occur in the future in the watershed.

## 8.4 Information and Education

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

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

Outreach and Education programs by the Millwood Lake Citizen Focus Committee, Arkansas Department of Parks and Tourism, AGFC, USACE, USFWS, USFS, and NRCS, have been working toward achieving these objectives in the Lower Little River watershed for over 10 years. These organizations will continue to promote water quality management in the watershed. The Arkansas Department of Health, and water utilities, will also be promoting water quality protection and improvement in their districts. These organizations are both stakeholders and implementation partners. Since they have been active in the watershed in the past, these organizations have established relationships with landowners in the watershed, who are also stakeholders, as well as with each other.

Following is a discussion of past and on-going information and education activities in the Lower Little River watershed. County Conservation Districts and the Arkansas Forestry Commission have lead past information and education projects in the watershed. These programs engage landowners in the Lower Little River watershed, and will continue to do so. Table 8.4 provides a summary of outreach and education activities within the Lower Little River watershed.

Table 8.4. Summary of information and education activities within the Lower Little River watershed.

| Project/Program<br>(lead agency/ organization)  | Practices   |                               | Location   | Status   |
|---|---|-------------------------------|--|----------|
| 00-700-Water Quality Education and Environmental Training in the Lower Little River Watershed | Information not available   |                               | Hempstead, Howard, Little River, Sevier Counties                 | Complete |
| 03-153 TWQE Mini-grant (Little River Conservation District)                                   | Erosion demonstration and education in schools  | 4,000 students                | Foreman, Wikes, Ashdown, Nashville, Lockesburg                   | Complete |
|   | Demonstrations at festivals, fairs  | 4 events                      | Entire watershed   |          |
| 08-700 Arkansas Silvicultural Nonpoint Source Project (Arkansas Forestry Commission)          | Forestry BMP guidebook  |                               | Statewide  | Complete |
|   | Forestry BMP workshops  | 27 workshops<br>802 attendees |  |          |
|   | Forest landowner BMP workshops  | 6 workshops<br>318 attendees  |  |          |
|   | Forestry courtesy exams   | 12 sessions<br>81 people      |  |          |
| Annual voluntary forestry BMP assessment (Arkansas Forestry Commission)                       | Evaluation of random sampling of active or recently active forestry operations                    | Minimum of 200 sites          | Statewide  | On-going |
|   | Survey of private, non-industrial forestland owners   | 12                            |  |          |
| State Parks programs (Arkansas Department of Parks and Tourism)                               | Festivals, educational displays, brochures, websites  |                               | Cossatot River State Park, Millwood Lake State Park              | On-going |
| AGFC educational programs (AGFC)  | Brochures, websites, educational programs, conservation education center                          |                               | WMAs, Rick Evans Grandview Prairie Conservation Education Center | On-going |
| National Wildlife Refuge (USFWS)  | Educational programs, visitors center, information kiosks, interpretive trail, brochures, website |                               | Pond Creek NWR   | On-going |
| Ouachita National Forest (USFS)   | Educational programs, brochures, interpretive areas, website                                      |                               | Ouachita National Forest   | On-going |
| Stakeholder meeting (ANRC, U of A Cooperative Extension Service, U of A Public Policy Center) | Watershed stakeholder meeting   |                               | Arkansas nonpoint source priority watersheds                     | planned  |
| Extension service information programs  | Website, brochures  |                               | Statewide  | On-going |
| Interest groups   | Newsletters, websites, conferences, meetings  |                               |  | On-going |

### **8.4.1 Previous Information and Education Efforts**

Examples of information and education activities that have been occurring in the Lower Little River watershed since preparation of the watershed restoration action strategy are summarized in Table 8.4. Organizations that have been involved in these efforts include County Conservation Districts and the Arkansas Forestry Commission.

### **8.4.2 Existing and Planned Information and Education Efforts**

There are a number of agencies and organizations that have on-going information and education programs within the Lower Little River watershed. Examples of federal and state programs are shown in Table 8.4 and discussed below. In addition, there are interest groups that provide information and education to stakeholders within the watershed. These activities will continue into the future.

#### **8.4.2.1 US Fish and Wildlife Service**

The USFWS conducts outreach and education for local landowners and the public at large through the Pond Creek NWR. The NWR visitor center includes educational displays and information about the refuge and the habitats surrounding it. In addition, there are two information kiosks located in the refuge where information and brochures about the refuge are available. There are also two interpretive trails on the refuge (USFWS 2014c).

#### **8.4.2.2 US Forest Service**

There is one Ouachita National Forest recreation area in the Lower Little River watershed that includes interpretive areas for outdoor learning, Shady Lake.

#### **8.4.2.3 University of Arkansas Cooperative Extension Service**

The University of Arkansas Cooperative Extension Service has hosted a series of public meetings in nonpoint source priority watersheds. The purpose of these meetings is to offer a forum for watershed residents to identify issues and discuss solutions, with the idea of stirring interest in watershed planning and management practice implementation. One of these meetings is planned for the Lower Little River watershed.

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#### **8.4.2.4 Arkansas Game and Fish Commission**

Information and education are part of the mission of the AGFC. This mission is fulfilled through a number of educational programs, a bi-monthly magazine, a website, and nature and education centers. The Rick Evans Grandview Prairie Conservation Education Center is located in the Lower Little River watershed, east of Millwood Lake. Education available at this center includes programs on the blackland prairies of the area, wildlife of the area, and fishing and hunting (AGFC 2015a).

#### **8.4.2.5 Arkansas Department of Parks and Tourism**

Outreach and education are missions of the Arkansas state park system. There are two state parks in the Lower Little River watershed; Cossatot River State Park, and Millwood Lake State Park. Interpretive programs at both of these parks teach about the natural resources of the Lower Little River watershed.

#### **8.4.2.6 Interest Groups**

There are a number of interest groups active in the Lower Little River watershed, including Agricultural interest groups such as the Arkansas Farm Bureau, Arkansas Grazing Lands Coalition, and Arkansas Forage and Grasslands Council; Forestry interest groups; Audubon Arkansas; and the Millwood Lake Citizen Focus Committee. These organizations provide information to their constituents through a variety of means including websites, newsletters, and annual conferences.

At a February 2016 stakeholder meeting, stakeholders agreed to pursue continued interaction with the Millwood Lake Focus Committee or establish a new 501(c3) organization for implementation of this plan. There was particular interest expressed by the water utilities that obtain their raw drinking water from, or downstream of, Millwood Lake. Continued interaction with the Millwood Lake Focus Committee, Conservation Districts in the watershed, and the AR Health Department (drinking water utilities) is expected.

## **8.5 Supplemental Watershed Implementation Plans**

The process of developing a watershed implementation plan can increase the implementation of voluntary management practices by encouraging stakeholder buy-in and leveraging technical and financial resources. Locally developed watershed implementation plans are envisioned as the mechanism for implementing management practices in the Lower Little River recommended subwatersheds. These plans will include more specific information about pollutant sources that exist, and how these sources will be addressed by management practices.

Watershed implementation plans are required under the Clean Water Act for waterbodies for which TMDLs have been completed. Therefore, watershed implementation plans are needed to address the pathogen impairments in Mine Creek and Holly Creek subwatersheds. The purpose of these plans is to provide a road map for how the water quality will be improved so that it meets state water quality standards.

A supplemental watershed implementation plan (WIP) will be prepared for each recommended 12-digit HUC subwatershed watershed in the Lower Little River and incorporated in this Watershed-Based Management Plan. The WIP will emphasize the management practices, pollutants, and sources that are being targeted within the subwatershed. Estimates of the TSS and pathogen load reductions expected through implementation of management practices will be included. ANRC will coordinate with the NRCS and Conservation Districts to track management practices implemented through the NRCS EQIP, FSA Conservation Reserve, Conservation Reserve Enhancement and similar programs to reduce pollutant loads. ANRC also coordinates with other organizations such as Ducks Unlimited, The Nature Conservancy, and other agencies such as the US Fish and Wildlife Service and Arkansas Game and Fish Commission and will track their efforts at restoring stream and wetland habitat that also contribute to pollutant load reductions and increased aquatic assimilation capacity. Each participating organization/agency will be requested to provide information to ANRC on evaluated or monitored pollutant load reductions within the recommended 12-digit HUC subwatersheds to supplement the Lower Little River Watershed-Based Management Plan.

## 8.6 Implement Management Strategies

Management strategies that are recommended and planned, for the recommended 12-digit HUC subwatersheds are discussed in Section 7. A summary of these strategies along with the priority pollutants and sources they address is given in Table 8.5.

Table 8.5. Management strategies for the Lower Little River watershed.

| Strategy  | Streambank Erosion | Sheet/rill/wind, gully erosion | Pathogens |
|---|--------------------|--------------------------------|-----------|
| Fencing   | X                  |                                | X         |
| Alternative water supply  | X                  |                                | X         |
| Heavy use area treatment  |                    | X                              |           |
| Prescribed grazing  | X                  | X                              | X         |
| Controlled stream access  | X                  |                                | X         |
| Riparian buffers  | X                  | X                              | X         |
| Streambank stabilization/<br>restoration                                      | X                  |                                |           |
| Training on erosion control<br>practices for unpaved roads                    | X                  | X                              |           |
| Forestry BMPs (streamside<br>management zones, stream<br>crossing, road BMPs) | X                  | X                              |           |
| Pasture planting  |                    | X                              | X         |
| Filter strips   |                    | X                              | X         |
| Stacking sheds  |                    |                                | X         |
| Conservation plans  | X                  | X                              | X         |
| Nutrient management plans   |                    |                                | X         |

## **8.7 Evaluation**

Evaluation is a required activity for adaptive watershed management. The evaluation framework outlined below considers three major elements of the implementation of a watershed-based plan: program inputs, outputs, and outcomes. These elements will be evaluated for information/education, monitoring, and implementation of management practices. The Millwood Lake Focus Committee will be responsible for evaluation of the watershed management plan in 2023. ANRC will provide information they have collected about implementation activities to the Millwood Lake Focus Committee for their evaluation.

### **8.7.1 Inputs**

The inputs for implementation of this plan are the assistance programs available, and stakeholder participation. Indicators that measure this component of the plan implementation are listed in Table 8.6. The stakeholders and organizations that participate in implementation of this plan will provide the ANRC with annual totals for these inputs indicators for the period 2017 through 2022 by April 2023.

### **8.7.2 Outputs**

The outputs for implementation of this plan are development of supplemental watershed implementation plans, implementation of nonpoint source management practices, information and education, and monitoring. Indicators that measure this component of the plan implementation are listed in Table 8.7. The stakeholders and organizations that participate in implementation of this plan will provide ANRC with annual totals for these indicators for the period 2017 through 2022 by April 2023

Table 8.6. Indicators of inputs for implementation of this watershed management plan.

| Implementation Task            | Activity  | Indicators  |
|--------------------------------|---|---|
| Monitoring                     | Monitoring  | Resources spent on monitoring in Lower Little River watershed<br>Hours and number of personnel involved   |
| Information/Education          | Public meeting to discuss nonpoint source pollution in Lower Little River watershed (Cooperative Extension Service) | Number of attendees<br>Resources spent on public meeting and summary<br>Hours and number of people involved   |
|                                | Informational booth at County fairs (Millwood Lake Focus Committee)   | Number of people visiting booths<br>Hours and number of people involved in manning booths   |
|                                | Arkansas grazing lands conference (Arkansas Grazing Lands Coalition)  | Number of conference attendees from Lower Little River watershed  |
|                                | Annual Forestry and Land Judging Contest (Howard & Pike County Conservation Districts)                              | Number of contestants from Lower Little River watershed<br>Hours and number of people involved<br>Cost  |
|                                | Field Days (Conservation Districts)   | Number of attendees<br>Hours and number of people involved<br>Cost  |
|                                | Water bill brochures (water utilities)  | Hours and number of people involved<br>Cost   |
|                                | Presentations to interest groups (Millwood Lake Focus Committee)  | Number of attendees<br>Hours and number of people involved<br>Cost  |
| Implement management practices | Assistance programs in the lower Little River watershed   | Resources distributed to Lower Little River watershed<br>Hours and number of people assisting stakeholders in Lower Little River watershed<br>Number of Lower Little River watershed stakeholders requesting assistance |

Table 8.7. Indicators of outputs of implementation of this watershed management plan.

| Implementation Task            | Activity  | Indicators   |
|--------------------------------|---|--|
| Monitoring                     | Monitoring  | Number of active water quality monitoring stations<br>Number of turbidity/sediment data collected<br>Number of <i>E. coli</i> data collected<br>Number of biological surveys |
| Information/Education          | Public meeting to discuss nonpoint source pollution in Lower Little River watershed (Cooperative Extension Service) | Meeting held<br>Meeting summary published/distributed  |
|                                | Informational booth at County fairs (Millwood Lake Focus Committee)   | Number of fairs attended   |
|                                | Arkansas grazing lands conference (Arkansas Grazing Lands Coalition)  | Number of conferences  |
|                                | Annual Forestry and Land Judging Contest (Howard & Pike County Conservation Districts)                              | Number of contests   |
|                                | Field Days (Conservation Districts)   | Number of field days   |
|                                | Water bill brochures (water utilities)  | Number of brochures distributed  |
|                                | Presentations to interest groups (Millwood Lake Focus Committee)  | Number of presentations<br>Number of interest groups visited   |
| Implement management practices | Assistance programs in the lower Little River watershed   | Number/amount of management practices implemented<br>Number of contracts/projects started and finished   |

### 8.7.3 Outcomes

The intended outcomes for this watershed-based management plan include improvement in water quality, and increased awareness of and interest in water quality concerns of the Lower Little River watershed. The long term goal of this watershed based plan is that impaired waterbodies in the Lower Little River watershed will meet water quality criteria and attain their designated uses. The primary indicators for this goal are turbidity and *E. coli* levels. Secondary indicators are indicators of biological integrity, including the condition of populations of endangered mussels and fish. These are the parameters that will be monitored to allow for evaluation of the overall effectiveness of nonpoint source pollution management within the Lower Little River watershed. Within the next three to five years, the goal of this plan is to reduce the percentage of turbidity and *E. coli* measurements that exceed applicable state water quality criteria.

The monitored waterbodies in the Lower Little River watershed are assessed by ADEQ every two years to develop the Arkansas integrated water quality assessment report, which includes the 303(d) list of impaired waterbodies. Progress toward achieving the goal of improved water quality will be evaluated during the Arkansas biennial integrated water quality assessment.

Implementation of this plan will be considered successful if:

- A watershed implementation plan has been developed and implemented for at least one recommended 12-digit HUC subwatershed by 2021,
- By 2022, the percentage of *E. coli* criteria exceedances at stations RED0018B and RED0034B have decreased from the percentage during the 2008 integrated water quality assessment,
- By 2024, the percentage of turbidity criteria exceedances at station RED0021 has decreased from the percentage during the 2014 integrated water quality assessment, and
- Populations of Rabbitsfoot mussel and endemic fisheries remain stable or increase.

If these criteria are not satisfied, the management approaches, scientific knowledge, and stakeholder knowledge and opinions in the recommended subwatersheds will be re-evaluated and management elements adjusted accordingly. This evaluation will take into account the fact that it can take more than five years, or even decades, before water quality improvements resulting from implementation of management measures become apparent (Meals et al. 2010). The time period required to see significant changes in water quality is, in part, a function of how close to management activities water quality is measured.

## **8.8 Update Watershed Management Plan**

Development of the supplemental implementation plans for the recommended 12-digit HUC subwatersheds will be part of the update of this watershed management plan. The Millwood Lake Focus Committee will be responsible for preparing a comprehensive update of this watershed management plan in 2023.

This update will consider and address the following information.

- Results of the evaluation of the implementation of this plan, described in Section 8.7,
- Relevant information about the Lower Little River system and how it works, nonpoint source management practices, and pollutant sources in the watershed that has been developed since 2016,
- Changes in water quality related issues in the watershed,
- Changes in water quality management assistance programs, and
- Changes in land use, industry, population, and/or economy in the watershed.

The Millwood Lake Focus Committee will prepare a summary of the evaluation of implementation of the previous plan and changes in the watershed over the period since completion of the previous watershed management plan. This summary will be presented at one or more public stakeholder meetings. At this meeting(s), stakeholders will provide input on adjustments to management of and/or goals for the Lower Little River watershed. This may include a focus on management in other 12-digit HUC subwatersheds for water quality improvement or protection.

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The Millwood Lake Focus Committee will prepare a draft update of this watershed management plan utilizing the information from the implementation evaluation and the public meeting(s), and any other information it deems appropriate. This update will also be presented at one or more public stakeholder meetings to elicit feedback. The final update of the watershed management plan will then be prepared, incorporating stakeholder comments. A copy of this final update will be provided to ANRC to maintain eligibility for nonpoint source funding assistance for work in the Lower Little River watershed.

## 9.0 COSTS, BENEFITS, AND ASSISTANCE

This section discusses costs that will be associated with implementation of this watershed management plan, the economic and environmental benefits of implementing this plan, and technical and funding assistance that is available for implementing this plan.

### 9.1 Cost

The cost information provided below are estimates. Actual costs may differ from those given below for a variety of reasons.

#### 9.1.1 Monitoring

Estimated costs for synoptic surveys (Section 8.3.2.2) are \$5,000 for two in-situ monitors, and \$5,000 for personnel to collect and enter the information into [www.arkansaswater.org](http://www.arkansaswater.org). The *E. coli* samples would be transported to a commercial laboratory for incubation and analysis within the 8 hour holding time requirements. Estimated cost for *E. coli* analyses is \$4,000.

The cost of monitoring effects of management practices (Section 8.3.2.4) can vary from the cost of in-situ instrumentation with volunteer monitoring through the AG&FC Stream Team or similar volunteer arrangement (approximately \$5,000 for an in-situ instrument with four parameters plus a backup instrument) to \$40,000-50,000 per year for the USGS to monitor the site. *E. coli* analyses are estimated at \$4,000 per year if volunteers collect samples.

#### 9.1.2 Supplemental Watershed Implementation Plans

Estimated costs for preparing watershed implementation plans to supplement the Lower Little River Watershed-Based Management Plan, is \$15-20,000 for each recommended 12-digit HUC subwatershed.

### 9.1.3 Estimated Cost of Nonpoint Source Pollution Reduction

The cost of implementing management practices to reduce nonpoint source pollution can be variable, depending on materials markets, site conditions (e.g., slope, soil type), and location within the subwatershed. Table 9.1 lists available cost information for management practices identified in Section 7. Costs shown in Table 9.1 are the 2015 funding allocations specified for the NRCS Arkansas EQIP. While these allocations do not necessarily reflect the actual cost of implementing the practice, they provide an idea of relative costs of management practices.

Table 9.1. Cost information for selected management practices for the Lower Little River watershed.

| Pollutant Source        | Practice  | Estimated Unit Cost   |
|-------------------------|---|---|
| Streambank erosion      | Stream exclusion (Fencing + alternative water supply) | Fence: \$0.86 - \$1.49 / ft<br>Pipeline: \$0.91 - 2.46/ft<br>Pond: \$2.06 - \$3.33 / cu yd<br>Pumping plant: \$120 - \$5,000<br>Watering facility: \$0.80 - \$2.41/gal<br>Well: \$10 - \$88 /ft |
|                         | Alternative water supply                              |   |
|                         | Controlled stream access                              | Fence: \$0.86 - \$1.49 / ft   |
|                         | Riparian buffer                                       | \$170 - \$278/ac  |
|                         | Streambank stabilization/ restoration                 | \$7.47 - \$107.45 / ft  |
| Sheet/rill/wind erosion | Stream crossing                                       | \$10.77 / sq ft   |
|                         | Pasture planting                                      | \$188 - \$257 /ac   |
|                         | Filter and buffer strips                              | \$66 - \$468 /ac  |
|                         | Heavy use area treatment                              | \$0.45 - \$2.02 /sq ft  |
| Manure management       | Prescribed grazing                                    | \$20.89 - \$64.95/ac  |
|                         | Nutrient management plan                              | \$3.77 - \$27.01 /ac  |

Table 9.2 provides examples of potential costs for implementation of selected management practices for which cost information is readily available, to reduce target nonpoint source pollutants in the recommended 12-digit HUC subwatersheds. These examples illustrate relative costs to achieve a 55% TSS load reduction using different management practices. The practice amounts used to calculate these costs are taken from table 7.9. Bank stabilization is the most expensive practice for reducing streambank erosion sediment loads. Pasture planting is the most expensive practice for reducing pasture erosions sediment loads.

Table 9.2. Estimates of relative costs for implementing management practices to reduce TSS load 55% in recommended 12-digit HUC subwatersheds of the Lower Little River.

| Practice                 | Assumed unit cost                              | Sand Creek – Saline River                 |             | Starch Creek – Saline River                 |              | Blue Bayou – Saline River                   |             | Saline River – Millwood Lake              |             |
|--------------------------|--|---|-------------|---|--------------|---|-------------|---|-------------|
|                          |  | Amount                                    | Total cost  | Amount                                      | Total cost   | Amount                                      | Total cost  | Amount                                    | Total cost  |
| Bank stabilization       | \$100/ft                                       | 50,000 ft                                 | \$5,000,000 | 110,000 ft                                  | \$11,000,000 | 52,000 ft                                   | \$5,200,000 | 82,000 ft                                 | \$8,200,000 |
| 50 ft riparian buffer    | \$200/ac                                       | 50,000 ft                                 | \$11,400    | 110,000 ft                                  | \$25,200     | 52,000 ft                                   | \$12,000    | 82,000 ft                                 | \$18,800    |
| Pasture stream exclusion | \$1.49/ft for fence, \$1,000/watering facility | 27,000 ft fence<br>27 watering facilities | \$67,230    | 240,000 ft fence<br>240 watering facilities | \$594,600    | 140,000 ft fence<br>140 watering facilities | \$345,600   | 91,000 ft fence<br>91 watering facilities | \$226,600   |
| Pasture planting         | \$200/ac                                       | 180 ac                                    | \$36,000    | 1,420 ac                                    | \$284,000    | 1,000 ac                                    | \$200,000   | 570 ac                                    | \$114,000   |
| Prescribed grazing       | \$40/ac  | 180 ac                                    | \$7,200     | 1,390 ac                                    | \$55,600     | 990 ac                                      | \$39,600    | 560 ac                                    | \$22,400    |
| Filter strips            | \$250/ac                                       | 22 ac                                     | \$5,500     | 200 ac                                      | \$50,000     | 120 ac                                      | \$30,000    | 76 ac                                     | \$19,000    |

## 9.2 Estimated Economic and Environmental Benefits

There are costs associated with implementing best management practices, as noted in Section 9.1. However, there are also economic and environmental benefits associated with these management practices, both to the landowner and to downstream users. Benefits that humans receive from nature are called ecosystem services. Ecosystem services include goods or products (provisioning services) that typically have market value, such as timber production, commercial fisheries, agricultural production, and biochemical extracts. In addition, there are other services and benefits provided by ecosystems that are not as easy to value economically, but are critical to our quality of life, including regulating services such as erosion control, improved air and water quality through contaminant removal, and pollination; supporting services such as soil moisture retention, nutrient cycling, and soil formation; and cultural services such as fishing, bird watching, and wildflowers that provide aesthetic pleasure. Additional examples of ecosystem services are listed in Table 9.3.

Best management practices proposed for the Lower Little River subwatersheds are listed in Table 9.4 along with the benefits that accrue from the implementation of these BMPs. While not all these benefits have directly marketable economic value, there have been economic assessments of several of them. For example, excluding cattle from streams, providing alternative water supplies, and rotational grazing have resulted in increased cattle production, which has a direct economic value. Alternative water supply alone was documented to improve production in steers and heifers from 0.6 to 1.8 lb/day through reduction in foot rot, bovine virus diarrhea, fever, tuberculosis, and environmental mastitis (Faulkner 2000, Zeckoski et al. 2007). In Missouri, beef cattle raised and finished on high quality pasture through prescribed grazing had an average daily gain of 2 or more pounds and reached marketable weight within 20 months (NRCS 2006). One of the hazards for stream exclusion in the Lower Little River watershed is flooding, which can destroy fences, requiring repeated replacement. GPS-enabled ear tags, currently being researched at the USDA Jornada Experimental Rangeland, will, in the near future, eliminate the need for actual fences, reduce the effects of flooding on stream exclusion, and reduce the time required to move cattle from one area to another (<http://www.ediblegeography.com/invisible-fences-an-interview-with-dean-anderson-2/>)

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Table 9.3. Environmental benefits and ecosystem services associated with increased soil health and best management practices.

| Ecosystem service or environmental benefit | Description  |
|--|--|
| Contaminant removal                        | Contaminants (sediment, nutrients (N, P), heavy metals, pesticides) sorbed onto soils, chelated by organic matter, or filtered from runoff, or taken up by vegetation, reducing contaminant loading/concentrations in receiving waterbodies.   |
| Erosion control                            | Vegetation, soil cover, or impounded water reduces impacts of rainfall in disrupting soil particles and/or reducing soil transport in runoff, including settling in impounded water, to receiving waterbodies.                                 |
| Fish habitat                               | Riparian vegetation, organic debris reduce soil and bank erosion and provide structure in streams for fish and other aquatic organisms.  |
| Flood mitigation                           | Soil organic matter, vegetation, retain water, slow water flow, and attenuate peak flow to reduce flooding.  |
| Forage quality                             | Improved vegetative cover, soil organic matter, and nutrient cycling increase forage quality for grazing and increase animal production.   |
| Nutrient retention -cycling                | Nutrient retention and slow release to crops reduces fertilizer requirements and associated costs, improves yields and reduces nutrient loading to receiving waterbodies.  |
| Soil formation                             | Vegetation, no/reduced tillage, and mulch add organic matter to soils, increase infiltration, reduce compaction, and improve soil structure and soil health, for potential increased crop yields or animal production.                         |
| Soil moisture retention                    | Increased soil organic matter from vegetative cover or residue retains water and increases soil moisture. Each 1 percent increase in soil organic matter helps soils hold about 20,000 gallons more water per acre, reducing irrigation costs. |
| Timber production                          | Forested riparian buffers reduce soil/bank erosion, reduce nutrient and other contaminant loading, improve fish habitat , and provide harvestable timber for additional revenue.   |
| Water purification                         | Contaminate sorption, filtering through soils and vegetative/organic debris, and uptake improves water quality by purifying the water.   |
| Waterfowl habitat                          | Winter water retention, forested riparian buffers increase habitat for waterfowl and potential hunting leases.   |
| Wildflower/wildlife habitat                | Filter strips, buffers, riparian corridors, conservation reserves provide additional habitat for wildflowers, birds, and wildlife and can be leased for hunting.   |

Table 9.4. Benefits associated with implementing best management practices in the Lower Little River subwatersheds.

| Best Management Practice              | Contam. removal | Erosion control | Fish habitat | Flood mitig. | Forage qual. | Nut. reten. | Soil form. | Soil moist. | Timber prod. | Water purific. | Water-fowl | Wildlife-flower habitat |
|---------------------------------------|-----------------|-----------------|--------------|--------------|--------------|-------------|------------|-------------|--------------|----------------|------------|-------------------------|
| Bank stabilization/stream restoration | ●               | ●               | ●            | ●            |              | ●           |            |             |              | ●              | ●          | ●                       |
| Riparian buffer                       | ●               | ●               | ●            | ●            |              | ●           |            |             | ●            | ●              | ●          | ●                       |
| Stream exclusion                      | ●               | ●               |              | ●            | ●            | ●           | ●          | ●           |              | ●              |            | ●                       |
| Pasture planting                      | ●               | ●               |              | ●            | ●            | ●           | ●          | ●           |              | ●              |            | ●                       |
| Prescribed grazing                    | ●               | ●               |              | ●            | ●            | ●           | ●          | ●           |              | ●              |            | ●                       |
| Filter strips                         | ●               | ●               |              | ●            | ●            | ●           | ●          | ●           |              | ●              |            | ●                       |

Other ecosystem services have intrinsic environmental benefits and value that are more difficult to economically assess. An example of this type of benefit was documented on a Mississippi farm where filter strips were implemented. During a reconnaissance to assess the effectiveness of the filter strips, the farmer remarked that during the year he would sometimes just drive around the filter strips to look at the wildflowers. He said, “If you had told me that one of the major benefits of filter strips would have been wildflowers, I would have looked at you like you were nuts and walked away. But, I enjoy their beauty.” (Thornton, personal communication, 2011).

### **9.3 Technical Assistance**

#### **9.3.1 Monitoring**

Agencies and universities conducting water quality monitoring generally have their own technical resources. Technical assistance for volunteer water quality monitoring programs is available through the Arkansas Game and Fish Commission Stream Team Program.

#### **9.3.2 Information and Education**

Assistance with information and education activities is available through the ADEQ Public Outreach and Assistance Division, Watershed Conservation Resource Center, Cooperative Extension Service, and others. A number of resources are also available from EPA through the Nonpoint Source Outreach Toolbox (<http://cfpub.epa.gov/npstbx/index.html>).

The ADEQ Public Outreach and Assistance Division offers technical assistance and resources to interested citizens and groups. The Watershed Outreach and Education program of this division provides “a variety of tools and services to facilitate and promote awareness, appreciation, knowledge, and stewardship of water resources” (ADEQ 2015i).

#### **9.3.3 Supplemental Watershed Implementation Plans**

EPA has a watershed planning website with links to a number of resources to assist watershed management plan developers (<https://www.epa.gov/polluted-runoff-nonpoint-source-pollution/watershed-planning-builder-and-guides>).

### 9.3.4 Technical Assistance for Nonpoint Source Pollution Management

There are a number of sources for technical assistance for management strategies in recommended subwatersheds. These are summarized in Table 9.5 and discussed below.

Table 9.5. Sources of technical assistance for management strategies.

| Practice/<br>Strategy                       | County<br>Conservation<br>Districts | U of A<br>Cooperative<br>Extension | U of A<br>Experiment<br>Stations | AGFC | NRCS, FSA | EPA | USFWS | TNC | Arkansas<br>Forestry<br>Commission |
|---|-------------------------------------|------------------------------------|----------------------------------|------|-----------|-----|-------|-----|------------------------------------|
| Fencing                                     | X                                   | X                                  | X                                |      | X         |     |       | X   |                                    |
| Alternate water supply                      | X                                   | X                                  | X                                |      | X         |     |       | X   |                                    |
| Prescribed grazing                          | X                                   | X                                  | X                                |      | X         |     |       | X   |                                    |
| Riparian buffers                            | X                                   | X                                  | X                                |      | X         | X   | X     | X   |                                    |
| Streambank<br>stabilization/<br>restoration | X                                   | X                                  | X                                | X    | X         | X   | X     | X   |                                    |
| Stream crossing                             | X                                   |                                    | X                                |      | X         |     |       |     |                                    |
| Heavy use area<br>treatment                 | X                                   | X                                  | X                                |      | X         |     |       |     |                                    |
| Forage/biomass<br>planting                  | X                                   | X                                  |                                  |      | X         |     |       |     |                                    |
| Conservation plan                           | X                                   | X                                  |                                  |      | X         |     |       |     |                                    |
| Nutrient management<br>plan                 | X                                   | X                                  |                                  |      | X         |     |       |     |                                    |
| Forestry BMPs                               |                                     |                                    |                                  |      |           |     |       |     | X                                  |
| Filter strips                               | X                                   | X                                  | X                                |      | X         | X   |       |     |                                    |
| Buffer strips                               | X                                   | X                                  | X                                |      | X         | X   |       |     |                                    |
| Controlled stream<br>access                 | X                                   | X                                  | X                                |      | X         | X   |       |     |                                    |
| Implementation plan                         |                                     | X                                  |                                  |      | X         | X   |       | X   |                                    |

#### 9.3.4.1 County Conservation Districts

County Conservation Districts generally work closely with NRCS and other natural resources agencies to provide technical support to landowners, including information and guidance about management practices for protecting soil and water resources.

#### **9.3.4.2 University of Arkansas Cooperative Extension Service**

The University of Arkansas Cooperative Extension Service provides technical assistance through a range of programs and services including testing of manure, hay, soil, and water; assistance with rotational (prescribed) grazing, nutrition and feeding of livestock, and grassland management; and field days and on-farm demonstrations. Cooperative Extension Service also maintains an extensive library of up-to-date, research-based fact sheets, applied research publications, and best management practice manuals and guidelines.

#### **9.3.4.3 University of Arkansas Agricultural Experiment Station**

The experiment station program of the University of Arkansas Division of Agriculture generates, interprets, and distributes information and technology useful to farmers in Arkansas.

#### **9.3.4.4 NRCS**

The NRCS offers several programs to help landowners address natural resources concerns related to pasture management, including the Grazing Lands Conservation Initiative. NRCS grassland specialists can work with farmers on resource assessments of pastures to design effective grazing systems. All owners and managers of private grazing lands are eligible for NRCS technical assistance (NRCS 2015b).

#### **9.3.4.5 EPA**

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

#### **9.3.4.6 US Fish and Wildlife Service**

Through its Partners for Fish and Wildlife program the USFWS provides technical assistance to private landowners on projects to protect, improve, or restore native habitat. Habitat for endangered species is a priority for this program.

#### **9.3.4.7 Arkansas Game and Fish Commission**

The Arkansas Game and Fish Commission Stream Team program assists individuals with planning and implementing stream related projects, including streambank restoration and stabilization. The Stream Team staff deals routinely with streambank issues, providing assistance with planning, design, permitting, and finding funding.

### **9.4 Funding Assistance**

#### **9.4.1 Monitoring**

ADEQ's monitoring is self-funded. Much of the funding for the USGS monitoring program is provided by state and local cooperators. USGS flow and/or water quality monitoring sites could be added in the watershed if a local entity would provide funds.

ANRC can provide funding for water quality monitoring projects in the Lower Little River watershed through the nonpoint source program. In 2015, University researchers are seeking State Wildlife Grant funding from the AGFC for a fishery survey project in the Lower Little River watershed (AGFC 2015b). In 2015, AGFC received \$533,622 in State Wildlife Grants (AGFC 2015c). The AGFC Stream Team program can also provide funding for volunteer monitoring programs through mini-grants.

#### **9.4.2 Information/Education**

The ANRC nonpoint source program has provided funding assistance for past information and education projects in the Lower Little River watershed. All projects funded through the ANRC nonpoint source program (Section 319(h) funds) are required to include an education and outreach component.

Projects funded through USDA NRCS and FSA cost-share and easement programs are often used as demonstrations in NRCS and Conservation District outreach and education programs.

There are several private foundations that fund education, and which may fund environmental education. The EPA also provides grants for environmental education (<http://www2.epa.gov/education/environmental-education-ee-grants>).

### **9.4.3 Supplemental Watershed Implementation Plans**

The ANRC nonpoint source program has provided funding assistance for watershed planning in the past. It is possible that EPA will stipulate in the future that Section 319 funds be used only for implementation of management practices, not for watershed planning. However, state nonpoint source program funds will continue to be a source for assistance with the costs of watershed planning in the future. Other potential sources for funding assistance for watershed planning include private foundations, industries, and interest groups.

### **9.4.4 Funding Assistance for Nonpoint Source Pollution Management**

Over the years since the development of the Watershed Restoration Action Strategy for the Lower Little River watershed, funding assistance has been provided for implementation of management practices in the watershed. There are a number of agencies and programs that offer financial assistance for planning and implementation of nonpoint source pollution management practices in the Lower Little River watershed. The majority of these are grant programs, some of which require matching funds from the grant recipient. In addition, at least one tax incentive program is active that addresses practices that reduce nonpoint source pollution. Table 8.1 lists management practices for the recommended 12-digit HUC subwatersheds along with funding sources. The “\$” symbol indicates an active program from which funds are available for activities in the highly recommended subwatersheds (along with other areas of the Lower Little River watershed). Information about the amount allocated to activities in the highly recommended subwatersheds was either not obtained or not available. The funding sources shown in Table 9.6 are described below.

Table 9.6. Funding availability for management practices for the recommended 12-digit HUC subwatersheds.

| Practice/Strategy                     | NRCS EQIP General | FSA | CALF (USFWS, AACD) | USFWS Partners for Wildlife | EPA | ANRC | AGFC | TNC |
|---------------------------------------|-------------------|-----|--------------------|-----------------------------|-----|------|------|-----|
| Fencing                               | \$                |     | \$                 | \$                          |     | \$   |      | \$  |
| Alternate water supply                | \$                |     | \$                 |                             |     | \$   |      | \$  |
| Prescribed grazing                    | \$                |     |                    |                             |     | \$   |      | \$  |
| Riparian buffers                      | \$                | \$  | \$                 |                             | \$  | \$   | \$   | \$  |
| Streambank stabilization/ restoration | \$                |     |                    |                             | \$  | \$   | \$   | \$  |
| Heavy use area treatment              | \$                |     | \$                 |                             |     | \$   |      |     |
| Forage/biomass planting               | \$                | \$  | \$                 |                             |     | \$   |      |     |
| Conservation plan                     | \$                |     |                    |                             |     | \$   |      |     |
| Filter and Buffer strips              | \$                |     |                    |                             | \$  | \$   |      |     |
| Controlled stream access              | \$                |     | \$                 | \$                          | \$  | \$   |      |     |
| Stream crossings for livestock        | \$                |     | \$                 |                             |     | \$   |      |     |
| Easements                             |                   | \$  |                    |                             |     |      |      |     |

#### **9.4.4.1 NRCS and FSA**

There are NRCS programs active in Arkansas that provide funding assistance for development and installation of management practices that are applicable to the recommended 12-digit HUC subwatersheds of the Lower Little River. These programs provide funding to individuals rather than groups or organizations. This includes EQIP and the Agricultural Conservation Easement Program. With EQIP a cost-share is usually required. The Agricultural Conservation Easement Program pays up to 50% of the fair market value of the easement land (USFWS 2015b). Information about these programs, including cost-share requirements and funding caps, is available online (<http://www.ar.nrcs.usda.gov/programs/>) or from a local USDA service center, local conservation district, or local cooperative extension agents. The 2016 national budget for the EQIP program is \$1,350 million, and the budget for the Agricultural Conservation Easement Program is \$450 million (US Department of Agriculture 2015).. In 2014, \$800,000 was allocated to the Ouachita National Forest through the EQIP Western Arkansas Woodland Restoration initiative (NRCS 2014).

The FSA CRP pays a yearly rental payment to landowners in exchange for the removal of environmentally sensitive land from agricultural production, and planting species that improve environmental quality (FSA 2015). The 2016 national budget for CRP is \$1,834 million (US Department of Agriculture 2015).

#### **9.4.4.2 US Fish and Wildlife Service**

There are several USFWS programs active in the Lower Little River watershed that provide funding assistance for development and installation of nonpoint source pollution management practices. Funding is available for individuals through the USFWS Partners for Fish and Wildlife program, and the CALF program (in cooperation with the Arkansas Association of Conservation Districts). Funding from these programs may require cost-share. The national 2016 budget for the Partners for Fish and Wildlife program is \$54.2 million.

#### **9.4.4.3 EPA**

EPA has several programs that offer funding assistance for restoration and conservation projects that reduce nonpoint source pollution. One of these is the Clean Water Act Section 319 program, through which ANRC is provided funding for the Arkansas Nonpoint Source Program.

#### **9.4.4.4 ANRC**

ANRC manages the state Section 319 grant program. This program provides grants to non-profit groups, organizations and academic institutions for projects related to the reduction, control, or abatement of nonpoint source pollution. Matching contributions are required for these grants. Organizations seeking grants must be capable of implementing projects, and are typically required to provide a minimum of 43% non-federal matching contributions. In 2014, approximately \$1.9 million in federal funds were spent on nonpoint source pollution projects in Arkansas through the ANRC 319 grant program. Forty-six percent of these funds were spent on implementation of management practices, 29% on water quality monitoring, 18% on planning, and 7% on outreach related to nonpoint source pollution (ANRC 2015). There is no guarantee that this level of funding will be available in the future. The national budget for the Section 319 grant program is \$164,915 thousand (EPA 2015c). At this time, Section 319 funds may not be used for watershed planning. However, state funds are also used in the ANRC nonpoint source pollution prevention program. These funds can be used to assist with development of implementation plans for recommended subwatersheds.

ANRC administers several state and federal funding sources that may be used to fund water quality improvement and/or protection activities, in addition to the Section 319 grant program. Funds are available as grants and as low interest loans to a wide range of government and non-government organizations. Projects from \$5,000 up to \$50,000,000 have been funded in the past (<http://anrc.ark.org/divisions/water-resources-development/water-and-wastewater-funding/>).

#### **9.4.4.5 Arkansas Game and Fish Commission**

There are two AGFC programs that provide funding for activities included in the management measures of this plan. The AGFC Stream Team Mini-Grants can be used to fund stream clean-up and stream bank stabilization projects. State Wildlife Grants can be used to address habitat issues, such as erosion and sedimentation, that impact species of greatest conservation need.

#### **9.4.5 Non-government Organizations**

There are a number of non-government organizations that have funding assistance programs that address water quality. Examples include TNC and the Walton Foundation. These organizations can provide funding assistance for planning and implementation of management practices.

#### **9.4.6 Tax Incentives**

Tax incentives are a slightly different financial mechanism for encouraging the use of management practices. The Arkansas Private Wetland and Riparian Zone Creation, Restoration, and Conservation Tax Credits Act of 1995 allows the application of a tax credit against Arkansas state taxes by taxpayers involved in conservation or restoration of riparian zones. Detailed information on this program is available from ANRC, who manages the program (<http://anrc.ark.org/divisions/water-resources-management/wetlands-riparian-zone-tax-credit/>).

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# **APPENDIX A**

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**Sign in Sheets from WMP Stakeholder Meetings**

Lower Little River Watershed Management Plan  
Ashdown Meeting – April 6, 2015

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# MEETING SIGN-IN SHEET

Project: ARKANSAS WATERSHED PLAN Public Meeting

Meeting Date: 4-6-15

Facilitator:

Place/Room: Ashdown

| Name           | Organization or Occupation | Phone        | Mailing Address | E-Mail                         |
|----------------|----------------------------|--------------|-----------------|--------------------------------|
| Jim Williamson | Reporter                   |              |                 | J.Williamson@TERRACONN.GOV     |
| Mike Whelan    | AFC                        |              |                 | Michael.Whelan@ARKANSAS.GOV    |
| Jean Whelan    | MFC                        |              |                 |                                |
| Amy Kay        | Senior Justice             | 877-642-2428 |                 |                                |
| Bob Furdool    | TP Dist 9                  | 870-898-6803 |                 |                                |
| Steve Spicer   | US Army Corps of Eng       | 501-240-1458 |                 | Steven.E.Spicer@USACE.Army.mil |
| Jeff Taverner  | AGFC                       | 870 777 5580 |                 | Jeffrey.Taverner@agfc.ar.gov   |
| Greg Carter    | SWEPCO                     | 903-746-4585 |                 | wjcarter@aep.com               |
| Eric Brinkman  | AGFC                       | 870-777-5580 |                 | eric.brinkman@agfc.ar.gov      |
| Les Claybrook  | AGFC                       | 870-777-5580 |                 | Les.Claybrook@agfc.ar.gov      |
| Evelyn Kort    | ADH                        | 501 661 2890 |                 | evelyn.kort@arkansas.gov       |
| Gary Childress | NRCS                       | 870-898-3611 |                 | gary.childress@ar.usda.gov     |





Lower Little River Watershed Management Plan  
Ashdown Meeting – August 26, 2015

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# MEETING SIGN-IN SHEET

Project: ARKANSAS WATERSHED PLAN Public Meeting Meeting Date: 8-26-18  
 Facilitator: Ashdown Place/Room:

| Name           | Organization or Occupation | Phone        | Mailing Address                                  | E-Mail                        |
|----------------|----------------------------|--------------|--|-------------------------------|
| Jan Jenkins    | Millwood Focus Comm        | 898-2960     | Lakewood Place<br>114 <del>Classic</del> Ashdown | Classic140eArl.com            |
| Jim Stanton    | Millwood Focus Comm        | 898-3534     | 167 BREAM TR.                                    | GARDSTANTON@MAIL.SUN          |
| Dan Dalton     | Rancher                    | 878-289-3603 | 184 West Main                                    | Locksburg W Va                |
| Mike Craft     | LTC<br>Judge               | 870-555-7202 | 3 Ashdown  | Mike.Craft@arknet.com         |
| Jim Williamson | reporter                   |              |  | J.Williamson@Texarkana.org    |
| Barbara Ayers  | Painter                    | 870-898-2711 | 285 Hwy 71 South<br>Ashdown, AR 71822            | brandon.ayers@dotstar.com     |
| Rick Rodenroth | Doutan                     | 903-824-8745 | "  | richard.rodenroth@dotstar.com |
| Linda Walker   | CAPP                       | 903-293-0473 | P.O. Box 781 Ashdown                             | WalkerLinda@78ogmail.com      |
|                |                            |              |  |                               |
|                |                            |              |  |                               |
|                |                            |              |  |                               |
|                |                            |              |  |                               |
|                |                            |              |  |                               |

# MEETING SIGN-IN SHEET

Project: ARKANSAS WATERSHED PLAN Public Meeting

Meeting Date: 8-26-12

Facilitator:

Place/Room: Ashdown

| Name            | Organization or Occupation                    | Phone        | Mailing Address                     | E-Mail                      |
|-----------------|---|--------------|-------------------------------------|-----------------------------|
| Mike Whelan     | Ark Forestry Comm.                            | 870 828 1224 | P.O. Box 134<br>Dierks, AR 71833    | Michael.Whelan@arkansas.gov |
| Bob Fowler      | ANRC  | 501 626 0700 |                                     | Bob.Fowler@arkansas.gov     |
| SUSTIN TENDLEY  | ADRESSY LAKE<br>HEMPSTEAD COUNTY HUNTING CLUB | 903 556 7086 |                                     | jtendley18@gmail.com        |
| Doug Teale      | Douton  | 903-824-9365 | 285 Hwy 715, Ashdown, AR<br>71822   | douglas.teale@douton.com    |
| JOE PAUL STUART | Ext. Service                                  | 903-278-4718 | 1411 N. Constitution<br>Ashdown     | jstuart@uax.edu             |
| SPER SPICAR     | USACE   | 501-340-1458 | 1528 Hwy 32E                        | Sper.E.Spice@usace.army.mil |
| ELBERT BRADLEY  |   | 903-278-7186 | 627 E. 1st Ave<br>Foreman, AR 71836 | elbert.bradley@dad.com      |
| GARY CHILDRESS  | NLS   |              |                                     |                             |
|                 |   |              |                                     |                             |
|                 |   |              |                                     |                             |
|                 |   |              |                                     |                             |
|                 |   |              |                                     |                             |

Lower Little River Watershed Management Plan  
Ashdown Meeting – December 9, 2015

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**MEETING SIGN-IN SHEET**

Project: ARKANSAS WATERSHED PLAN Public Meeting Meeting Date: 12-9-15

Facilitator: Place/Room: Ashdown

| Name             | Organization or Occupation | Phone        | Mailing Address        | E-Mail                           |
|------------------|----------------------------|--------------|------------------------|----------------------------------|
| Jim Stefan       |                            |              |                        |                                  |
| Minnie Goodman   | WR Conservation            | 870-848-3611 |                        | Minnie. Goldman<br>@ AR.nacs.net |
| Melissa Lombardi | USFWS                      | 501-513-4488 |                        |                                  |
| Chris Davidson   | FWS                        | 501-513-4481 |                        |                                  |
| Les Claybrook    | AGFC                       | 870-245-7550 |                        |                                  |
| Steve Spicer     | USACE                      | 501-340-1458 |                        |                                  |
| Brandon Ayers    | DARTAR                     |              |                        |                                  |
| Cheryl Chalmers  | ArForesstry Comm           | 870-828-1225 |                        | Charles, Cholenda @ arkansas.gov |
| Bruce T Jackson  | Livestock Producer<br>FBI  | 870-582-2471 | Circle J @windstar.net | circlej@windstar.net             |
| James S. Hottel  | Mayor Ashdown              |              |                        | mayor@ashdownarkansas.org        |
| Jeff Taverner    | AGFC                       | 870-331-7653 |                        | Jeffrey.Taverner@agfc.ar.gov     |
| Fonda Hawthorne  | Little River Chamber       |              |                        | fonda.hawthorne@yahoo.com        |

Lower Little River Watershed Management Plan  
Ashdown Meeting – February 25, 2016

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# MEETING SIGN-IN SHEET

Project: ARKANSAS WATERSHED PLAN Public Meeting

Meeting Date: 2-25-16

Facilitator:

Place/Room: Ashdown Lower Little River

| Name                 | Organization or Occupation   | Phone          | Mailing Address                       | E-Mail  |
|----------------------|------------------------------|----------------|---------------------------------------|---|
| Billy Willis         | Hope Water Right             | 870-703-9606   | Po Box 2020 Hops, AR                  | bwillis@hope-wl.com                                       |
| Billy Willis         | NAAGHULCE                    | 870-845-9237   |                                       | BILL WILLIS & NASTAR, ORG                                 |
| Brandon Hall         | Arkansas Forestry Commission | 870-898-2304   | 1163 Hwy 108<br>Ashdown AR 71822      |   |
| Rick Rodenroth       | Dowstar                      | 903-824-8745   | 285 Hwy 71 South<br>Ashdown, AR 71822 |   |
| Gary Smith           | Twin                         | 903-798-3829   | 801 Wood St<br>Trenton, Tx            | 6 Smith Co Texas.org<br>Stephanie.Burchfield@arkansas.gov |
| Stephanie Burchfield | ADH                          | (501) 280-4428 |                                       | Samantha.pike@arkansas.gov                                |
| Sam Pike             | ADH                          |                |                                       |   |
| Richard Kesterson    | GILHAM LAKE                  | 870-582-4425   | Po Box 203<br>WICKES, AR              | RJ KESTERSON at Yahoo.com                                 |
| Gary Williams        | MLFC                         |                |                                       | garywilliams@mlfc.com                                     |
|                      |                              |                |                                       |   |
|                      |                              |                |                                       |   |
|                      |                              |                |                                       |   |
|                      |                              |                |                                       |   |



# **APPENDIX B**

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## **Water Quality Data Summary**

Table B.1. Surface water quality monitoring inventory.

| <b>Station ID</b> | <b>Monitoring Agency/ Organization</b> | <b>Waterbody</b>      | <b>Date of first sample</b> | <b>Date of most recent sample</b> | <b>Data source</b> |
|-------------------|--|-----------------------|-----------------------------|-----------------------------------|--------------------|
| BEL0001           | ADEQ                                   | Big Bellville Creek   | 7/23/1991                   | 10/30/1991                        | ADEQ database      |
| BLB0001           | ADEQ                                   | Blue Bayou            | 7/23/1991                   | 3/16/2009                         | ADEQ database      |
| BRI0001           | ADEQ                                   | Bridge Creek          | 7/23/1991                   | 3/16/2009                         | ADEQ database      |
| CEG0001           | ADEQ                                   | Cool Easy Creek       | 7/23/1991                   | 10/30/1991                        | ADEQ database      |
| COS0001           | ADEQ                                   | Cossatot River        | 7/23/1991                   | 8/20/2002                         | ADEQ database      |
| COS0003           | ADEQ                                   | Cossatot River        | 7/23/1991                   | 8/20/2002                         | ADEQ database      |
| DIL0001           | ADEQ                                   | Dillard Creek         | 7/23/1991                   | 8/20/2002                         | ADEQ database      |
| LCO001            | ADEQ                                   | Little Cossatot River | 8/1/2000                    | 3/16/2009                         | ADEQ database      |
| LRED008A          | ADEQ                                   | Millwood Lake         | 8/2/1999                    | 4/6/2015                          | ADEQ database      |
| LRED008B          | ADEQ                                   | Millwood Lake         | 8/2/1999                    | 4/6/2015                          | ADEQ database      |
| LRED009A          | ADEQ                                   | Lake DeQueen          | 8/3/1999                    | 6/30/2015                         | ADEQ database      |
| LRED009B          | ADEQ                                   | Lake DeQueen          | 8/2/1999                    | 6/30/2015                         | ADEQ database      |
| LRED010A          | ADEQ                                   | Gillham Lake          | 8/2/1999                    | 6/30/2015                         | ADEQ database      |
| LRED010B          | ADEQ                                   | Gillham Lake          | 3/16/2011                   | 6/30/2015                         | ADEQ database      |
| LRED011A          | ADEQ                                   | Dierks Lake           | 8/3/1999                    | 5/12/2015                         | ADEQ database      |
| LRED011B          | ADEQ                                   | Dierks Lake           | 8/3/1999                    | 5/12/2015                         | ADEQ database      |
| MES0001           | ADEQ                                   | Messers Creek         | 7/23/1991                   | 8/20/2002                         | ADEQ database      |
| MIN0001           | ADEQ                                   | Mine Creek            | 7/23/1991                   | 5/12/1992                         | ADEQ database      |
| MIN0002           | ADEQ                                   | Mine Creek            | 7/23/1991                   | 8/20/2002                         | ADEQ database      |
| PLM0001           | ADEQ                                   | Plum Creek            | 7/23/1991                   | 3/16/2009                         | ADEQ database      |
| RED0002           | ADEQ                                   | Little River          | 9/4/1990                    | 12/16/2014                        | ADEQ database      |
| RED0018B          | ADEQ                                   | Mine Creek            | 4/22/1997                   | 1/6/2015                          | ADEQ database      |

Table B.1. Surface water quality monitoring inventory (continued).

| Station ID | Monitoring Agency/ Organization | Waterbody                                | Date of first sample | Date of most recent sample | Data source   |
|------------|---------------------------------|--|----------------------|----------------------------|---------------|
| RED0021    | ADEQ                            | Saline River                             | 1/22/1991            | 1/6/2015                   | ADEQ database |
| RED0022    | ADEQ                            | Cossatot River                           | 1/22/1991            | 1/6/2015                   | ADEQ database |
| RED0023A   | ADEQ                            | Rolling Fork River                       | 1/22/1991            | 1/6/2015                   | ADEQ database |
| RED0030    | ADEQ                            | Rolling Fork River                       | 1/22/1991            | 1/6/2015                   | ADEQ database |
| RED0031    | ADEQ                            | Cossatot River                           | 10/2/1990            | 1/6/2015                   | ADEQ database |
| RED0032    | ADEQ                            | Saline River                             | 9/4/1990             | 1/6/2015                   | ADEQ database |
| RED0033    | ADEQ                            | Bear Creek                               | 9/4/1990             | 1/6/2015                   | ADEQ database |
| RED0033B   | ADEQ                            | Bear Creek                               | 10/14/1997           | 9/25/2007                  | ADEQ database |
| RED0033C   | ADEQ                            | Bear Creek                               | 2/14/2011            | 11/28/2011                 | ADEQ database |
| RED0033D   | ADEQ                            | Bear Creek                               | 2/14/2011            | 11/28/2011                 | ADEQ database |
| RED0034A   | ADEQ                            | Holly Creek                              | 9/4/1990             | 1/6/2015                   | ADEQ database |
| RED0034B   | ADEQ                            | Holly Creek                              | 9/4/1990             | 1/6/2015                   | ADEQ database |
| RED0048A   | ADEQ                            | Mine Creek                               | 9/3/1997             | 11/28/2011                 | ADEQ database |
| RED0048B   | ADEQ                            | Mine Creek                               | 9/3/1997             | 1/6/2015                   | ADEQ database |
| RED0049    | ADEQ                            | Tyson Effluent                           | 9/3/1997             | 9/22/1998                  | ADEQ database |
| RED0051    | ADEQ                            | City of Nashville Effluent               | 9/3/1997             | 2/14/2011                  | ADEQ database |
| RED0051A   | ADEQ                            | Mine Creek                               | 9/3/1997             | 11/28/2011                 | ADEQ database |
| RED0051B   | ADEQ                            | Mine Creek                               | 9/3/1997             | 11/28/2011                 | ADEQ database |
| RED0052    | ADEQ                            | Coleman Creek                            | 9/3/1997             | 11/28/2011                 | ADEQ database |
| RED0053    | ADEQ                            | Brushy Creek                             | 6/23/1998            | 6/23/1998                  | ADEQ database |
| RED0058    | ADEQ                            | Rolling Fork River                       | 3/27/2000            | 1/6/2015                   | ADEQ database |
| RED0059    | ADEQ                            | Rolling Fork River                       | 2/14/2011            | 11/28/2011                 | ADEQ database |
| RED0061    | ADEQ                            | Tyson Effluent (into Rolling Fork River) | 2/14/2011            | 11/28/2011                 | ADEQ database |

Table B.1. Surface water quality monitoring inventory (continued).

| <b>Station ID</b> | <b>Monitoring Agency/ Organization</b> | <b>Waterbody</b> | <b>Date of first sample</b> | <b>Date of most recent sample</b> | <b>Data source</b> |
|-------------------|--|------------------|-----------------------------|-----------------------------------|--------------------|
| RED0063           | ADEQ                                   | Pond Creek       | 7/17/2007                   | 3/16/2009                         | ADEQ database      |
| RED0064           | ADEQ                                   | Walnut Bayou     | 5/30/2007                   | 3/16/2009                         | ADEQ database      |
| RED0068           | ADEQ                                   | Robinson Creek   | 2/14/2011                   | 11/28/2011                        | ADEQ database      |
| RSS0001           | ADEQ                                   | Sulphur Slough   | 7/23/1991                   | 11/27/2001                        | ADEQ database      |
| SAL0001           | ADEQ                                   | Saline River     | 7/23/1991                   | 11/27/2001                        | ADEQ database      |
| SAL0003           | ADEQ                                   | Saline River     | 7/23/1991                   | 8/20/2002                         | ADEQ database      |
| NLA06608-0500     | EPA                                    | Gillham Lake     | 9/14/2007                   | 9/14/2007                         | STORET             |
| NLA06608-1288     | EPA                                    | Millwood Lake    | 8/27/2007                   | 8/27/2007                         | STORET             |
| OWW04440-0021     | EPA                                    | Bell Brook       | 7/14/2004                   | 7/14/2004                         | STORET             |
| 7340000           | USGS                                   | Little River     | 4/6/1978                    | 11/30/1978                        | NWIS               |
| 7340290           | USGS                                   | Brushy Creek     | 5/2/1984                    | 7/12/1984                         | NWIS               |
| 7340300           | USGS                                   | Cossatot River   | 8/18/1967                   | 2/11/2015                         | NWIS               |
| 7340500           | USGS                                   | Cossatot River   | 7/1/1938                    | 12/16/1947                        | NWIS               |
| 7340595           | USGS                                   | Little River     | 9/7/1930                    | 11/1/1930                         | NWIS               |
| 7341000           | USGS                                   | Saline River     | 7/1/1938                    | 4/30/1947                         | NWIS               |
| 7341301           | USGS                                   | Little River     | 4/17/1979                   | 7/22/1986                         | NWIS               |

Table B.2. Groundwater quality monitoring inventory.

| Well ID         | Monitoring Agency/ Organization | Aquifer             | Date of first sample | Date of most recent sample | Source        |
|-----------------|---------------------------------|---------------------|----------------------|----------------------------|---------------|
| ATH004          | ADEQ                            | Unknown             | 6/3/2013             | 6/3/2013                   | ADEQ database |
| ATH005          | ADEQ                            | Unknown             | 6/3/2013             | 6/3/2013                   | ADEQ database |
| ATH006          | ADEQ                            | Unknown             | 6/3/2013             | 6/3/2013                   | ADEQ database |
| ATH016          | ADEQ                            | Unknown             | 6/25/2013            | 6/25/2013                  | ADEQ database |
| ATH017          | ADEQ                            | Unknown             | 6/25/2013            | 6/25/2013                  | ADEQ database |
| ATH018          | ADEQ                            | Unknown             | 6/10/2013            | 6/10/2013                  | ADEQ database |
| ATH019          | ADEQ                            | Unknown             | 6/10/2013            | 6/10/2013                  | ADEQ database |
| ATH021          | ADEQ                            | Unknown             | 6/10/2013            | 6/10/2013                  | ADEQ database |
| ATH027          | ADEQ                            | Unknown             | 6/10/2013            | 6/10/2013                  | ADEQ database |
| 333629093530501 | USGS                            | Nacatoch Sand       | 8/10/1951            | 8/10/1951                  | NWIS          |
| 333633093484101 | USGS                            | Nacatoch Sand       | 3/21/1951            | 3/21/1951                  | NWIS          |
| 333706093473401 | USGS                            | Nacatoch Sand       | 3/21/1951            | 3/21/1951                  | NWIS          |
| 333717094254501 | USGS                            | Quaternary Alluvium | 6/8/1972             | 2/1/1977                   | NWIS          |
| 333928094065401 | USGS                            | Terrace Deposits    | 6/10/1981            | 7/24/1991                  | NWIS          |
| 333951094071501 | USGS                            | Quaternary Alluvium | 6/8/1972             | 6/8/1972                   | NWIS          |
| 333959094184001 | USGS                            | Terrace Deposits    | 10/7/1959            | 2/27/1968                  | NWIS          |
| 334027094073801 | USGS                            | Terrace Deposits    | 7/11/1946            | 7/11/1946                  | NWIS          |
| 334027094073804 | USGS                            | Terrace Deposits    | 8/7/1951             | 8/7/1951                   | NWIS          |
| 334156094083801 | USGS                            | Not Given           | 8/22/2011            | 8/22/2011                  | NWIS          |
| 334159093473201 | USGS                            | Nacatoch Sand       | 3/29/1951            | 3/29/1951                  | NWIS          |
| 334200094232101 | USGS                            | Terrace Deposits    | 7/25/1951            | 7/25/1951                  | NWIS          |
| 334202093513401 | USGS                            | Tokio Formations    | 3/29/1951            | 2/28/1968                  | NWIS          |
| 334202094084501 | USGS                            | Not Given           | 6/19/1996            | 8/21/2006                  | NWIS          |
| 334333094235401 | USGS                            | Terrace Deposits    | 7/11/1946            | 7/11/1946                  | NWIS          |

Table B.2. Groundwater quality monitoring inventory (continued).

| <b>Well ID</b>  | <b>Monitoring Agency/ Organization</b> | <b>Aquifer</b>   | <b>Date of first sample</b> | <b>Date of most recent sample</b> | <b>Source</b> |
|-----------------|--|------------------|-----------------------------|-----------------------------------|---------------|
| 334334093432401 | USGS                                   | Nacatoch Sand    | 3/29/1951                   | 3/29/1951                         | NWIS          |
| 334346093433001 | USGS                                   | Nacatoch Sand    | 3/29/1951                   | 3/29/1951                         | NWIS          |
| 334405093531601 | USGS                                   | Nacatoch Sand    | 3/29/1951                   | 3/29/1951                         | NWIS          |
| 334425094084901 | USGS                                   | Terrace Deposits | 7/26/1951                   | 7/26/1951                         | NWIS          |
| 334436094084201 | USGS                                   | Terrace Deposits | 7/26/1951                   | 7/26/1951                         | NWIS          |
| 334447093335801 | USGS                                   | Tokio Formation  | 3/29/1951                   | 3/29/1951                         | NWIS          |
| 334524094113501 | USGS                                   | Terrace Deposits | 7/25/1951                   | 7/25/1951                         | NWIS          |
| 334530093541201 | USGS                                   | Tokio Formation  | 7/9/1951                    | 7/9/1951                          | NWIS          |
| 334605093464501 | USGS                                   | Nacatoch Sand    | 3/29/1951                   | 3/29/1951                         | NWIS          |
| 334609094160301 | USGS                                   | Terrace Deposits | 7/22/1951                   | 7/22/1951                         | NWIS          |
| 334610092542401 | USGS                                   | Tokio Formation  | 7/9/1951                    | 7/9/1951                          | NWIS          |
| 334610093553801 | USGS                                   | Not Given        | 7/12/1946                   | 7/7/1951                          | NWIS          |
| 334611093542501 | USGS                                   | Tokio Formation  | 7/9/1951                    | 7/9/1951                          | NWIS          |
| 334620094082401 | USGS                                   | Tokio Formation  | 7/20/1951                   | 7/20/1951                         | NWIS          |
| 334621094082501 | USGS                                   | Ozan Formation   | 7/17/1951                   | 7/17/1951                         | NWIS          |
| 334621094154601 | USGS                                   | Terrace Deposits | 7/23/1951                   | 2/27/1968                         | NWIS          |
| 334630094015401 | USGS                                   | Tokio Formation  | 7/11/1951                   | 7/11/1951                         | NWIS          |
| 334631094015501 | USGS                                   | Tokio Formation  | 7/11/1951                   | 7/11/1951                         | NWIS          |
| 334700093522401 | USGS                                   | Tokio Formation  | 7/9/1951                    | 7/9/1951                          | NWIS          |
| 334700093542401 | USGS                                   | Tokio Formation  | 7/9/1951                    | 7/9/1951                          | NWIS          |
| 334701094040101 | USGS                                   | Tokio Formation  | 7/11/1951                   | 7/11/1951                         | NWIS          |
| 334716093455801 | USGS                                   | Tokio Formation  | 6/26/1951                   | 6/26/1951                         | NWIS          |
| 334720094030001 | USGS                                   | Tokio Formation  | 7/11/1951                   | 7/11/1951                         | NWIS          |
| 334720094071201 | USGS                                   | Tokio Formation  | 8/16/1951                   | 8/16/1951                         | NWIS          |
| 334720094082401 | USGS                                   | Tokio Formation  | 8/15/1951                   | 8/15/1951                         | NWIS          |

Table B.2. Groundwater quality monitoring inventory (continued).

| <b>Well ID</b>  | <b>Monitoring Agency/ Organization</b> | <b>Aquifer</b>  | <b>Date of first sample</b> | <b>Date of most recent sample</b> | <b>Source</b> |
|-----------------|--|-----------------|-----------------------------|-----------------------------------|---------------|
| 334750094040001 | USGS                                   | Tokio Formation | 7/11/1951                   | 7/11/1951                         | NWIS          |
| 334750094071201 | USGS                                   | Tokio Formation | 8/16/1951                   | 8/16/1951                         | NWIS          |
| 334750094082401 | USGS                                   | Tokio Formation | 8/16/1951                   | 8/16/1951                         | NWIS          |
| 334751094071301 | USGS                                   | Tokio Formation | 8/16/1951                   | 8/16/1951                         | NWIS          |
| 334800093542401 | USGS                                   | Tokio Formation | 7/9/1951                    | 7/9/1951                          | NWIS          |
| 334836094082501 | USGS                                   | Tokio Formation | 7/20/1951                   | 7/20/1951                         | NWIS          |
| 334840094020001 | USGS                                   | Tokio Formation | 7/11/1951                   | 7/11/1951                         | NWIS          |
| 334848093424001 | USGS                                   | Tokio Formation | 3/29/1951                   | 3/29/1951                         | NWIS          |
| 334855093510901 | USGS                                   | Not Given       | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 334856093540001 | USGS                                   | Not Given       | 7/9/1951                    | 7/9/1951                          | NWIS          |
| 334900093501201 | USGS                                   | Tokio Formation | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 334900093532401 | USGS                                   | Tokio Formation | 8/16/1951                   | 8/16/1951                         | NWIS          |
| 334900094020001 | USGS                                   | Tokio Formation | 7/11/1951                   | 7/11/1951                         | NWIS          |
| 334901093512501 | USGS                                   | Tokio Formation | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 334902093512601 | USGS                                   | Tokio Formation | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 334902093542601 | USGS                                   | Tokio Formation | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 334903093490901 | USGS                                   | Tokio Formation | 3/21/1951                   | 3/21/1951                         | NWIS          |
| 334918093543501 | USGS                                   | Not Given       | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 334920094040001 | USGS                                   | Tokio Formation | 7/7/1951                    | 7/7/1951                          | NWIS          |
| 334920094071201 | USGS                                   | Tokio Formation | 8/16/1951                   | 8/16/1951                         | NWIS          |
| 334920094082401 | USGS                                   | Tokio Formation | 8/16/1951                   | 8/16/1951                         | NWIS          |
| 334920094091201 | USGS                                   | Tokio Formation | 8/16/1951                   | 8/16/1951                         | NWIS          |
| 334921094040101 | USGS                                   | Tokio Formation | 7/11/1951                   | 7/11/1951                         | NWIS          |
| 334921094082501 | USGS                                   | Tokio Formation | 8/16/1951                   | 8/16/1951                         | NWIS          |
| 334922094082601 | USGS                                   | Tokio Formation | 8/21/1951                   | 8/21/1951                         | NWIS          |

Table B.2. Groundwater quality monitoring inventory (continued).

| <b>Well ID</b>  | <b>Monitoring Agency/ Organization</b> | <b>Aquifer</b>     | <b>Date of first sample</b> | <b>Date of most recent sample</b> | <b>Source</b> |
|-----------------|--|--------------------|-----------------------------|-----------------------------------|---------------|
| 334940093501801 | USGS                                   | Tokio Formation    | 3/21/1951                   | 3/21/1951                         | NWIS          |
| 334941093251901 | USGS                                   | Tokio Formation    | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 334942093252001 | USGS                                   | Tokio Formation    | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 335000094040001 | USGS                                   | Tokio Formation    | 7/11/1951                   | 7/11/1951                         | NWIS          |
| 335000094082401 | USGS                                   | Tokio Formation    | 8/16/1951                   | 8/16/1951                         | NWIS          |
| 335000094091201 | USGS                                   | Tokio Formation    | 7/20/1951                   | 7/20/1951                         | NWIS          |
| 335005093511601 | USGS                                   | Not Given          | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 335010094250401 | USGS                                   | Terrace Deposits   | 2/27/1968                   | 2/27/1968                         | NWIS          |
| 335012094273301 | USGS                                   | Terrace Deposits   | 7/24/1951                   | 7/24/1951                         | NWIS          |
| 335014094230601 | USGS                                   | Terrace Deposits   | 7/24/1951                   | 7/24/1951                         | NWIS          |
| 335040094015401 | USGS                                   | Tokio Formation    | 7/12/1951                   | 7/12/1951                         | NWIS          |
| 335047093431601 | USGS                                   | Tokio Formation    | 3/28/1951                   | 3/28/1951                         | NWIS          |
| 335102093432701 | USGS                                   | Tokio Formation    | 3/28/1951                   | 3/28/1951                         | NWIS          |
| 335110093552401 | USGS                                   | Woodbine Formation | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 335111093582501 | USGS                                   | Woodbine Formation | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 335150094015401 | USGS                                   | Tokio Formation    | 7/11/1951                   | 7/11/1951                         | NWIS          |
| 335150094031801 | USGS                                   | Tokio Formation    | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 335210093501201 | USGS                                   | Trinity Group      | 3/21/1951                   | 6/21/1951                         | NWIS          |
| 335220093434501 | USGS                                   | Ozan Formation     | 3/29/1951                   | 3/29/1951                         | NWIS          |
| 335240093573601 | USGS                                   | Tokio Formation    | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 335250093511201 | USGS                                   | Tokio Formation    | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 335300093540601 | USGS                                   | Tokio Formation    | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 335300093572401 | USGS                                   | Woodbine Formation | 8/16/1951                   | 8/16/1951                         | NWIS          |
| 335301093540701 | USGS                                   | Tokio Formation    | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 335320093571201 | USGS                                   | Tokio Formation    | 6/27/1951                   | 6/27/1951                         | NWIS          |

Table B.2. Groundwater quality monitoring inventory (continued).

| <b>Well ID</b>  | <b>Monitoring Agency/ Organization</b> | <b>Aquifer</b>     | <b>Date of first sample</b> | <b>Date of most recent sample</b> | <b>Source</b> |
|-----------------|--|--------------------|-----------------------------|-----------------------------------|---------------|
| 335324093461201 | USGS                                   | Tokio Formation    | 4/10/1951                   | 4/10/1951                         | NWIS          |
| 335350093510001 | USGS                                   | Woodbine Formation | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 335350093520601 | USGS                                   | Trinity Group      | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 335350093531201 | USGS                                   | Trinity Group      | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 335350093541801 | USGS                                   | Tokio Formation    | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 335350093550601 | USGS                                   | Tokio Formation    | 7/10/1951                   | 7/10/1951                         | NWIS          |
| 335350094041801 | USGS                                   | Trinity Group      | 7/10/1921                   | 7/10/1951                         | NWIS          |
| 335351093510101 | USGS                                   | Tokio Formation    | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 335351093520701 | USGS                                   | Woodbine Formation | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 335351093531301 | USGS                                   | Trinity Group      | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 335351093541901 | USGS                                   | Tokio Formation    | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 335352093510201 | USGS                                   | Tokio Formation    | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 335352093531401 | USGS                                   | Trinity Group      | 8/16/1951                   | 8/16/1951                         | NWIS          |
| 335353093531501 | USGS                                   | Tokio Formation    | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 335353093531502 | USGS                                   | Woodbine Formation | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 335354093531601 | USGS                                   | Tokio Formation    | 7/12/1951                   | 7/12/1951                         | NWIS          |
| 335430093520601 | USGS                                   | Trinity Group      | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 335430093530601 | USGS                                   | Trinity Group      | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 335430093541201 | USGS                                   | Tokio Formation    | 8/14/1951                   | 8/14/1951                         | NWIS          |
| 335430093551801 | USGS                                   | Trinity Group      | 7/11/1946                   | 6/27/1951                         | NWIS          |
| 335430093562401 | USGS                                   | Tokio Formation    | 7/11/1951                   | 7/11/1951                         | NWIS          |
| 335431093520601 | USGS                                   | Woodbine Formation | 6/27/1951                   | 6/27/1951                         | NWIS          |
| 335431093551901 | USGS                                   | Tokio Formation    | 8/14/1951                   | 8/14/1951                         | NWIS          |
| 335440093592401 | USGS                                   | Trinity Group      | 7/10/1951                   | 7/10/1951                         | NWIS          |
| 335440094015401 | USGS                                   | Tokio Formation    | 7/10/1951                   | 7/10/1951                         | NWIS          |

Table B.2. Groundwater quality monitoring inventory (continued).

| <b>Well ID</b>  | <b>Monitoring Agency/ Organization</b> | <b>Aquifer</b>     | <b>Date of first sample</b> | <b>Date of most recent sample</b> | <b>Source</b> |
|-----------------|--|--------------------|-----------------------------|-----------------------------------|---------------|
| 335450094035401 | USGS                                   | Trinity Group      | 7/13/1951                   | 7/13/1951                         | NWIS          |
| 335508093461301 | USGS                                   | Tokio Formation    | 3/29/1951                   | 3/29/1951                         | NWIS          |
| 335530093531201 | USGS                                   | Tokio Formation    | 8/14/1951                   | 8/14/1951                         | NWIS          |
| 335530093541801 | USGS                                   | Tokio Formation    | 7/10/1951                   | 7/10/1951                         | NWIS          |
| 335550094223601 | USGS                                   | Trinity Group      | 1/8/1952                    | 1/8/1952                          | NWIS          |
| 335620093541201 | USGS                                   | Trinity Group      | 8/14/1951                   | 8/14/1951                         | NWIS          |
| 335621093541301 | USGS                                   | Trinity Group      | 8/14/1951                   | 8/14/1951                         | NWIS          |
| 335622093541401 | USGS                                   | Trinity Group      | 8/14/1951                   | 8/14/1951                         | NWIS          |
| 335623093541501 | USGS                                   | Trinity Group      | 8/14/1951                   | 8/14/1951                         | NWIS          |
| 335624093541601 | USGS                                   | Trinity Group      | 8/14/1951                   | 8/14/1951                         | NWIS          |
| 335630093530601 | USGS                                   | Tokio Formation    | 8/14/1951                   | 8/14/1951                         | NWIS          |
| 335656093472401 | USGS                                   | Tokio Formation    | 3/29/1951                   | 3/29/1951                         | NWIS          |
| 335708093491701 | USGS                                   | Tokio Formation    | 3/29/1951                   | 3/29/1951                         | NWIS          |
| 335710093520001 | USGS                                   | Tokio Formation    | 8/17/1951                   | 8/17/1951                         | NWIS          |
| 335710093520002 | USGS                                   | Trinity Group      | 8/16/1951                   | 8/16/1951                         | NWIS          |
| 335750093563001 | USGS                                   | Trinity Group      | 8/16/1951                   | 8/16/1951                         | NWIS          |
| 335806094100102 | USGS                                   | Trinity Group      | 6/9/1972                    | 6/20/2011                         | NWIS          |
| 335830093505401 | USGS                                   | Woodbine Formation | 8/16/1951                   | 8/16/1951                         | NWIS          |
| 335844093465401 | USGS                                   | Tokio Formation    | 3/29/1951                   | 3/29/1951                         | NWIS          |
| 335910094102401 | USGS                                   | Trinity Group      | 8/15/1951                   | 8/15/1951                         | NWIS          |
| 335917093472301 | USGS                                   | Tokio Formation    | 3/28/1951                   | 3/28/1951                         | NWIS          |
| 340000094102401 | USGS                                   | Trinity Group      | 8/15/1951                   | 8/15/1951                         | NWIS          |
| 340000094110001 | USGS                                   | Trinity Group      | 8/15/1951                   | 8/15/1951                         | NWIS          |
| 340001094110101 | USGS                                   | Trinity Group      | 8/15/1951                   | 8/15/1951                         | NWIS          |
| 340002094110201 | USGS                                   | Trinity Group      | 8/15/1951                   | 8/15/1951                         | NWIS          |

Table B.2. Groundwater quality monitoring inventory (continued).

| <b>Well ID</b>  | <b>Monitoring Agency/<br/>Organization</b> | <b>Aquifer</b>        | <b>Date of first sample</b> | <b>Date of most recent sample</b> | <b>Source</b> |
|-----------------|--|-----------------------|-----------------------------|-----------------------------------|---------------|
| 340200092242401 | USGS                                       | Trinity Group         | 1/8/1952                    | 1/8/1952                          | NWIS          |
| 340250094200001 | USGS                                       | Trinity Group         | 1/9/1952                    | 1/9/1952                          | NWIS          |
| 340251094200101 | USGS                                       | Trinity Group         | 1/9/1952                    | 1/9/1952                          | NWIS          |
| 340252094200201 | USGS                                       | Trinity Group         | 1/9/1952                    | 1/9/1952                          | NWIS          |
| 340253094200301 | USGS                                       | Trinity Group         | 1/9/1952                    | 1/9/1952                          | NWIS          |
| 340858093425701 | USGS                                       | Jackfork Sandstone    | 10/24/1962                  | 10/24/1962                        | NWIS          |
| 341041094190501 | USGS                                       | Trinity Group         | 10/23/1962                  | 10/23/1962                        | NWIS          |
| 341350093525001 | USGS                                       | Hot Springs Sandstone | 10/24/1962                  | 10/24/1962                        | NWIS          |
| 341504094064201 | USGS                                       | Not Given             | 10/23/1962                  | 10/23/1962                        | NWIS          |

# **APPENDIX C**

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## **Turbidity/TSS Load Reduction Target Analysis**

Linear regression analysis of turbidity and TSS measurements from ADEQ station RED0021 from 2010 through 2014:

| Dependent Variable          | TSS    |
|-----------------------------|--------|
| N                           | 57     |
| Multiple R                  | 0.949  |
| Squared Multiple R          | 0.900  |
| Adjusted Squared Multiple R | 0.898  |
| Standard Error of Estimate  | 14.768 |

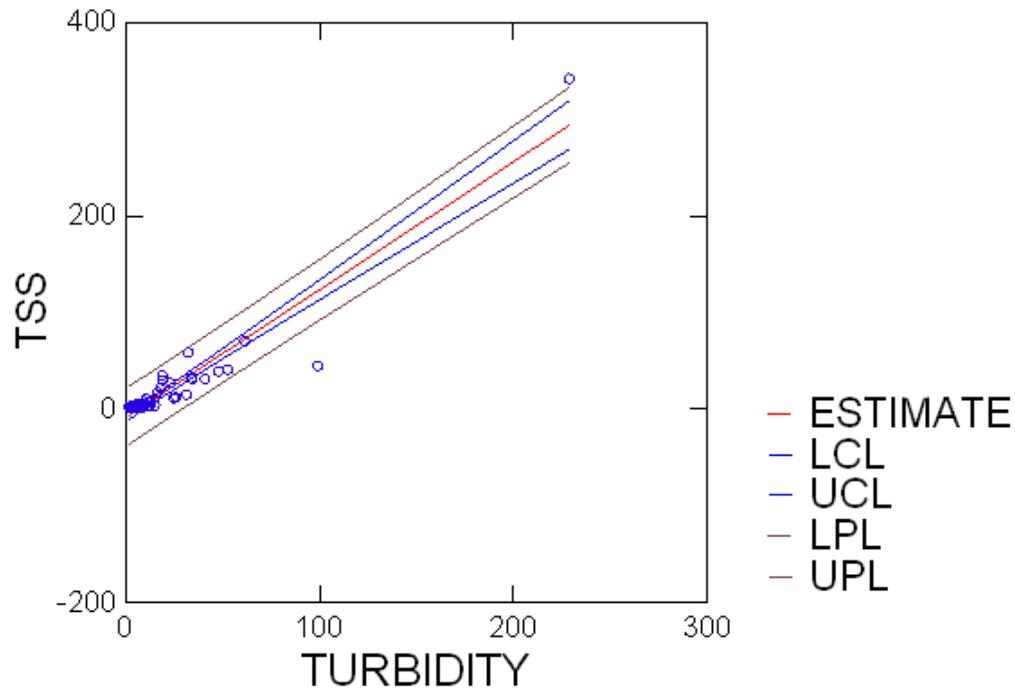
| Regression Coefficients $B = (X'X)^{-1}X'Y$ |             |                |                  |           |        |         |
|---|-------------|----------------|------------------|-----------|--------|---------|
| Effect                                      | Coefficient | Standard Error | Std. Coefficient | Tolerance | t      | p-value |
| CONSTANT                                    | -8.612      | 2.268          | 0.000            | .         | -3.798 | 0.000   |
| TURBIDITY                                   | 1.322       | 0.059          | 0.949            | 1.000     | 22.283 | 0.000   |

| Analysis of Variance |             |    |              |         |         |
|----------------------|-------------|----|--------------|---------|---------|
| Source               | SS          | df | Mean Squares | F-ratio | p-value |
| Regression           | 108,288.610 | 1  | 108,288.610  | 496.530 | 0.000   |
| Residual             | 11,994.992  | 55 | 218.091      |         |         |

**WARNING**

|      |    |                     |                       |   |         |
|------|----|---------------------|-----------------------|---|---------|
| Case | 2  | is an Outlier       | (Studentized Residual | : | -8.879) |
| Case | 53 | has large Leverage  | (Leverage             | : | 0.727)  |
| Case | 53 | is an Outlier       | (Studentized Residual | : | 10.478) |
| Case | 53 | has large Influence | (Studentized Residual | : | 49.149) |

**Confidence Interval and Prediction Interval**



Conversion equation based on the results above:

$$\text{TSS} = 1.322 * \text{turbidity} - 8.612$$

This equation used to convert numeric turbidity water quality criteria to TSS target concentrations:

| <b>Parameter (units)</b> | <b>Base flow criterion</b> | <b>All flows criterion</b> |
|--------------------------|----------------------------|----------------------------|
| Turbidity (NTU)          | 21                         | 32                         |
| TSS (mg/L)               | 19.1                       | 33.6                       |

The base flow criteria should not be exceeded in 20% or more of samples collected June to October. The all flow criteria should not be exceeded in more than 25% of all samples collected over an entire year (Arkansas Pollution Control and Ecology Commission 2014). Percentage of exceedences of turbidity criteria and TSS targets for data from 2010 – 2014 are summarized in the table below. As can be seen in this table, only the base flow turbidity measurements exceed the impairment criterion (less than 20% exceedences). Therefore, the reduction target is estimated based on meeting the base flow TSS target concentration.

| <b>Year</b> | <b>Turbidity criteria exceedences</b> |                 | <b>TSS target exceedences</b> |                 |
|-------------|---------------------------------------|-----------------|-------------------------------|-----------------|
|             | <b>Base flow</b>                      | <b>All flow</b> | <b>Base flow</b>              | <b>All flow</b> |
| 2010        | 20%                                   | 17%             | 20%                           | 17%             |
| 2011        | 0                                     | 8%              | 0                             | 0               |
| 2012        | 0                                     | 8%              | 0                             | 8%              |
| 2013        | 20%                                   | 8%              | 20%                           | 8%              |
| 2014        | 20%                                   | 17%             | 20%                           | 17%             |

The table below lists turbidity and TSS measurements from ADEQ station RED0021 for the period 2010 through 2014, along with indicators of the measurements that exceed the base flow numeric turbidity water quality criterion and the TSS target concentration calculated from that criterion. The last two columns show TSS values reduced by 53% so that TSS concentrations during the base flow period (June through October) are less than the TSS base flow target concentration. Since there are five measurements during the base flow period, even one exceedence means the impairment criterion is not met, i.e., less than 20% of measurements exceed. Therefore, for less than 20% of the base flow measurements to exceed the TSS target concentration, none of the TSS measurements during the base flow period can exceed the target concentration.

| <b>Year</b> | <b>Month</b> | <b>Turbidity</b> | <b>Turbidity Exceed Base Flow</b> | <b>TSS</b> | <b>TSS Exceed Base Flow</b> | <b>TSS Reduced by 53%</b> | <b>Reduced TSS Exceed Base Flow</b> |
|-------------|--------------|------------------|-----------------------------------|------------|-----------------------------|---------------------------|-------------------------------------|
| 2010        | 1            | 10.2             |                                   | 2.5        |                             | 1.175                     |                                     |
| 2010        | 2            | 99.6             |                                   | 44         |                             | 20.68                     |                                     |
| 2010        | 3            | 12.9             |                                   | 3          |                             | 1.41                      |                                     |
| 2010        | 4            | 6.89             |                                   | 2.5        |                             | 1.175                     |                                     |
| 2010        | 5            | 23.6             |                                   | 26         |                             | 12.22                     |                                     |
| 2010        | 6            | 53.1             | Y                                 | 40         | Y                           | 18.8                      | N                                   |
| 2010        | 7            | 7.72             | N                                 | 4          | N                           | 1.88                      | N                                   |
| 2010        | 8            | 6.55             | N                                 | 1.5        | N                           | 0.705                     | N                                   |
| 2010        | 9            | 5.35             | N                                 | 3          | N                           | 1.41                      | N                                   |
| 2010        | 10           | 5.43             | N                                 | 0          | N                           | 0                         | N                                   |
| 2010        | 11           | 4.65             |                                   | 1          |                             | 0.47                      |                                     |
| 2010        | 12           | 9.29             |                                   | 1.5        |                             | 0.705                     |                                     |
| 2011        | 1            | 13.2             |                                   | 5.5        |                             | 2.585                     |                                     |
| 2011        | 2            | 5.52             |                                   | 0          |                             | 0                         |                                     |
| 2011        | 3            | 9.53             |                                   | 2.5        |                             | 1.175                     |                                     |
| 2011        | 4            | 7.05             |                                   | 1          |                             | 0.47                      |                                     |
| 2011        | 5            | 34.3             |                                   | 31.5       |                             | 14.805                    |                                     |
| 2011        | 6            | 14.1             | N                                 | 0          | N                           | 0                         | N                                   |
| 2011        | 7            | 5.4              | N                                 | 1.5        | N                           | 0.705                     | N                                   |
| 2011        | 8            | 4.15             | N                                 | 1          | N                           | 0.47                      | N                                   |
| 2011        | 9            | 3.09             | N                                 | 0          | N                           | 0                         | N                                   |
| 2011        | 10           | 1.92             | N                                 | 1.5        | N                           | 0.705                     | N                                   |
| 2011        | 11           | 2.46             |                                   | 1          |                             | 0.47                      |                                     |
| 2011        | 12           | 16.9             |                                   | 16.5       |                             | 7.755                     |                                     |
| 2012        | 1            | 6.65             |                                   | 3          |                             | 1.41                      |                                     |
| 2012        | 2            | 11.7             |                                   | 6.5        |                             | 3.055                     |                                     |
| 2012        | 3            | 11               |                                   | 10         |                             | 4.7                       |                                     |
| 2012        | 4            | 26.2             |                                   | 11.5       |                             | 5.405                     |                                     |
| 2012        | 4            | 32.7             |                                   | 57.5       |                             | 27.025                    |                                     |
| 2012        | 6            | 6.16             | N                                 | 3          | N                           | 1.41                      | N                                   |
| 2012        | 7            | 3.65             | N                                 | 2.5        | N                           | 1.175                     | N                                   |
| 2012        | 8            | 3.16             | N                                 | 2          | N                           | 0.94                      | N                                   |
| 2012        | 9            | 2.46             | N                                 | 1          | N                           | 0.47                      | N                                   |
| 2012        | 10           | 2.66             | N                                 | 1.3        | N                           | 0.611                     | N                                   |
| 2012        | 11           | 3.28             |                                   | 0          |                             | 0                         |                                     |
| 2012        | 12           | 4.87             |                                   | 0          |                             | 0                         |                                     |

| <b>Year</b> | <b>Month</b> | <b>Turbidity</b> | <b>Turbidity Exceed Base Flow</b> | <b>TSS</b> | <b>TSS Exceed Base Flow</b> | <b>TSS Reduced by 53%</b> | <b>Reduced TSS Exceed Base Flow</b> |
|-------------|--------------|------------------|-----------------------------------|------------|-----------------------------|---------------------------|-------------------------------------|
| 2013        | 1            | 5.86             |                                   | 1.3        |                             | 0.611                     |                                     |
| 2013        | 2            | 5.18             |                                   | 2.2        |                             | 1.034                     |                                     |
| 2013        | 3            | 5.41             |                                   | 1.5        |                             | 0.705                     |                                     |
| 2013        | 4            | 6.4              |                                   | 4.5        |                             | 2.115                     |                                     |
| 2013        | 5            | 18.4             |                                   | 21.5       |                             | 10.105                    |                                     |
| 2013        | 6            | 48.2             | Y                                 | 38.5       | Y                           | 18.095                    | N                                   |
| 2013        | 6            | 6.89             | N                                 | 3.5        | N                           | 1.645                     | N                                   |
| 2013        | 8            | 3.84             | N                                 | 3          | N                           | 1.41                      | N                                   |
| 2013        | 9            | 3.59             | N                                 | 1          | N                           | 0.47                      | N                                   |
| 2013        | 10           | 6.04             | N                                 | 1          | N                           | 0.47                      | N                                   |
| 2013        | 11           | 4.27             |                                   | 0          |                             | 0                         |                                     |
| 2013        | 12           | 15.4             |                                   | 3          |                             | 1.41                      |                                     |
| 2014        | 1            | 19.4             |                                   | 29         |                             | 13.63                     |                                     |
| 2014        | 2            | 5.33             |                                   | 1.5        |                             | 0.705                     |                                     |
| 2014        | 3            | 19.3             |                                   | 34         |                             | 15.98                     |                                     |
| 2014        | 4            | 25.4             |                                   | 10.5       |                             | 4.935                     |                                     |
| 2014        | 5            | 229              |                                   | 341        |                             | 160.27                    |                                     |
| 2014        | 6            | 9.1              | N                                 | 3.5        | N                           | 1.645                     | N                                   |
| 2014        | 7            | 9.2              | N                                 | 5          | N                           | 2.35                      | N                                   |
| 2014        | 8            | 9                | N                                 | 2.5        | N                           | 1.175                     | N                                   |
| 2014        | 9            | 7.43             | N                                 | 3.8        | N                           | 1.786                     | N                                   |
| 2014        | 10           | 34.9             | Y                                 | 30.3       | Y                           | 14.241                    | N                                   |
| 2014        | 11           | 3.28             |                                   | 0          |                             | 0                         |                                     |
| 2014        | 12           | 31.7             |                                   | 14         |                             | 6.58                      |                                     |