US Army Corps of Engineers®

FINAL ENVIRONMENTAL IMPACT STATEMENT

White River Basin, Arkansas, Minimum Flows

Prepared By:
Little Rock District

November 2008

FINAL
ENVIRONMENTAL IMPACT STATEMENT

LEAD AGENCY: U.S. Army Corps of Engineers

TITLE FOR PROPOSED ACTION: White River Basin, Arkansas, Minimum Flows

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PREPARED BY: Little Rock District, Corps of Engineers
P.O. Box 867
Little Rock, AR 72203-0867

Contact Mike Biggs 501-324-7342 Mike Rodgers 501-324-5030

This Document is the Final EIS following the Supplemental Draft EIS filed with the Federal Register on August 8, 2008. Copies, depending upon availability, may be obtained by contacting the above.

ABSTRACT: The Water Resource Development Acts (WRDA) of 1999 and 2000 modified the basic authorization and operation for the five multipurpose White River Basin lakes, Beaver, Table Rock, and Bull Shoals Lakes on the White River; Norfork Lake on the North Fork River; and Greer Ferry Lake on the Little Red River. WRDA 99 & 00 directed the Corps to complete a study and report to determine if minimum flow reallocations adversely affect other authorized purposes. Also, this study is to identify Federal costs that will be incurred. The White River Minimum Flows Reallocation Study Report, signed July 2004, analyzed reallocation water storage and release scenarios at five multipurpose White River lakes. The July 2004 Reallocation Report identified economically justified, technically sound, and environmentally acceptable reallocation and release scenarios at each lake.

A Draft EIS was filed with the Federal Register on June 2, 2006, which analyzed the reallocation water storage and release scenarios covered in the July 2004 Reallocation Report for the five multipurpose White River lakes . Subsequent to the completion of the Draft Environmental Impact Statement (DEIS), Section 132 of the FY 2006 Energy and Water Resources Development Act (P.L. 109-103) authorized the implementation of plans BS-3 at Bull Shoals and NF-7 at Norfork lakes that were described in the 2004 Reallocation Report, at full Federal expense in accordance with section 906(e) of WRDA 86. Section 132 did not authorize implementation of Minimum Flows at Beaver, Table Rock, and Greers Ferry Lakes. Also, Section 132 repealed the previous project authorities in WRDA 99 and WRDA 00.

The August 2008 Supplemental DEIS analyzed the impacts to the five White River Reservoirs, however; emphasis is placed on Bull Shoals and Norfork Lakes due to the changes made with the FY 2006 Energy and Water Resources Development Act (P.L. 109-103). Previous study efforts evaluating the other lakes are included in the interest of full disclosure.

The Final Environmental Impact Statement (FEIS) concludes that the trout tailwater fishery below Bull Shoals and Norfork dams will benefit from the increased wetted perimeter resulting from

increased minimum flows while impacts to hydropower will be fully compensated and modifications to in-lake recreation would allow for reasonable continued use.

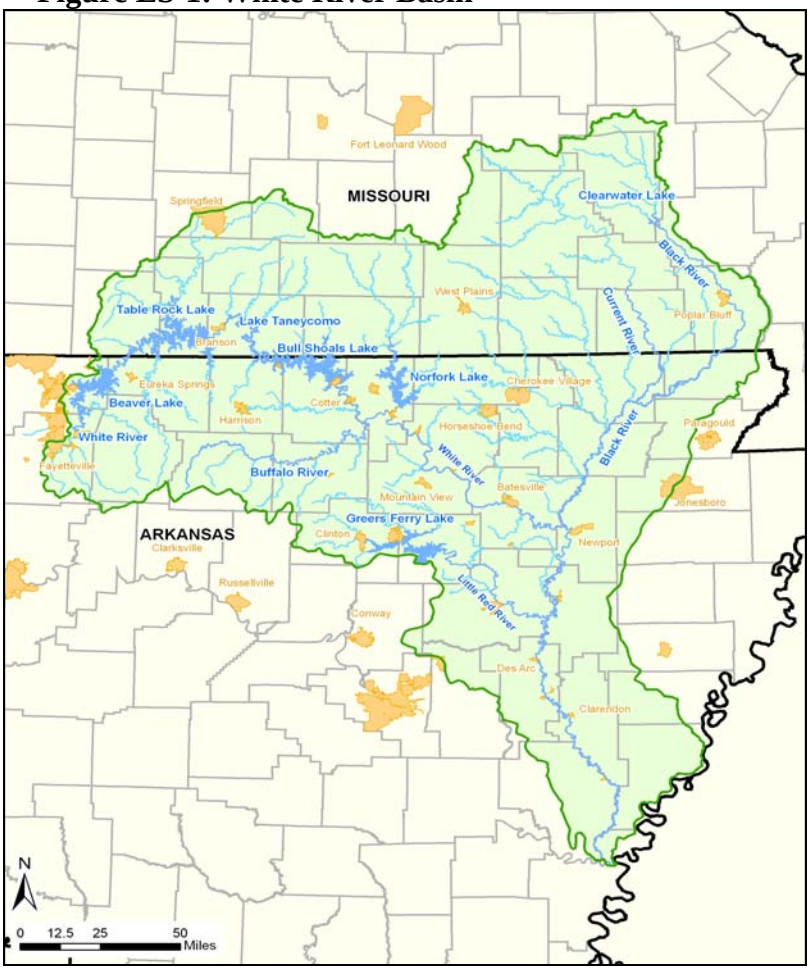
Executive Summary

Introduction

The purpose of this EIS is to evaluate the effects of the proposed action on the human and natural environment as prescribed by the National Environmental Policy Act (NEPA), accomplishing congressionally authorized project purposes while balancing permitted private uses, social and economic needs, and the application of sound environmental stewardship to managed resources. The purpose of the proposed action is to provide fish and wildlife enhancements, facilitate seasonal flood control and hydropower releases, and permit reasonable continued use of lakeside facilities at Bull Shoals and Norfork Lakes as directed in Section 132 of the FY 2006 Energy and Water Development Appropriation Act (EWDAA, P.L. 109-103).

The Water Resource Development Acts (WRDA) of 1999 (Section 374) and 2000 (Section 304) modified the basic authorization and operation for the five multipurpose White River Basin lakes: Beaver, Table Rock, and Bull Shoals Lakes on the White River; Norfork Lake on the North Fork White River; and Greers Ferry Lake on the Little Red River (See Figure ES-1). Under their original authorization, the lakes' water levels have been managed primarily for flood control and hydroelectric power generation, and to a lesser extent water supply. Because all of the storage space in the lakes is already allocated to existing purposes and no unused storage or surplus storage is available, there would need to be a reallocation of storage to implement the added measure.

Figure ES-1: White River Basin



Under WRDA 1999 and 2000, the Corps was directed to complete a study and report to determine if minimum flow reallocations adversely affect other authorized purposes. In addition, the study was required to identify Federal costs that would be incurred.

The White River Minimum Flows Reallocation Study Report, signed in July 2004, analyzed reallocation and release scenarios at these five multipurpose lakes. The Reallocation Report identified economically justified, technically sound, and environmentally acceptable reallocation and release scenarios at each lake. The July 2004 Reallocation Report resulted in Section 132 of the FY 2006 Energy and Water Development Appropriations Act (P.L. 109-103) authorizing and directing the implementation of plans BS-3 at Bull Shoals and NF-7 at Norfork Lakes, both described in the July 2004 Reallocation Report. The proposed action is to be at full Federal expense in accordance with section 906(e) of WRDA 86, with the exception of certain features required of a non-Federal Sponsor. Section 132 did not authorize implementation of Minimum Flow proposals at Beaver, Table Rock, and Greers Ferry Lakes. In addition, Section 132 repealed the previous project authorities in WRDA 99 and WRDA 00, eliminating further consideration of alternative plans.

Alternatives

Alternatives identified and evaluated in the White River Minimum Flows Reallocation Study Report, dated July 2004, included five lakes and more than 1,000 action alternatives to provide minimum flows, and the no action alternative. For the feet of storage specified at each of the five lakes in WRDA 1999 and 2000, alternatives were developed for reallocating the storage from either the flood control pool, the conservation (hydropower) pool, or both pools 50/50. In accordance with congressional language in the 2006 EWDAA, alternatives BS-3 for Bull Shoals Lake and NF-7 at Norfork were selected for implementation. The alternatives in this EIS include the implementation of plans BS-3 (Bull Shoals), NF-7 (Norfork), and the no action alternative. Information regarding additional alternatives including those that were originally developed but not carried forward for further evaluation can be found in Appendix G.

The 2006 EWDAA specified the reallocation of 5 feet of flood control storage at Bull Shoals (see figure ES-2). This would increase the top of the conservation pool by 5 ft to 659 ft MSL, increasing the surface area by 2,565 acres or 5.6 percent, and provide a minimum flow of 800 cubic feet per second (cfs). An increase of conservation pool storage will reduce the flood pool volume by 233,000 acre feet (AF). The volume of the incremental increase in conservation storage is calculated using the existing elevation-storage tables for Bull Shoals Lake. No additional land will be flooded that is not currently flooded annually.

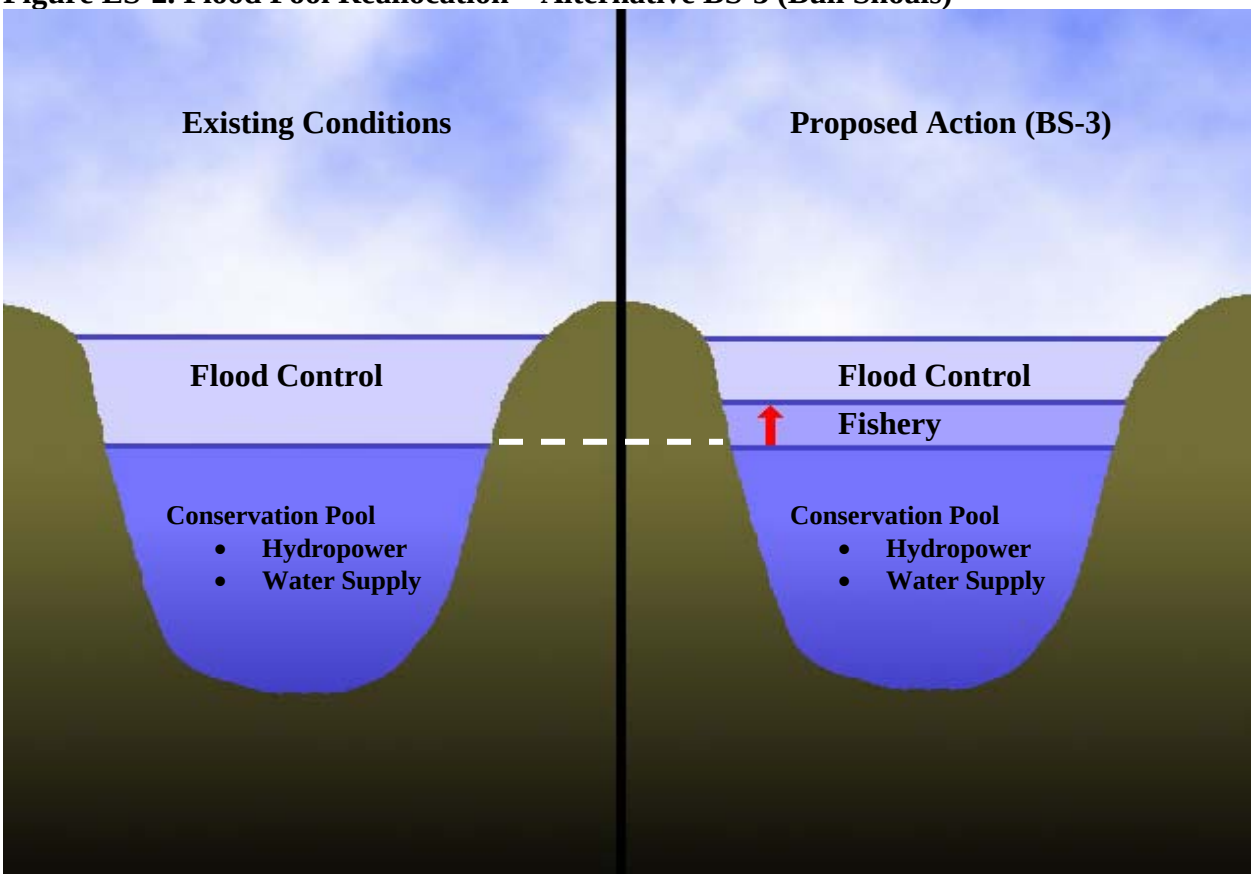
Under the authorized plan for the Bull Shoals project, five feet of storage for minimum flows will be reallocated from the flood control pool with provisions to provide a portion of the reallocated storage for hydropower's use to maintain the yield of the current hydropower storage. The current seasonal pool plan will be superimposed on the new top of conservation pool. As a result, both the conservation and seasonal pool levels at Bull Shoals will be raised five feet.

A flood pool reallocation would result in changes to the Corps' flood operations. The Corps would continue to evacuate floodwaters as quickly as possible to provide maximum protection from future rainfall runoff. Once flood releases are concluded, at the top of the new conservation pool (659 ft MSL), Southwestern Power Administration (SWPA) will begin either hydropower operations or minimum flow releases will resume.

During droughts, the conservation pool may be reduced and refilled only when rainfall occurs. When hydropower storage (conservation pool storage) is depleted due to drought, power-generating operations are stopped until inflows recharge conservation pool storage. Similarly, in drought years the minimum flow releases will be halted whenever the specific volume of minimum flow storage has been used and will not be restarted until inflows have recharged the storage.

At Bull Shoals, the minimum flow release is large enough to generate a small amount of hydropower with the existing main turbine. Authorized reallocation and release scenario BS-3, specifies the use of the main turbine at Bull Shoals to facilitate minimum flow release and is considered the final solution for minimum flow implementation under current authorization. The remote operating computer language, SCADA, can be modified quickly in order to use the main turbine for minimum flow releases. Note, test releases in June 2001 revealed that the use of main turbines to make minimum flow releases is only feasible at Bull Shoals.

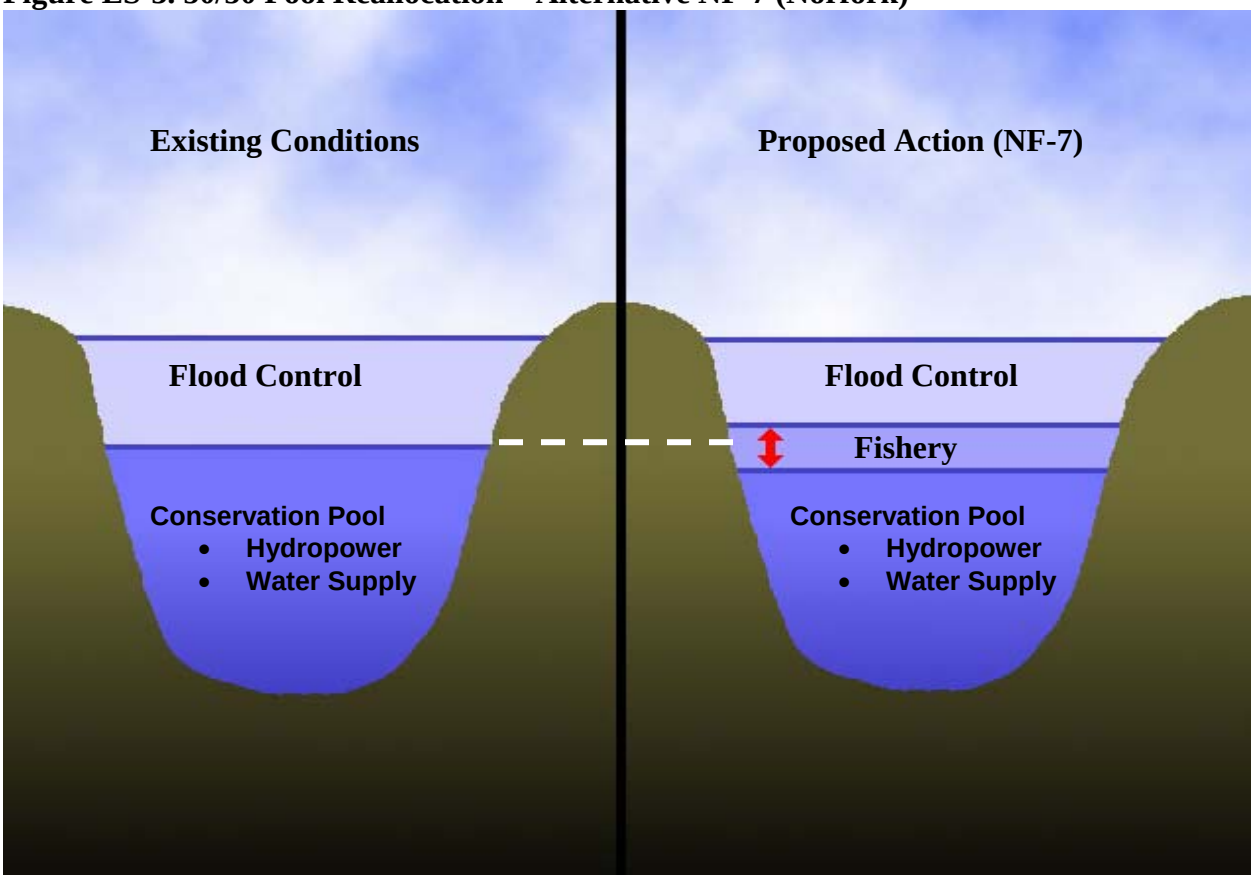
Figure ES-2. Flood Pool Reallocation – Alternative BS-3 (Bull Shoals)



At Norfork Lake, the 2006 EWDAA directed reallocation of 3.5 feet of storage to be evenly divided (50:50) between the conservation and flood control pools to provide a minimum flow release of 300 cfs (see figure ES-3). The top of the conservation pool elevation will increase 1.75 feet to 553.75 ft MSL and the surface area will increase 464 acres or 2.1 percent. An increase of conservation pool storage will reduce the flood pool volume by 38,900 AF. The volume of the incremental increase in conservation storage is calculated using the existing elevation-storage tables for Norfork Lake. No additional lands will be flooded that is not currently flooded annually.

The reallocation portion from the flood control storage is similar to the storage reallocation at Bull Shoals in that the hydropower storage yield for that portion will be maintained and the existing seasonal pool plan will be superimposed on the new top of conservation pool. As a result, both the conservation and seasonal pool levels at Norfork will be raised 1.75 feet. Unlike Bull Shoals, all minimum flow releases at Norfork, whether from reallocated flood or hydropower storage, would be spilled through a siphon with no energy generated from the water. A 50:50 reallocation would result in changes to the Corps' flood operations. The Corps would continue to evacuate floodwaters as quickly as possible to provide maximum protection from future rainfall runoff. Once flood releases are concluded, at the top of the new conservation pool (553.75 ft-msl), SWPA will begin either hydropower operations or minimum flow releases will resume.

Figure ES-3. 50/50 Pool Reallocation – Alternative NF-7 (Norfork)



To comply with NEPA, the "No Action" alternative was also evaluated. This alternative would consist of no change in current minimum flow operations at each reservoir. The only effect associated with the "No Action" alternative is the continuation of the sub-optimal trout fishery habitat below each dam. The "No Action" alternative does not meet the requirements of the purpose and need of the White River Minimum Flow Reallocation Study Report as directed by Congress

Environmental Analysis

The following sections summarize the anticipated effects of the proposed action on each general resources of concern. Section 4.12 in the EIS discusses the proposed actions' consistency with federal laws and regulations. Appendix A and B includes the agency and public involvement that has occurred.

ES.2 Land Use

The land use within the project area will not be affected by the "No Action" alternative or the proposed action reallocations considered in the study. The lands around each reservoir that might be affected are currently flooded annually. These areas are affected by the normal operation plan at each reservoir and characteristic of multipurpose projects with little or no vegetation. These areas are commonly referred to as the "bathtub ring" and the area displays the effects of frequent elevation increases and decreases.

ES.3 Geology & Soils

Implementation of the proposed action will affect the geology associated with the area around the lakes by increases or decreases in the duration of karst area flooding. However, these areas are currently affected annually by the frequent fluctuation in water elevations.

ES.4 Water Resources

Lake Effects

Implementation of BS-3 (Flood Pool reallocation) at Bull Shoals will result in a 5 feet increase to the top of conservation pool to 659 ft. MSL resulting in a 2,565 surface acre increase to the pool and reduce the flood pool volume by 233,000 AF. The NF-7 reallocation at Norfork will increase the conservation pool elevation from 552 to 553.75 ft. MSL with an increase of 464 surface acres to the pool and reduce the flood pool volume by 38,900 AF.

From a hydrologic and hydraulic perspective, the proposed project would have slightly higher flood pool elevations with minimum impacts to the duration that the pools are above conservation pool at both Bull Shoals and Norfork Lakes when considering operations during extreme events. It would be expected that Bull Shoals would have less severe minimums and Norfork would have slightly lower minimum pool elevations during droughts. At both lakes it would be expected that it will take longer to refill the lakes to conservation pool. It is expected that the increase in the maximum stages downstream from the lakes for extreme events will be minor, but there is no expected increase in the duration of the events above flood stage.

Fisheries management options of large multipurpose reservoirs are limited due to the water level management objectives (flood control, hydropower generation, etc.). Many times, lakes of this nature exemplify the "boom or bust" condition in standing crops. The shorelines of the White River reservoirs are characterized by bluffs, shelf-rock, boulder, and cobble. Clay, silt, and sandy substrates are limited but occasionally occur in tributary areas. There is very little aquatic vegetation and vegetative cover increases when terrestrial vegetation is inundated.

When considering the effects of the proposed action on the in-lake fisheries, effects can generally be categorized as minor beneficial with any reallocation that results in decreased durations of elevations suitable for vegetation establishment. The benefit would be short term and eventually the habitat would revert to the current conditions due to the operation plan. A

critical factor for the fishery is stable water levels that inundate the vegetation during the spawning and recruitment periods but does not result in vegetation mortality.

Tailwaters

Increases in wetted area (amount of bottom substrate that is always covered) and duration will increase at each tailwater under the implementation of proposed action (BS-3 and NF-7). Target flows will result in wetted area consisting of 3,366 acres downstream of Bull Shoals and 83 acres downstream of Norfork, which is a 33 percent increase in Bull Shoals tailwater and a 53.7 percent in Norfork tailwater.

In both tailwaters the proposed action benefits include: Increased food production from increased continual riffle coverage; large scale trout habitat increases; potential trout reproduction; an increase in trout growth rates, and navigation improvements from mean depth increases. Increases in wetted area (amount of bottom substrate that is covered) and duration will increase at each tailwater. The wetted area is important but the duration increase of this area is a critical component of increased ecological function. The wetted area (primarily riffle areas) is the source of aquatic invertebrate production. Increased wetted area would substantially increase the area available for aquatic invertebrate (particularly aquatic insects) production. Increased aquatic insect production would not only provide a direct increase in forage available for trout but also for organisms such as sculpins, dace, stonerollers, and crayfish that are essential forage species. The increase in abundance of primary forage levels should translate to increased growth rates for trout.

ES.6 Threatened & Endangered Species

The USFWS identified 670, 675, & 690 feet as elevations of concern on the Bull Shoals project relative to the potential impacts on the endangered Tumbling Creek Cave Snail and its habitat. The concern is that the velocities of the drainage system of the Tumbling Creek Cave (and resulting sedimentation) are affected at the higher lake levels. There will be a 2.3 percent increase in duration annually at the 670 elevation and < 2 percent increase at 675 and 690 with BS-3 implementation

A Biological Assessment (BA) was completed by the Corps to comply with Section 7 of the Endangered Species Act. The BA concluded that any reallocation of 5 feet of storage from the proposed storage alternatives may affect, but is not likely to adversely affect the Tumbling Creek Cavesnail. The USFWS concurred with these findings in their letter dated July 13, 2004. The complete Tumbling Creek Cavesnail BA and USFWS concurrence letter can be found in Appendix F.

The elevations identified by the USFWS as critical elevations (≥ 580 ft MSL) at Norfork Lake for the Ozark hellbender (a Federal candidate species) are above the top of the flood pool and will not be affected by implementation of NF-7.

ES.7 Air Quality

Other than the no action alternative, the reallocation alternatives may result in a decrease in hydropower production in a worst-case scenario drought condition. Should this happen, this power would have to be provided by alternative sources such as other hydropower plants, combustion plants (gas, coal, oil) or nuclear power plants. Even if all additional power were acquired from combustion plants, air quality would not be significantly impacted. The percent increase in statewide emissions as a result of the proposed action would be deminimus.

ES.8 Socioeconomic Resources
Implementation of Minimum Flows could lead to some short-run increase in economic activity. Some of the implementation alternatives require some construction and this will require skilled labor, leading to a small boost in welfare to those individuals and those who supply them. Long-run conditions could be more fruitful. Under Minimum Flows, the study area could experience an increase in economic activity attributable to freshwater sportsmen. Increased visitations to the study area would undoubtedly lead to increased benefits to business owners and those employed by them.

Recreation activities at each lake will continue to be available to the public. Impacts to some Lakeside Facilities such as campsites and day use areas are expected through the increased pool elevations. The non-Federal Sponsor will provide relocations or modifications for roads, parking lots, restrooms, picnic areas, boat ramps, and electrical facilities to allow for reasonable continued use.

ES.9 Cultural Resources
Regarding the reallocation alternatives, in 2002, Little Rock District consulted with the Arkansas State Historic Preservation Office, the Missouri State Historic Preservation Office, and the appropriate Native American Tribes. It was determined that the resulting minimum flow would be much less than that released during power generation. Therefore, there would be no additional damage to cultural resources, including archeological sites and standing structures, in the tailwaters of the dams. There would also be no significant changes in pool elevation frequency and duration.

ES.10 Cumulative Impacts
Cumulative effects or impacts can result from individually minor, but collectively significant actions taking place over a specified time period. Cumulative effects are the impacts on the environment that could result from the incremental effect of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. The geographical boundary for the proposed action consists of Bull Shoals and Norfork lakes, land immediately adjacent to or surrounding the lakes, and the confined channel area of their respective tailwaters. The Bull Shoals project area consists of 101,196 acres including land and water surfaces. The total area contained in the Norfork project, including both land and water surface, consists of 54,228 acres. The Bull Shoals Tailwater is defined as the White River below Bull Shoals Dam to Guion, a total, length of 89 miles (144 km). The Norfork Tailwater is defined as the North Fork river below Norfork Dam to the confluence with the Bull Shoals Tailwater of the White River, a total of 4.7 miles.

Past, present, and reasonably foreseeable future actions are diverse and too numerous to list each individual activity but can be categorized by the following types of activities:

- Water supply reallocations
- Reservoir operations by the Corps of Engineers
- Corps Planning Projects such as Ecosystem Restoration Projects
- Corps Regulatory (i.e. Section 404 permitting - CWA)
- Fish and Wildlife Management activities by the U.S Fish and Wildlife Service, Arkansas Game and Fish Commission, and the Missouri Department of Conservation as well as other agencies.

- Source point and non-point source pollutant activities by the public and industrial sectors.

With respect to cumulative impact analysis, no environmental resources within the Bull Shoals and Norfork geographic project boundaries were found to be significantly adversely impacted. However, projects in the Bull Shoals and Norfork Lake areas will create increased recreation opportunities and urbanization, which may well increase the completion for land use surrounding the lakes. Increased demand for water uses will eventually reach the Corps 50,000 acre-foot limit and require Congressional authorization for future water supply.

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1.0 Introduction

1.1 Purpose and Need

The purpose of the proposed Minimum Flows action is to provide fish and wildlife enhancements for the tailwaters downstream of Bull Shoals and Norfork Lakes, while minimizing adverse effects to the environment and the flood control, hydropower, water supply, and in-lake recreation uses of the two lakes.

The need for the proposed action is to increase minimum flows for the benefit of the tailwater fisheries below Bull Shoals and Norfork dams. When the dams were first constructed the release of cold water resulted in a conversion of the existing warm water fishery to a cold-water fishery. As a result, mitigation for this change resulted in the stocking of trout in the lakes and below the dams to create a non-native trout fishery. Since that time, it has become apparent that releases below the dams have not been sufficient to maintain the life cycle requirements of the trout and have actually caused fish mortality and chronic sub lethal effects due to low dissolved oxygen levels and warm water temperature in the dam releases.

The Little Rock District manages the water and land areas at Bull Shoals and Norfork lakes to ensure compliance with specific congressionally authorized flood control and power generation purposes, as well as to provide water supply, recreational, and other benefits to the public. The proposed action is to provide an improved minimum flow for the benefit of the tailwater fishery as directed in Section 132 of the FY 2006 Energy and Water Resources Development Act (P.L. 109-103). The purpose of this EIS is to evaluate the proposed actions under the National Environmental Policy Act, accomplishing congressionally authorized project purposes while balancing permitted private uses, social and economic needs, and the application of sound environmental stewardship to managed resources.

1.2 Background

The Water Resource Development Acts (WRDA) of 1999 (Section 374) and 2000 (Section 304) modified the basic authorization and operation for the five multipurpose White River Basin lakes: Beaver, Table Rock, and Bull Shoals Lakes on the White River; Norfork Lake on the North Fork White River; and Greers Ferry Lake on the Little Red River (See Figure 1.3-1). Under the original authorization, water levels have been managed primarily for flood control, hydroelectric power generation, and to a lesser extent water supply. Because all of the storage space in the lakes is already allocated to existing purposes and no unused storage or surplus storage is available, there would need to be a reallocation of storage to implement the added measure.

Under WRDA 1999 and 2000, the Corps was directed to complete a study and report to determine if minimum flow reallocations adversely affect other authorized purposes. In addition, the study was required to identify Federal costs that would be incurred.

The White River Minimum Flows Reallocation Study Report, signed in July 2004, analyzed reallocation and release scenarios at these five multipurpose lakes. The Reallocation Report

identified economically justified, technically sound, and environmentally acceptable reallocation and release scenarios at each lake. The July 2004 Reallocation Report resulted in Section 132 of the FY 2006 Energy and Water Development Appropriations Act (P.L. 109-103) authorizing and directing the implementation of plans BS-3 at Bull Shoals and NF-7 at Norfork Lakes, both described in the White River Minimum Flows Reallocation Study Report, dated July 2004. The action is to be at full Federal expense in accordance with section 906(e) of WRDA 86, with the exception of certain features required of a non-Federal Sponsor. Section 132 did not authorize implementation of Minimum Flow proposals at Beaver, Table Rock, and Greers Ferry Lakes. In addition, Section 132 repealed the previous project authorities in WRDA 99 and WRDA 00, eliminating further consideration of alternative plans.

Section 132 of 2006 Energy and Water Development Appropriations Act (EWDAA) (Public Law 109-103) is shown below. (Note that subsection 132(b) is not applicable to the Minimum Flows project and subsection 132(c) deauthorizes the previous WRDA 1999 and 2000 authorities for Minimum Flows.)

> ***Sec 132. White River Basin, Arkansas.--***
> *(a) Minimum Flows.-*
> *(1) IN GENERAL.— The Secretary is authorized and directed to implement alternatives BS–3 and NF–7, as described in the White River Minimum Flows Reallocation Study Report, Arkansas and Missouri, dated July 2004.*
> *(2) COST SHARING AND ALLOCATION.— Reallocation of storage and planning, design and construction of White River Minimum Flows project facilities shall be considered fish and wildlife enhancement that provides national benefits and shall be a Federal expense in accordance with section 906(e) of the Water Resources Development Act of 1986 (33 U.S.C. 2283(e)). The non-Federal interests shall provide relocations or modifications to public and private lakeside facilities at Bull Shoals Lake and Norfork Lake to allow reasonable continued use of the facilities with the storage reallocation as determined by the Secretary in consultation with the non-Federal interests. Operations and maintenance costs of the White River Minimum Flows project facilities shall be 100 percent Federal. All Federal costs for the White River Minimum Flows project shall be considered non-reimbursable.*
> *(3) IMPACTS ON NON-FEDERAL PROJECT.— The Administrator of Southwestern Power Administration, in consultation with the project licensee and the relevant state public utility commissions, shall determine any impacts on electric energy and capacity generated at Federal Energy Regulatory Commission Project No. 2221 caused by the storage reallocation at Bull Shoals Lake, based on data and recommendations provided by the relevant state public utility commissions. The licensee of Project No. 2221 shall be fully compensated by the Corps of Engineers for those impacts on the basis of the present value of the estimated future lifetime replacement costs of the electrical energy and capacity at the time of implementation of the White River Minimum Flows project. Such costs shall be included in the costs of implementing the White River Minimum Flows project and allocated in accordance with subsection (a)(2)above.*

(4) OFFSET.—In carrying out this subsection, losses to the Federal hydropower purpose of the Bull Shoals and Norfork Projects shall be offset by a reduction in the costs allocated to the Federal hydropower purpose. Such reduction shall be determined by the Administrator of the Southwestern Power Administration on the basis of the present value of the estimated future lifetime replacement cost of the electrical energy and capacity at the time of implementation of the White River Minimum Flows project.

(b) FISH HATCHERY.-In constructing, operating, and maintaining the fish hatchery at Beaver Lake, Arkansas, authorized by section 105 of the Water Resources Development Act of 1976 (90 Stat. 2921), losses to the Federal hydropower purpose of the Beaver Lake Project shall be offset by a reduction in the costs allocated to the Federal hydropower purpose. Such reduction shall be determined by the Administrator of the Southwestern Power Administration based on the present value of the estimated future lifetime replacement cost of the electrical energy and capacity at the time operation of the hatchery begins.

(c) REPEAL.-Section 374 of the Water Resources Development Act of 1999 (113 Stat. 321) and section 304 of the Water Resources Development Act of 2000 (Public Law 106-541) are repealed.

This EIS will focus on the authorized projects at Bull Shoals (BS-3) and Norfork (NF-7). Refer to Appendix G for information related to WRDA study efforts at Beaver, Table Rock, and Greers Ferry Lakes.

1.3 Study Area

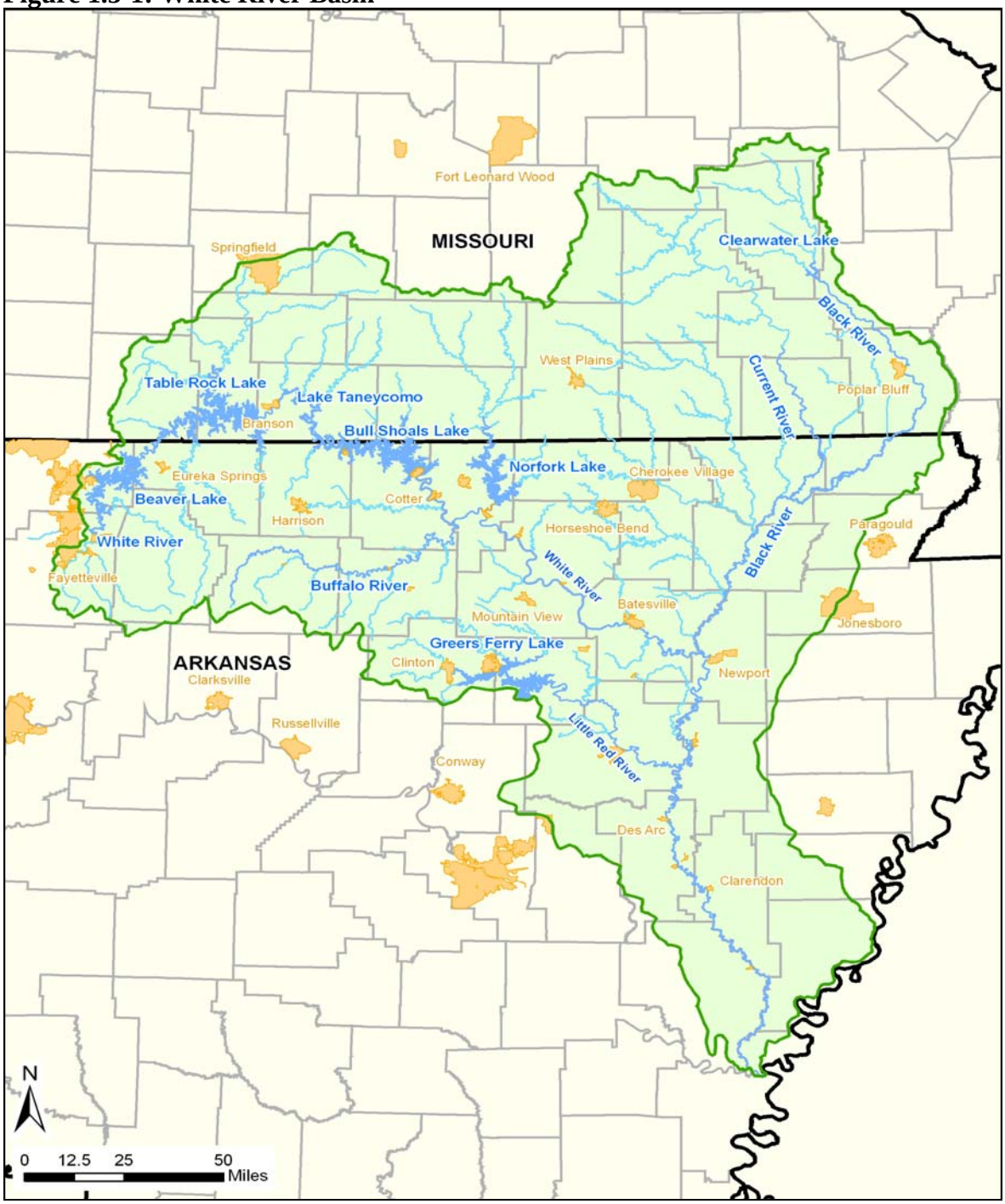
The White River and its tributaries drain a total area of 27,765 square miles (10,620 square miles in Missouri and 17,145 square miles in Arkansas). The basin is shown in figure 1.3-1. The White River Basin originates in the Boston Mountains of northwest Arkansas (AR), near the city of Fayetteville. Three forks, the White River, the Middle Fork, and the West Fork, come together in Washington County, AR to form the mainstem of the White River. The White River is first impounded as Lake Sequoyah, a 500-acre impoundment at the junction of the Middle Fork and the White River, near Fayetteville. The White River flows south out of Lake Sequoyah and joins the West Fork before entering Beaver Lake just west of Eureka Springs, AR. The White flows out of Beaver Dam (the first in a series of four hydroelectric dams) northward into Missouri (MO) near the town of Eagle Rock, Barry County. The White then flows eastward where it has been impounded as Table Rock Lake, just below its confluence with the James River near Branson. The White River below Table Rock Lake is again impounded by Powersite Dam at the private Ozark Beach hydropower project operated by Empire District Electric Company near Forsyth, MO, forming Lake Taneycomo. The river flow takes a southerly turn and flows back into Arkansas where it is impounded by Bull Shoals Dam near Cotter, Marion County. The White River flows towards the southeast from Bull Shoals Dam. The White River exits the Ozark Plateau and enters the Mississippi Alluvial Plain near Newport, AR. The White River continues to flow in a southerly direction from where it enters the delta until its confluence with the Mississippi River near Montgomery Point, AR, some 720 miles from its origin.

In order to evaluate the different alternative plans, and to determine the potential impacts of the respective plans on an individual and cumulative basis, it was necessary to compare the effects from the alternatives to the existing or baseline conditions. It was determined that the study area should include the White River Basin in Arkansas and Missouri with the exception of the Black River Basin.

The primary focus of this study is Bull Shoals Lake, Lake Norfork, and their respective tailwaters. White River mile (WRM) 418.6 to 329.1) includes the Bull Shoal tailwater. North Fork River Mile (NRM) 4.8 to 0.0 is considered the North Fork tailwater. The Buffalo National River enters the White River at WRM 387.8 and the North fork of the White River enters at WRM 376.4.

The Norfork tailwater (TW) and Bull Shoals TW were created upon the completion of Norfork and Bull Shoals dams in 1944 and 1952 respectively. Subsequently, releases of cold hypolimnetic water essentially destroyed the native warm water fishery of both streams within their respective cold-water tailwaters.

Figure 1.3-1: White River Basin



2.0 Description of the Proposed Action and Alternatives

The directed alternative at Bull Shoals Lake is BS-3, reallocation from the flood pool released through an existing hydropower main turbine. The directed alternative for Norfork Lake, NF-7, is a 50:50 reallocation with releases through existing station service units and a siphon. These satisfy the need of the proposed action, comply with the Congressional directives, and provide compensation to the hydropower users and affected facilities.

2.1 The Proposed Action

2.1.1 Bull Shoals (BS-3) Reallocate from Flood Pool

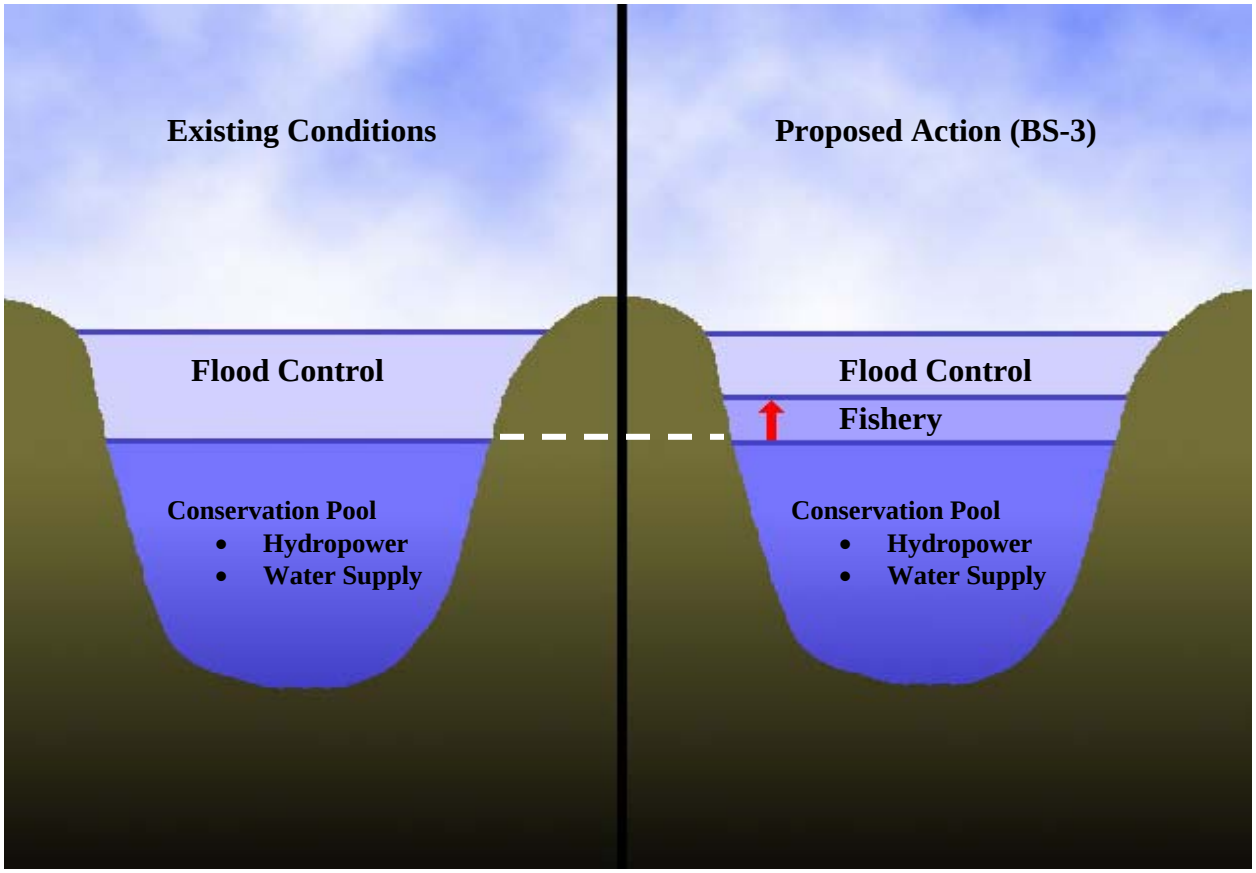
The 2006 EWDAA directed reallocation of 5 feet of flood control storage at Bull Shoals (see figure 2.1-1). This would increase the top of the conservation pool by 5 ft to 659 ft MSL, increasing the surface area by 2,565 acres or 5.6 percent, and provide a minimum flow of 800 cubic feet per second (cfs). An increase of conservation pool storage will reduce the flood pool volume by 233,000 acre feet (AF). The volume of the incremental increase in conservation storage is calculated using the existing elevation-storage tables for Bull Shoals Lake. No additional land will be flooded that is not currently flooded annually.

A flood pool reallocation would result in changes to the Corps' flood operations. The Corps would continue to evacuate floodwaters as quickly as possible to provide maximum protection from future rainfall runoff. Once flood releases are concluded, at the top of the new conservation pool (659ft-msl), SWPA will begin either hydropower operations or minimum flow releases will resume.

During droughts, the conservation pool may be reduced and refilled only when rainfall occurs. When hydropower storage (conservation pool storage) is depleted due to drought, power-generating operations are stopped until inflows recharge conservation pool storage. Similarly, in drought years the minimum flow releases will be halted whenever the specific volume of minimum flow storage has been used and will not be restarted until inflows have recharged the storage.

At Bull Shoals the minimum flows release is large enough to generate a small amount of hydropower with the existing main turbine. Authorized reallocation and release scenario BS-3, specifies the use of the main turbine at Bull Shoals to facilitate minimum flow releases and is considered the final solution for minimum flows implementation under current authorization. The remote operating computer language, SCADA, can be modified quickly in order to use the main turbine for minimum flow releases. Note, test releases in June 2001 revealed that the use of main turbines to make minimum flow releases is only feasible at Bull Shoals.

Figure 2.1.1-1: Flood Pool Reallocation



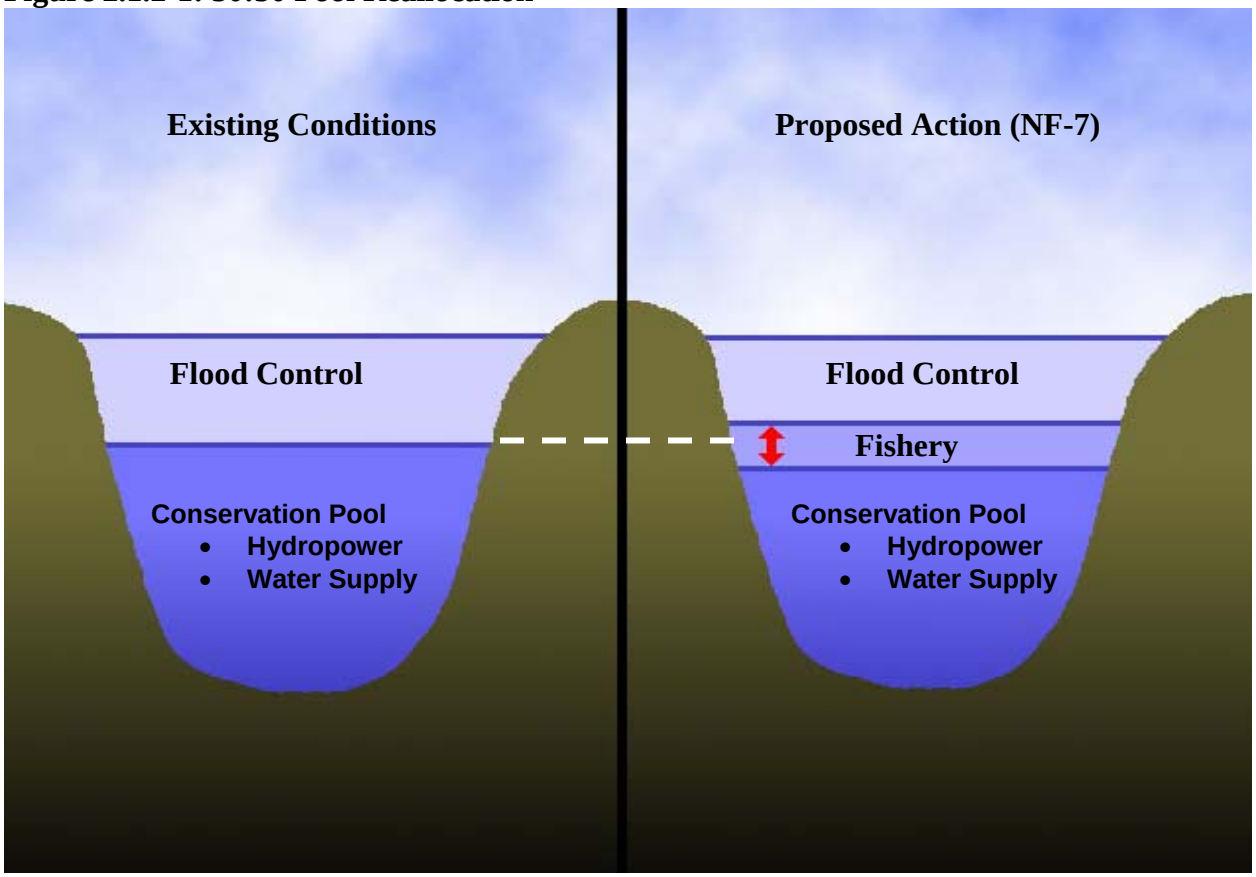
2.1.2 Norfork (NF-7) Reallocate 50 percent from Conservation and 50 percent Flood Pool

The 2006 EWDAA directed reallocation of 3.5 feet of storage at Norfork to be evenly divided (50:50) between the conservation and flood control pools to provide a minimum flow release of 300 cfs(see figure 2.1-2). NF-7 requires a siphon and valve system with a layered intake to be constructed and operated in concert with the existing Station Service Unit to make the minimum flow release. A siphon system will include a 24" diameter steel pipe through and along the downstream face of the dam with discharge through a knife valve that has potential for significant improvements in the tailwater DO during non-generation periods, and a multi-layered intake system on the lakeside. The siphon system provides the ability to remotely operate the discharge for the minimum flow release. It does not affect other operations of the dam or powerhouse. The top of the conservation pool elevation will increase 1.75 feet to 553.75 ft MSL and the surface area will increase 464 acres or 2.1 percent. An increase of conservation pool storage will reduce the flood pool volume by 38,900 AF. The volume of the incremental increase in conservation storage is calculated using the existing elevation-storage tables for Norfork Lake. No additional lands will be flooded that is not currently flooded annually.

A 50:50 reallocation would result in changes to the Corps' flood operations. The Corps would continue to evacuate floodwaters as quickly as possible to provide maximum

protection from future rainfall runoff. Once flood releases are concluded, at the top of the new conservation pool (553.75 ft-msl), SWPA will begin either hydropower operations or minimum flow releases will resume.

Figure 2.1.2-1: 50:50 Pool Reallocation



2.1.2.1 No Action Alternative

To comply with NEPA the "No Action" alternative was also evaluated. This alternative would consist of no change in current minimum flow operations at each reservoir. The only effects associated with the "No Action" alternative is the continuation of the sub-optimal trout fishery habitat below each dam. The "No Action" alternative does not meet the requirements of the purpose and need of the White River Minimum Flow Reallocation Study Report as directed by Congress

2.1.2.2 Alternatives Considered But Eliminated

The White River Minimum Flows Reallocation Study Report, dated July 2004, identified and evaluated more than 1,000 alternatives for providing the minimum flows. The following alternatives were originally evaluated but eliminated from further consideration in accordance with language found in EWDAA 2006. Information related to the eliminated alternatives is located in Appendix G. For the feet of storage specified at each of the five lakes in WRDA 1999 and 2000, (Beaver 1.5 feet, Table Rock 2 feet, Bull Shoals 5 feet, Norfork 3.5 feet, Greers Ferry 3 feet) alternatives were developed for reallocating the storage from either the flood control pool, the conservation (hydropower)

pool, or both pools 50/50. Additionally, combinations of various methods for making the releases were applied to each of those pool scenarios. These release methods included using the main hydropower turbines, using the small station service units that provide electricity for lake project facilities, or using siphons that bypass all power generation. The alternatives also used target minimum flow volumes identified by Arkansas Game and Fish Commission in previous studies.

LAKE	REALLOCATION SCENARIO	RELEASE METHOD	PLAN ID
BEAVER	FLOOD POOL	SIPHON & SS UNITS	BV1
	FLOOD POOL	NEW SS UNIT	BV2
	FLOOD POOL	SIPHON ONLY	BV3
	CON. POOL	SIPHON & SS UNITS	BV4
	CON. POOL	NEW SS UNIT	BV5
	CON. POOL	SIPHON ONLY	BV6
	50/50	SIPHON & SS UNITS	BV7
	50/50	NEW SS UNIT	BV8
	50/50	SIPHON ONLY	BV9
LAKE	**REALLOCATION SCENARIO**	**RELEASE METHOD**	**PLAN ID**
TABLE ROCK	FLOOD POOL	SIPHON & SS UNITS	TR1
	FLOOD POOL	NEW SS UNIT	TR2
	FLOOD POOL	SIPHON ONLY	TR3
	CON. POOL	SIPHON & SS UNITS	TR4
	CON. POOL	NEW SS UNIT	TR5
	CON. POOL	SIPHON ONLY	TR6
	50/50	SIPHON & SS UNITS	TR7
	50/50	NEW SS UNIT	TR8
	50/50	SIPHON ONLY	TR9

* SS = Station Service

LAKE	REALLOCATION SCENARIO	RELEASE METHOD	PLAN ID
BULL SHOALS	FLOOD POOL	SIPHON & SS UNITS	BS1
	FLOOD POOL	NEW SS UNIT	BS 2
	FLOOD POOL	SIPHON ONLY	BS 4
	CON. POOL	SIPHON & SS UNITS	BS 5
	CON. POOL	NEW SS UNIT	BS 6
	CON. POOL	MAIN TURBINE	BS 7
	CON. POOL	SIPHON ONLY	BS 8
	50/50	SIPHON & SS UNITS	BS 9
	50/50	NEW SS UNIT	BS 10
	50/50	MAIN TURBINE	BS 11
	50/50	SIPHON ONLY	BS12
LAKE	**REALLOCATION SCENARIO**	**RELEASE METHOD**	**PLAN ID**
NORFORK	FLOOD POOL	SIPHON & SS UNITS	NF1
	FLOOD POOL	NEW SS UNIT	NF2
	FLOOD POOL	SIPHON ONLY	NF3
	CON. POOL	SIPHON & SS UNITS	NF4
	CON. POOL	NEW SS UNIT	NF5
	CON. POOL	SIPHON ONLY	NF6
	50/50	NEW SS UNIT	NF8
	50/50	SIPHON ONLY	NF9
LAKE	**REALLOCATION SCENARIO**	**RELEASE METHOD**	**PLAN ID**
GREERS FERRY	FLOOD POOL	SIPHON & SS UNITS	GF1
	FLOOD POOL	NEW SS UNIT	GF2
	FLOOD POOL	SIPHON ONLY	GF3
	CON. POOL	SIPHON & SS UNITS	GF4
	CON. POOL	NEW SS UNIT	GF5
	CON. POOL	SIPHON ONLY	GF6
	50/50	SIPHON & SS UNITS	GF7
	50/50	NEW SS UNIT	GF8
	50/50	SIPHON ONLY	GF9

* SS = Station Service

3.0 Affected Environment

This chapter describes the study area within the White River Basin and outlines its major features and existing conditions with respect to various categories pertinent to this study. The categories include land use, climatology, physiography and soils, water resources, biological resources, water quality, air quality, cultural resources, socioeconomics, environmental justice, and recreational resources.

3.1 Climatology

The climate of the White River Basin is humid with annual precipitation ranges from about 42 inches in the northern part of the area to about 53 inches in the Boston Mountains. The average monthly temperature in the northern part of the study area ranges from about 40°F in the winter to almost 80°F in the summer. The average monthly temperate in the southern part of the basin ranges from about 45°F in February to 82°F in July.

3.2 Land Use

The White River floodplain includes a total of 787, 170 acres. An unpublished report from the U.S. Department of Agriculture divides the White River floodplain into cropland (55.7 percent), pasture land (2.7 percent), woodland (32.9 percent) water (4.8 percent), and other (3.9 percent). Outside the immediate flood plain, there are considerable acreages of public lands administered by the State wildlife agencies of Arkansas and Missouri, the Corps of Engineers, the U.S. Forest Service, and the National Park Service.

Private landowners own the majority of land in the Ozark Mountains. Major land uses include timber production and grazing with less than 3.0 percent in cultivated land. Among the areas held by public landholders, the U.S. Forest Service manages almost one million acres, and the National Park Service manages some 90,000 acres. In addition, the U.S. Army Corps of Engineers oversees four reservoirs that have inundated more than 175,000 acres. The State of Arkansas owns and manages more than 45,000 acres in the Ozarks, most of which is set aside for hunting and fishing.

Land use within the Mississippi Alluvial Plain portion of the study area consists primarily of agriculture. Timber production also occurs in this area of the basin although a vast amount of forested area no longer exists. Land ownership in this area is mainly private, though the U.S. government maintains three national wildlife refuges totaling about 133,000 acres and the State of Arkansas manages nearly 160,000 acres for game and fish. Table 3.2-1 lists public areas within the White River Minimum Flow Study area.

Table 3.2-1: Public Areas in the White River Minimum Flow Study Area

Area Name	Management[1]	County	Acres	Impoundment Acres
Roaring River State Park	MDNR	Barry	3,403	
Roaring River CA	MDC	Barry	439	
Roaring River Fish Hatchery	MDC	Barry	3	
Busiek State Forest	MDC	Christian	2,505	
Grundy Memorial WA	MDC	Douglas	40	
Squires Towersite	MDC	Douglas	5	
Caney Mountain CA	MDC	Ozark	7,882	
Wilderness Towersite	USFS	Stone	2	
Ruth and Paul Henning CA	MDC	Taney/Stone	1,534	
Shepard of the Hills Fish Hatchery and Visitor Center	MDC	Taney	211	
Hollister Towersite	MDC	Taney	180	
Boston Ferry CA	MDC	Taney	180	
Hilltop Towersite	MDC	Taney	3	
Drury-Mincy CA	MDC	Taney	5,699	
Branson MDC Office	MDC	Taney	4	
Cedar Creek Towersite	MDC	Taney	4	
Cooper Creek Access	MDC/EDEC	Taney	29	
Bull Shoals Lake*	MDC/USCOE	Various	62,326	45,440
Lake Taneycomo	MDC/USCOE	Taney	NA[2]	2,080
Empire Park	EDEC/MDC	Taney	3	
Table Rock Lake*	USCOE/MDC	Various	24,102	43,100
Table Rock State Park	MDNR	Taney	356	
Hercules Glades Wilderness	USFS	Taney	12,315	
Mark Twain National Forest	USFS	Numerous	186,253	
Wildcat Shoals Access	AGFC	Baxter	2	
Beaver Lake/ State Park Hobbs State Mgmt. Area	USCOE, AGFC, ADP&T, ANHC	Benton	11,644	
Bull Shoals Nursery Pond	AG&FC	Boone	NA[2]	
Houseman Access	AF&FC	Carroll	NA[2]	
Withrow Springs State Park	ADP&T	Carroll	780	
Hindsville Lake	AG&FC	Madison	1	
Madison County WMA*	AG&FC	Madison	14,227	
Marble Access	AG&FC	Madison	1	
Ozark National Forest	USFS	Madison	6,000	
Rock House Access	AGFC	Madison	23	
Bull Shoals State Park	ADP&T	Marion	660	
Crooked Creek Access	AG&FC	Marion	2	
Marion County WMA*	AG&FC	Marion	120	
Pot Shoals Net Pen Proj.	AG&FC	Marion	90	
Ranchette Access	AG&FC	Marion	1	
Marion County Access	AG&FC	Marion	NA[2]	
White Hole Access	AG&FC	Marion	NA[2]	
Bayou Des Arc WMA*	AG&FC	Prairie	953	320
Bayou Meto WMA*	AG&FC	Arkansas, Jefferson	33,700	
Buffalo River WMA*	AG&FC	Newton, Searcy	17,652	
Jones Point WMA*	AG&FC	Marion	NA[2]	
Loafer's Glory WMA*	AG&FC	Searcy	2,720	
Norfork Lake/ WMA*	USCOE/AGFC	Baxter	10,000	22,000
Cypress Bayou WMA*	AG&FC	White, Lonoke	NA[2]	
Dagmar Lake/WMA*	AG&FC	Monroe	7,976	
Departee Creek WMA*	AG&FC	White	448	
Greers Ferry Lake/ WMA*	USCOE/AG&FC	Cleburne, Van Buren	NA[2]	31,500
Gulf Mt. WMA*	AG&FC	Van Buren	14,000	
Henry Gray/Hurricane Lake WMA*	AG&FC	White	17,000	
Holland Bottoms WMA*	AG&FC	Lonoke	NA[2]	
Piney Creek WMA*	AG&FC	Newton	NA[2]	
Prairie Bayou WMA*	AG&FC	Lonoke	NA[2]	
Searcy County WMA*	AG&FC	Searcy	NA[2]	
Sylamore WMA*	USFS/AG&FC	Marion, Searcy, Stone, Baxter	1,280	
Trusten Holder WMA*	USCOE, USFWS, AG&FC	Arkansas, Desha	10,268	
Wattensaw WMA*	AG&FC	Prairie	16,809	
White Rock WMA*	USFS, AG&FC	Washington, Madision	NA[2]	
Lake Barnett	AG&FC	White	NA[2]	
Bob Kidd Lake	AG&FC	Washington	NA[2]	
Greenlee Lake	AG&FC	Monroe	NA[2]	

*Wildlife Management Area

[1]Management responsibility- ADNH = Arkansas Department of Natural Heritage; ADP&T = Arkansas Department of Parks & Tourism; AGFC = Arkansas Game & Fish Commission; MDC = Missouri Department of Conservation; MDNR = Missouri Department of Natural Resources; EDEC = Empire District Electric Company; USCOE = United States Army Corps of Engineers; USFS = United States Forest Service.

[2]NA indicates that no acreage was reported for these areas.

SOURCES: URL:http://www.conservation.state.mo.us/fish/watershed/whriver/contents/390cotxt.htm
Last modified: Tuesday, 30-Jan-2001 16:34:17 CST
URL:http://www.agfc.state.ar.us/lakes-wmas/default.htm

3.3 Physiography

The area drained by the White River includes parts of two major physiographic divisions, the Interior Highlands and the Coastal Plain. Each is further divided into provinces and sections. Figure 3.3-1 depicts the ecoregions found within the White River Basin.

3.3.1 Interior Highlands

The Interior Highlands include about three-fourths of the White River drainage basin, and are characterized by plateau surfaces entrenched by steep-walled valleys. The nearly flat, plateau surfaces tend to delay runoff. Where the plateau surfaces are underlain by calcareous rocks, karst topography develops. This enhances infiltration of precipitation. Karst features are locally prominent in both the Salem and Springfield plateaus (MDNR 1986a). Several faults are present in the watershed, but most have only tens of feet of displacement (MDNR 1986a). The fractured limestone of the watershed allows a direct conduit from surface water to ground water, making aquifers underlying the watershed extremely susceptible to contamination (USGS 1996).

Most of the Interior Highlands in the White River Basin are within the Ozark Plateaus province. The basin includes parts of the Springfield-Salem Plateaus and Boston Mountains section. The Salem Plateau is underlain by rocks of Ordovician age or older. The Springfield Plateau is underlain by rocks of Mississippian age.

The upland parts of the plateaus are the remains of an old erosional surface. The surface has been modified by continued solution and erosion resulting in a somewhat lowered surface. Local relief of the upland surface generally does not exceed 50 feet. Valleys dividing the upland surfaces range in depth from 50 to 100 feet near their head, to as much 1,500 feet in the entrenched meanders of larger streams near their mouths.

The Boston Mountains are a dissected plateau approximately 200 miles long and 35 miles wide. This plateau is underlain by sedimentary rocks of Pennsylvanian age, and bounded on the north by a conspicuous escarpment. Toward the east and west, the summit level declines gradually to that of the surrounding surface. The summit slope is toward the south and is similar to the dip of the underlying formations. It is nearly flat close to the main crest and is steeper near the south edge. Along the southern boundary, the Boston Mountains merges with the hills of the Arkansas Valley section of the Ouachita province.

The Interior Highlands is separated abruptly from the Coastal Plain by the Fall Line. The Fall Line is the westernmost boundary of rocks of Cretaceous or younger age except for Recent alluvium in stream valleys of the Interior Highlands.

3.3.2 Coastal Plains

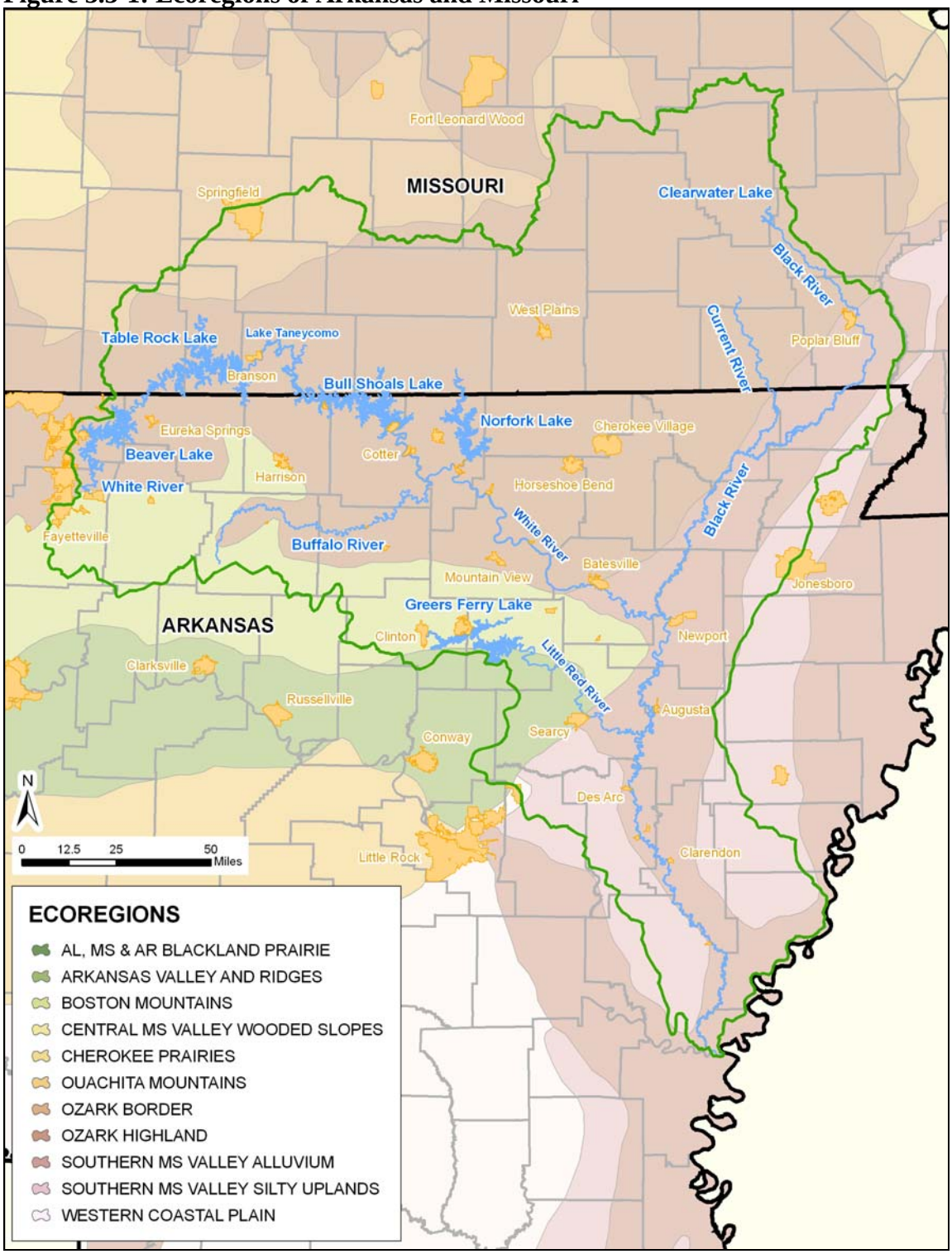
Approximately one-fourth of the White River basin is in the Mississippi Alluvial Plain section of the Coastal Plain province. Topography of the Coastal Plain is characterized by flat monotonous plains traversed by sluggish meandering streams. Crowley's Ridge, an important physiographic feature, forms part of the eastern border of the basin area and rises

as much as 200 feet above the general level of the Coastal Plain. The land surface of the rest of the Coastal Plain is principally made up of Quaternary age terrace deposits and flood plain deposits of the Mississippi River and its tributaries. The land surface slopes southward from an altitude of about 300 feet above MSL at Poplar Bluff, Missouri, to about 150 feet at the mouth of the White River.

The Grand Prairie region, a low terrace, lies between the White River and Bayou Meto (Arkansas River basin) south of Wattensaw Bayou, and includes most of Arkansas County and parts of Lonoke, Prairie, and Monroe Counties.

In the lower parts of the White River basin, the drainage divides into the White River and other tributaries of the Mississippi River that are poorly defined and difficult to determine. In many places, the divide is formed by a levee or a dike.

Figure 3.3-1: Ecoregions of Arkansas and Missouri



3.4 Geology & Soils

The Salem Plateau is the lowest of the plateaus making up the Ozark Plateau province. The Salem Plateau lies essentially north and east of the White River and forms the drainage area of its eastern tributaries. The Springfield Plateau, which lies south and west of the White River in this region, is represented by isolated knobs, such as Bull Shoals Mountain, in the immediate vicinity of the dam. These plateau surfaces are now intricately and deeply dissected by the dendritic pattern of the White River drainage system. The area is characterized by narrow, flat-topped ridges between deeply cut valleys. The prominent topographic features of the area are the extensive and deeply cut meanders of the White River and its principal tributaries. The White River follows a meandering course through a narrow valley, which has an asymmetrical valley profile at the sharp river bends. A steep, rock bluff forms the valley wall on the outside of the bends and a long, gentle, slip-off slope forms the inside valley wall. Along straight courses of the river between bends, both valley walls are steep and more or less symmetrical. The elevations of the lake area vary from 450 feet MSL in the streambed to 1,100 feet on adjacent hills and ridge tops. The land generally rises from the narrow alluvial bottom in steep slopes to narrow upland plateaus or ridges. In general, the entire area may be classified as rough and broken.

The strata in the region of Bull Shoals Lake have a slight dip to the south. The region is on the southern flank of a large regional dome with its nucleus in the igneous rocks of the St. Francis Mountains about 200 miles northeast. Locally, short anticlines and dome structures with as much as 90 feet of structural relief are noted in the exposures along the White River. Faults with small displacements are found in the vicinity. There is no record of any seismic activity originating in the Bull Shoals area. It is believed that all faults in the region are static and no future movements are expected. Three rock formations of Ordovician age are present above the river level within the region. These formations include the Cotter, Powell, and Everton. The Jefferson City formation underlies the Cotter, and is present only a few feet below river level at the dam. These formations consist largely of dolomite limestone with occasional lenses of sandstone and shale. The Everton and Powell formations are not present at the dam, but cap the nearby hills. These capped hills are remnants of the Springfield Plateau surface.

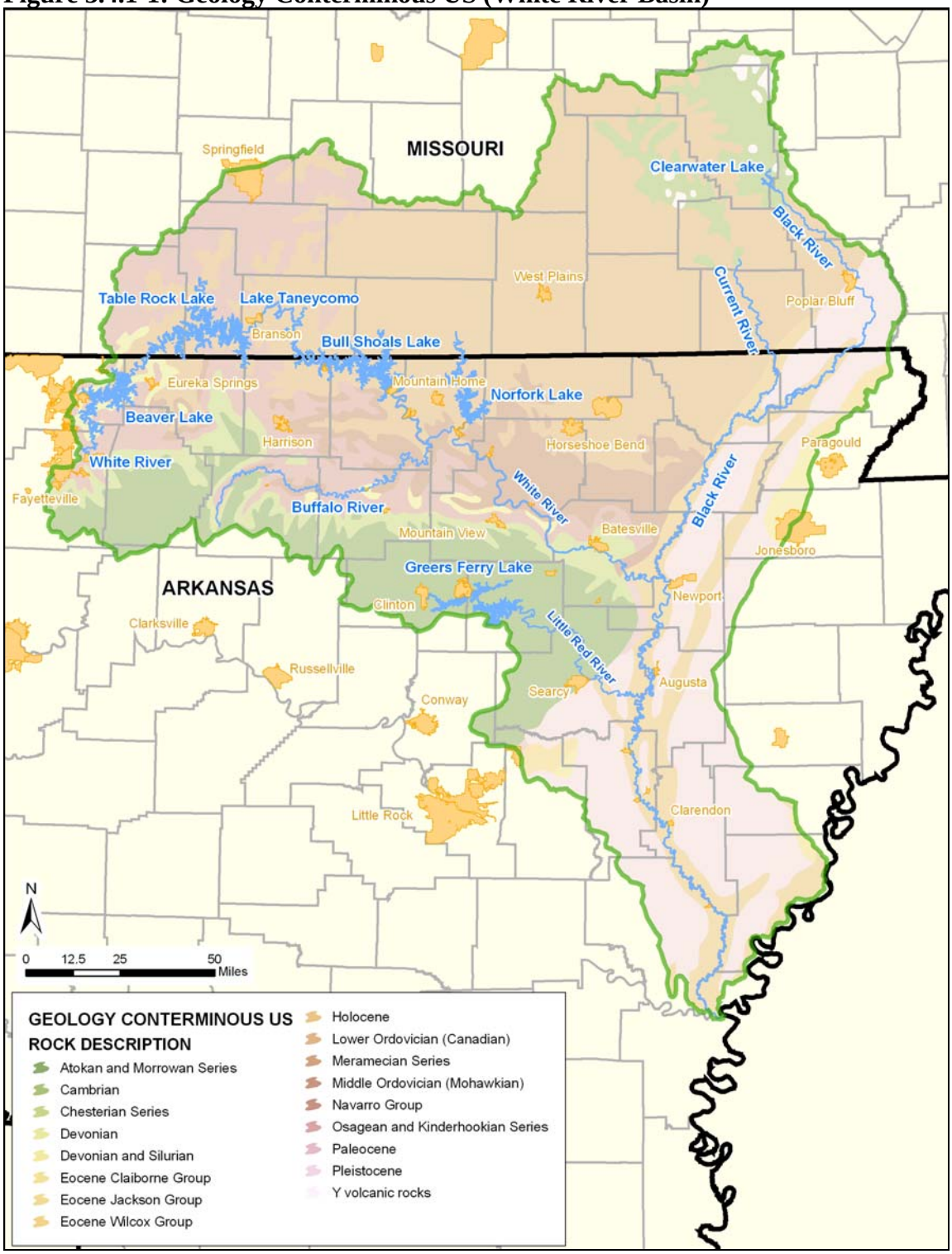
3.4.1 Geology

The uplands of the Salem Plateau are underlain by Jefferson City Dolomite and the Roubidoux Formation, and the valleys are floored by Gasconade Dolomite of Ordivician age. The Springfield Plateau is underlain by Mississippian limestones. The Boston Mountain Plateau is underlain by resistant clastic rocks of Pennsylvanian age. The Eureka Springs escarpment is the boundary between the Mississippian limestone of the Springfield Plateau and the Devonian limestone of the Salem Plateau.

The large dolomite mass, which is present in the Ozarks, has tremendous water storing capability, and the Salem Plateau is the locality for the greatest number and largest springs in Missouri, followed secondly by the Springfield Plateau. The large reservoirs in the southern part of the watershed probably cover many springs. Karst features are locally prominent in both the Salem and Springfield plateaus (MDNR 1986a). Several faults are present in the

watershed, but most have only tens of feet of displacement (MDNR 1986a). The fractured limestone of the watershed allows a direct linkage from surface waters to ground waters, making aquifers underlying the watershed extremely susceptible to contamination (USGS 1996). Figure 3.4-1 depicts the geology found within the White River Basin.

Figure 3.4.1-1: Geology Conterminous US (White River Basin)



3.4.2 Soils

Soils in the Missouri portion of the study area are of the Ozark type. The major soil association is Gasconade-Opequon-Clarksville, found in the western and central portions. A Captina-Clarksville-Doniphan association is present on the watershed's eastern edge. Other minor soil associations include Nixa-Clarksville, along the Missouri-Arkansas border, and Needleye-Viration-Wilderness, near the northwest corner (Allgood and Persinger 1979).

Soils in the Missouri portion of the watershed are generally acidic and of moderate to low fertility. Productivity of watershed soils varies widely, with forest and grassland being the dominant land cover (USDA-SCS 1975). A typical watershed landscape consists of broad forested areas on moderately steep to very steep slopes and small pastures and cultivated fields on smoother ridge tops and in level valley bottoms. Tall fescue is the main grass used for pastures. Native, tall and midtall grasses are found in glade and savannah areas. They are less common than before European settlement (Allgood and Persinger 1979). The moisture holding capacity of these soils is limited, adding to the general unsuitability for crop production. (USDA-SCS 1975).

Ozark soils vary widely in character. Some soils are infertile stoney-clay type soils, while others are loess-capped and fertile. Some watershed soils are stone free, while others may have a stone content exceeding 50 percent, and some areas may have no soils covering bedrock. The majority of the watershed is dominated by stoney, cherty soils found on steep slopes with lower stone contents found in soils on more level areas. Soils in Missouri become less stoney on the western fringe of the watershed. Soils in the watershed are formed from residue high in iron, which oxidizes on exposure, giving the soil a red color. Soils formed in the residuum from cherty limestone or dolomite, range from deep to shallow and contain a high percentage of chert in most places. Soils formed in a thin mantle of loess are found on the ridges and have fragipans, which restrict root penetration. Soils formed in loamy, sandy, and cherty alluvium are found in narrow bottomland areas, and are the most fertile soils in the watershed (Allgood and Persinger 1979).

Soils in the Arkansas portion of the watershed are also Ozarkian. Major soil associations include Clarksville-Nixa-Noark, Captina-Nixa-Tonti, and Arkana-Moko in the Salem and Springfield plateaus and Linker-Mountainburg-Sidon and Enders-Nella-Mountainburg-Steprock in the Boston Mountains (USDA-SCS 1982a).

Soils in the Upper White River area that is below Bull Shoals Lake and above Batesville, Arkansas include the following associations: Talbott-Colbert, Corydon-Sogn, and Sogn-Mountainburg in Baxter County; Sturkie-Peridge, Noark-Portia, Arkana-Moko and Brockwell-Boden-Portia in Izard and Stone Counties; Clarksville-Gepp-Ventris, Beasley-Gasconade, and Egam-Arrington in Independence County. The Sturkie, Portia, and Egam soil series contain lands classified as prime farmland; the other series listed above contain no prime farmland. The Corydon-Sogn association is the primary soil association in the vicinity of Bull Shoals Lake. Neither the Corydon nor the Sogn soil is classified as prime farmland

Soils resources in the vicinity of the Lower White River include the Sharkey-Boudre association in Woodruff County, the Sharkey-Commerce association in Monroe County, the

Sharkey and Newellton-Sharkey-Tunica associations in Phillips County, the Sharkey-Acadia association in Arkansas County, and the Sharkey association in Desha County. The above soils with the exception of the Commerce series in Monroe County and the Sharkey and Acadia series in Arkansas County are classified as prime farmlands.

3.5 Water Resources

3.5.1 Rivers

3.5.1.1 White River

The White River in the western part of the basin flows in a northeasterly direction to the Missouri-Arkansas State line (river mile 591.9). Flow continues in an easterly direction for about 115 miles in southern Missouri and eventually crosses back into Arkansas at about river mile 447.4. Downstream from the state border, flow continues in a southeasterly direction to the mouth of the Black River (river mile 264.8) near Newport, Arkansas. The river flows through the mountainous area for about 428 miles from its source to near Batesville, Arkansas and about 35 miles from Batesville to the confluence with the Black River. The total distance is about 463 miles. A large part of the upper White River consists of a series of lakes formed by Beaver, Table Rock, Ozark Beach, and Bull Shoals dams.

In the mountainous area, the river flows in a very crooked, narrow channel that has eroded vertically through rock to a depth of more than 100 feet in numerous places. The streambed in this reach is composed mostly of rocks, gravel, and boulders. The White River enters the alluvial plain downstream from Batesville, Arkansas. Here, the channel widens and begins to meander. The stream banks are formed of comparatively stable material. In the upper portion of the basin, the White River and its tributaries are classified as clearwater streams and transport only a small amount of sediment.

The elevation of the White River at its source is about 2,050 ft. MSL. In the reach from Batesville to the mouth of the Black River, the stream gradient ranges from a maximum of about 2.5 feet per mile to a minimum of about 1 foot per mile. The gradient throughout the greater part of the Ozark Mountains averages 3 to 4 feet per mile. The flood plain in the highland area is narrow, ranging from one-fourth to 2 miles in width. From Batesville to the mouth of the Black River, bank width ranges from 100 to 500 feet and bank heights range from about 15 feet high in the headwater reaches to about 20 feet in the downstream reach.

Below the confluence with the Black River, the White River is characterized by a meandering channel. The banks and streambed are composed mostly of fine sand, silt, and clay. The fall of the river averages about 0.3 foot per mile in the lower valley. The channel ranges from 200 to 400 feet wide between banks and heights range from 20 to 25 feet in the upstream one-third. In the downstream two-thirds, channel widths range from 400 to 800 feet wide and depths above low water range from 25 to 30 feet. Flow is sluggish in the lower reach. Oxbow lakes, which were formerly channels of the White River, are common.

3.5.1.2 North Fork River

The North Fork River drains 1,825 square miles of the Salem Plateau in Arkansas and Missouri. The basin is underlain mainly by younger dolomite of the Cotter and Jefferson City formations, with older sandstone (the Roubidoux and Gasconade formations of

Ordovician age and the Eminence and Potosi formations of Cambrian age) exposed in the stream valleys in the northern two-thirds of the basin. Isolated outcrops of chert and limestone occur throughout the basin. Outcrops of younger limestone are confined to several small areas in the extreme southeastern part of the area. Norfork Lake is impounded on the North Fork River beginning at approximately 4.8 miles upstream of its confluence with the White River.

3.5.1.3 Buffalo National River

The Buffalo National River (BNR), the nation's first National River, is one of the few remaining unpolluted, free-flowing rivers in the lower 48 states offering both swift-running and placid stretches. The BNR encompasses 135 miles of the 150-mile long river. It begins as a trickle in the Boston Mountains 15 miles above the park boundary. Following what is likely an ancient riverbed, the Buffalo National River cuts its way through massive limestone bluffs traveling eastward through the Ozarks and into the White River. The national river has three designated wilderness areas within its boundaries.

The BNR headquarters is located in Harrison, Arkansas, providing administrative services to the national river. The Tyler Bend Visitor Center, the main visitor center for the park, is located eleven miles north of Marshall, Arkansas. The park has two other visitor contact stations; the Pruitt Ranger Station, located five miles north of Jasper, Arkansas on Highway 7, and Buffalo Point Ranger Station, located 17 miles south of Yellville, Arkansas, on Highway 14 (NPS internet page).

The river originates high in the Boston Mountains. Over its course, the BNR drops steadily to its confluence with the White River. The gradient is steep and the water is faster along the upper river, leveling and slowing as the river runs its course. Relatively long, quiet stretches characterize the lower two thirds of the BNR. The meaning of the BNR today is not difficult to discern. It is reflected in the faces of people accepting the river's recreational challenges. It rises in the spirits of people immersed in this landscape's beauty (NPS internet page).

BNR bluffs reach as high as 440 feet above the river. They are the Ozarks' highest. These stacks of ancient seabeds have been relentlessly sculpted by erosion. Their towering multi-colored cliffs sharply accent the surrounding wild mountain beauty. The park's geology with its numerous caves, sinkholes, waterfalls, springs, and interesting rock formations, typifies the Arkansas Ozarks.

North Arkansas' BNR is roughly 150 miles long and includes nearly 95,000 acres of public land along its corridor. A river for all seasons, the River offers floating, hiking, camping and spectacular sights, from 500-foot bluffs to 200-foot waterfalls. Mid-America's largest herd of elk can be seen from several spots.

Considered a model smallmouth bass stream by many, the BNR's cool, clean waters also provides perfect habitat for channel catfish, green and long-ear sunfish and spotted bass. Fishing is governed by state regulations, and an Arkansas fishing license is required.

The Buffalo National River and White River confluence is at approximately WRM 388 within the cold-water segment of the White river. The influence of the cold-water segment has long been thought to be adversely impacting the interaction of the BNR and White River native, warm-water fisheries since the dams began operating. The populations of the channel catfish (and any other fish species whose movements are inhibited by the cold water temperatures of the White River) may continue to decline without remedial efforts (Petersen and Justus 2005).

Research suggested the low population density of adult channel catfish was a product of reduced migration caused by the artificial, cold-water habitat in the White River (Siegwarth, 1992). Siegwarth concluded that the BNR channel catfish population was not self-sustaining, and he attributed the low population densities of channel catfish within the BNR to reduced immigration caused by the migration barrier of the cold-water system within the White River (NPS communication by letter 2006).

Reduced abundances and extirpations of some warm water fish species is also thought to negatively affect the native mussel communities within the River. Effects on other aquatic communities such as macroinvertebrates are unknown (NPS). Currently, 22 species of native mussels are found within the River, and 11 of these species are considered rare and are state listed (Christian, Mathews, and others, ongoing research, 2006; ANHC**,** 2006). Of the mussel species known to be historically abundant within the BNR (Meek and Clark, 1912), several are in decline. *Ligumia recta* and *Potamilus purpuratus***,** both species of concern, have been reduced in abundance are thought to be totally absent from the River. Research suggests that significant environmental changes or habitat modifications may have occurred since the Meek and Clark survey, which render the BNR unsuitable for these species. Or, another possibility is that some species of large migrant spawning fishes have been greatly reduced and perhaps totally eliminated within in BNR, which native mussels need as suitable fish hosts for reproduction (Harris, 1995).

National Park Service management policies mandate that the service will maintain as part of the natural ecosystems of parks all native plants and animals by preserving and restoring the natural abundances, diversities, dynamics, distributions, habitats, and behaviors of native plant and animal populations and the communities and ecosystems in which they occur (NPS 2001, Section 4.4.1). Given the loss of native fisheries in the BNR, this policy is not being accomplished because of the current management actions being implemented by State and Federal agencies responsible for the water and fisheries management in the White River Basin. Fisheries mitigation actions put in place when the dams were constructed on the White River (trout hatchery and stocking program) have only compounded the complexity of native fisheries management in the BNR by allowing non-native trout species access to the river. Mitigation of the native fishery impacts in the BNR has never been separated from other warm water fishery impacts mitigated through the establishment of the trout hatcheries on the White River upon the completion of the White River dams.

3.5.2 Lakes

3.5.2.1 Bull Shoals Lake

Bull Shoals Lake is an impoundment located in Marion County in north Arkansas, on the White River, about seven miles north of Cotter, Arkansas (Figure 3.5.2.1-1). The reservoir is 45,440 surface acres, receiving water from the surrounding 6,036 square mile watershed. Bull Shoals Lake has an average depth of 67 feet (DPCE, 1996). It is authorized for flood control, hydropower, water supply, recreation and fish/wildlife. It is located in the Ozark Highlands Ecoregion, and was constructed primarily for flood control and power generation (DPCE, 1996), but the lake also serves to provide many recreational opportunities. Construction on Bull Shoals Dam commenced in 1947 and was completed in 1951. The powerhouse and switchyard were completed in 1953, with commercial generation beginning in 1952. With installation of the final four generating units in December 1963, construction was completed for an approximate cost of $86 million. A more detailed discussion of flood control and hydropower operations can be found in Appendix B and C of the White River Basin, Arkansas, Minimum Flows Project Report, dated November 2008.

A general description of Bull Shoals Lake is gently sloped to steep inclines typical of the Ozark highlands. Bluffs of near vertical slope are present where the original White River channel has eroded the residual limestone substrate. Upper reaches of several small tributaries contain small flood plains and gentle slopes of less then 5 percent. Primary ridges and connecting spur ridges have 0 to 10 percent slope with side slopes ranging from 10 to 25 percent inclines. Aspect is generally described as easterly in nature for all land occurring on the west side of the reservoir and westerly in nature for land occurring on the east side of the reservoir, however the presence of ridges and drainages create aspects of all directions.

The Bull Shoals project area contains 101,196 acres; 100,090 acres owned in fee and 1,106 acres are managed by flowage easement. The 71,240 acres below the top of Flood Control Pool elevation (695 msl) and 75 acres required for the dam and appurtenant works are allocated for Project Operations. There are 9,505 acres allocated for recreation-intensive use and 22,718 acres for wildlife management, which includes areas located below the Flood Control Pool elevation.

Table 3.5.2.1-1 depicts the natural and recreational resource benefits that are derived from Bull Shoals Lake.

Figure 3.5.2.1-1: Bull Shoals Lake

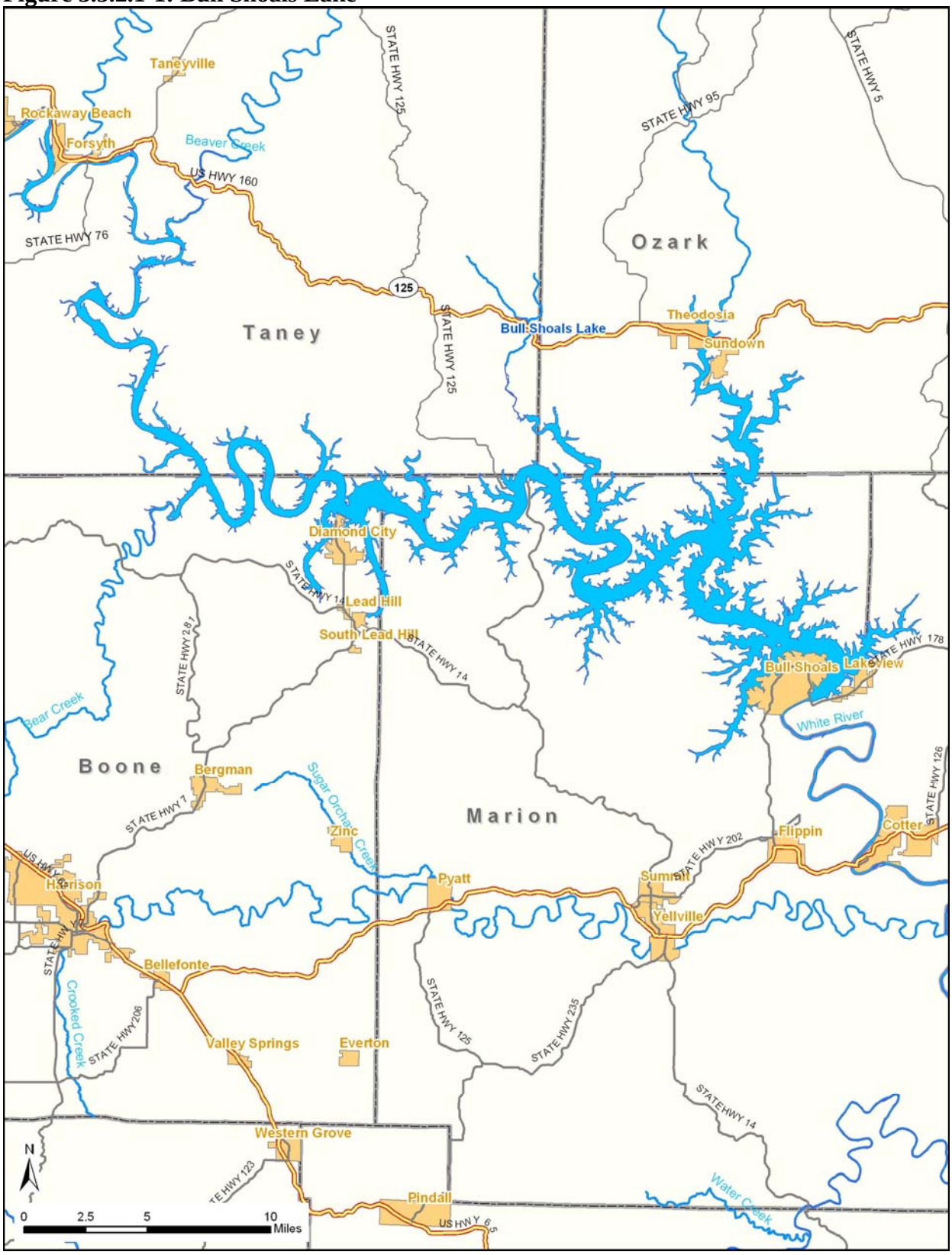


Table 3.5.2.1-1: Natural and recreational resource benefits at Bull Shoals Lake.

Social Benefits		
Facilities	**Visits (person-trips)**	**Benefits in Perspective**
- 30 recreation areas	- 5,552,500 in total	
- 89 picnic sites	- 277,625 picnickers	By providing opportunities for active recreation, Corps lakes help combat one of the most significant of the nation's health problems: lack of physical activity.
- 930 camping sites	- 30,371 campers	
- 18 playgrounds	- 1,277,075 swimmers	
- 14 swimming areas	- 166,575 water skiers	
- 13 trail miles	- 2,609,675 boaters	
- 1 fishing docks	- 2,221,000 sightseers	Recreational programs and activities at Corps lakes also help strengthen family ties and friendships; provide opportunities for children to develop personal skills, social values, and self-esteem; and increase water safety.
- 28 boat ramps	- 2,887,300 fishermen	
- 13 marinas	- 333,150 hunters	
- 2,058 marina slips	- 888,400 others	
Economic Benefits		
5,552,500 visits per year resulted in:		**Benefits in Perspective**
- $95.87 million in visitor spending within 30 miles of the Corps lake.		The money spent by visitors to Corps lakes on trip expenses adds to the local and national economies by supporting jobs and generating income. Visitor spending represents a sizable component of the economy in many communities around Corps lakes.
- 67% of the spending was captured by local economy as direct sales effects.		
With multiplier effect, visitor trip spending resulted in:		
- $122.22 million in total sales.		
- $65.36 million in total income.		
- Supported 3,277 jobs in the local community surrounding the lake.		
Environmental Benefits		
		Benefits in Perspective
- 62,326 land acres		
- 45,440 water acres		Recreation experiences increase motivation to learn more about the environment; understanding and awareness of environmental issues; and sensitivity to the environment.
- 740 shoreline miles		
- 126 acres reforested		
- 2,100 environmental education contacts		

Source: Value to the Nation web site at www.CorpsResults.us. Use Fast Facts to view this and other reports.

Topography

Bull Shoals Lake is located within two physiographic areas of the Ozark Highland. The Salem Plateau is exposed across northern and central Baxter County. The Springfield Plateau is exposed in parts of west central and across most of southern Marion County and most of southern Baxter County, and the Missouri counties of Taney and Ozark. The Salem Plateau is characterized by gently sloping to rolling uplands, and steep, stony side slopes with outcrops of dolomite. The elevation ranges from about 700 to 1,000 feet above sea level. There are a few broad areas on uplands that have a gradient of 1 to 8 percent.

The Springfield plateau is adjacent to and higher in elevation than the Salem plateau. This plateau has been strongly dissected by streams. Steep, V-shaped valleys separated by gently sloping to moderately sloping land characterize it. The side slopes have a gradient of 12 to 50 percent. The elevation atop the ridges ranges from about 1,000 to 1,200 feet above sea level. There are a few broad areas on uplands where the gradient is 1 to 8 percent.

Stream valleys are entrenched and are commonly less than one-fourth mile wide. Most flood plains are 100 to 1,000 feet wide.

Vegetation

The present forest of the Bull Shoals Lake area bears little resemblance to the original forests. Those original forests included stands of high quality oak, hickory, shortleaf pine, elm, and walnut on favorable soils occurring usually on a slope with a northeast aspect. Eastern red cedar and scattered stands of short-leaf pine usually occurred more successfully than hardwoods on the slopes having poor thin soils with a southwest aspect. Today's forest is largely composed of upland oak, hickory, and eastern red cedar. The red cedar has invaded former grasslands and abandoned farmsteads.

Some of the plant communities include post oak savannas. These ecosystems exhibit an open canopy of low density stocking of trees allowing considerable light penetration to the understory. This condition permits a wide variety of shrubs and/or native grass to perpetuate under natural disturbances such as fire. Other plant communities are the dolomite/limestone glades, which are characterized by barrens-like communities of native forbs and grasses occurring on shallow soil over outcroppings of bedrock.

The shoreline areas are affected by the normal reservoir operation plan and characteristic of multipurpose project with little or no vegetation. These areas are commonly referred to as the “bathtub ring” and the display the effects of frequent elevation increases and decreases.

Fish and Wildlife

Bull Shoals Lakes' fishery is managed in a cooperative effort between Missouri Department of Conservation and the Arkansas Game and Fish Commission (AGFC). Bull Shoals Lake is a warm water fishery with most endemic species of the Ozarks Mountains present. Black bass species, white and striped bass, walleye, crappie, channel, flathead, and blue catfish, various sunfish species, are the common game fish on Bull Shoals Lake. Stocking programs of certain game fish occur on Bull Shoals Lake. An annual report of stocking rates and species is submitted by AGFC as required in their lease.

Forest species of wildlife present include white-tailed deer, eastern wild turkey, gray fox, southern flying squirrel, raccoon, opossum, bobcat, and skunks. Black bears were introduced into the area around Bull Shoals Lake by the (AGFC) in the 1960's and are occasionally seen by visitors and harvested by hunters. Upland wildlife present includes bobwhite quail, coyote, red fox, and cottontail rabbit. Migratory game birds include mourning dove, greater Canada geese, and various puddle and diver ducks. Aquatic wildlife includes mink, river otter, muskrat, and beaver. Numerous non-game species, including the Bachman Sparrow, a Missouri-listed endangered species, which uses dense river cane stands for nesting areas. Riparian zones provide habitat and travel corridors for aquatic and terrestrial wildlife and are some of the most productive and important of habitat types found on the project. During the fall migration, bald eagles, osprey, red shouldered, red-tailed, coopers, and sharp shinned hawks are found in abundance. During the spring mating season numerous neo-tropical migrate, passerine songbirds utilize the various habitats types surrounding the lake for breeding and rearing young.

Deer, turkey, squirrel, dove, and rabbit are the species most commonly hunted for game. Trapping for furbearers along the shoreline and upland habitat is common with mink, muskrat, raccoon, and beaver being the most common harvested. Wildlife populations on Bull Shoals Lake are abundant and several species are expanding their number. Through proper management practices, all native species of wildlife can and should continue to maintain or increase in numbers.

Threatened and Endangered Species

The Federally listed endangered species including the gray bat *(Myotis grisescen*s), Indiana bat *(Myotis sodali*s), and Tumbling Creek Cavesnail (*Antrobia culveri*) have been observed in the Bull Shoals lake area (Table 3.5.2.1-2). There are several known eagle nests downstream of the lake and the eagle has been seen frequently on the lake. The Bald Eagle was delisted on June 28, 2007 but consideration of the species will continue and effort to minimize disturbance of nesting sites will continue to be of concern.

The Tumbling Creek cavesnail (*Antrobia culveri*) is a small, white, blind, aquatic snail with a height and diameter of barely over two millimeters. The occurrence of the cavesnail is restricted to a single location in southwestern Missouri. It is found only in Tumbling Creek Cave in southern Taney County, Missouri (USFWS, 2003). Tumbling Creek Cave is located west of the Big Creek tributary to Bull Shoals Lake. The number of cavesnails has significantly decreased over the last few decades. Between January 2001 and April 2003, only one individual was found within the survey area, and a small population of approximately 40 individuals was found to occur in a small area upstream of the survey area (USFWS 2003).

Tumbling Creek Cave also provides habitat for a large maternity colony of federally listed gray bat *(Myotis grisescen*s), with a 1998 estimated breeding population of 12,400 individuals. The Gray Bat Recovery Plan lists Tumbling Creek Cave as a "Priority 1" cave. Priority 1 gray bat caves have the highest level of biological significance for a gray bat maternity site (USFWS 2003).

There have been historical observations in Tumbling Creek Cave of a small hibernating population of the federally listed Indiana bat *(Myotis sodali*s). The Indiana bat has not been documented at the site since 1989 (USFWS 2003).

Table 3.5.2.1-2: Bull Shoals Lake Threatened and Endangered Species

Common Name	Scientific Name	Status
Gray bat	*Myotis grisescens*	endangered
Indiana bat	*Myotis sodalis*	endangered
Tumbling Creek cavesnail	*Antrobia culveri*	endangered

Water Supply

The Marion County Water District is the only water utility currently utilizing Bull Shoals Lake as a water supply. This user is contracted for 880 acre-feet of storage in the lake. Currently, over 49,000 acre-feet of Corps discretionary storage remains in Bull Shoals Lake. This lake continues to provide a safe and dependable public drinking and industrial water

supply, as well as aquatic habitat, and recreational opportunities. Safeguarding the water quality of the lake is of utmost importance. The cooperation of all individuals, federal, state, and local agencies is necessary in this effort.

Park Facilities

Support facilities are located in 19 parks operated by the Corps of Engineers, Arkansas State Parks, local governments and a marina. These parks include 18 boat ramps, 11 campgrounds, 13 picnic shelters, 11 marinas, 7 designated swim areas, and hundreds of miles of undeveloped shoreline.

Park areas offer campsites, playgrounds, hiking trails, group picnic shelters, designated swimming areas, and boat-launching ramps. Over 740 miles of shoreline provides opportunities for photography, wildlife viewing, and relaxation. Fees are charged for the use of some facilities. Concessionaire-operated marinas provide boat and motor rentals, fuel and other related supplies and services.

Table 3.5.2.6-1: Bull Shoals Lake Recreation Areas and Amenities

Recreation Area	Public Launch Ramp	Designated swim beacl	Group Picnic Shelter	Public play ground	Public campground	Electrical Outlets	Public drinking water	Waterbourne restroon	Showers	Vault toilet	Sanitary dump station	Marina	Marine dump station	Scuba air	Café or snack bar	Lodging	Laundromat
Beaver Creek	X		X	X	X	X	X	X	X	X	X	X			*	*	*
Buck Creek	X	X	X	X	X	X	X	X	X	X	X	X		*	*	*	
Bull Shoals	X				X	X	X			X	*	X	X	X	*	*	*
Bull Shoals State Park	X		X	X	X	X	X	X	X		X	X			*	*	*
Dam Site	X		X	X	X	X	X	X	X		X	*			*	*	*
Highway 125	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	
Highway K	X											X					
Kissee Mills					X												
Lakeview	X	X	X	X	X	X	X	X	X	X	X	X		*	*	*	*
Lead Hill	X	X	X	X	X	X	X	X	X	X	X	X	X	*	*	*	*
Oakland	X	X	X	X	X	X	X	X	X	X	X	X	X		*	*	*
Ozark Isle	X			X	X	X	X	X	X	X		*	*		*	*	*
Point Return	X	X	X	X	X		X			X	X	*			*	*	
Pontiac	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	*	
River Run	X			X	X	X	X	X	X	X	X	*			*	*	*
Shadow Rock	X		X	X	X	X	X	X	X		X				*	*	*
Spring Creek	X																
Theodosia	X	X	X	X	X	X	X	X	X	X	X	X			X	X	*
Tucker Hollow	X		X	X	X	X	X	X	X	X	X	X				X	
Woodward	X															*	

X = Available on Project Lands * = Available Nearby

3.5.2.2 Norfork Lake

Norfork Lake is an impoundment located along the northern Arkansas and southern Missouri border, lies within Baxter and Fulton Counties in Arkansas and Ozark County in Missouri (figure 3.5.2.2-1). The reservoir is 22,000 surface acres, receiving water from the surrounding 1,806 square mile watershed. Norfork Lake has an average depth of 57 feet (DPCE, 1996). It is located in the Ozark Highlands Ecoregion, and was constructed primarily for hydroelectric power and flood control and is also authorized for water supply, recreation and fish/wildlife. Construction commenced on Norfork Dam in the spring of 1941 and was completed in 1944. Construction of the powerhouse and switchyard was completed in 1949. Overall construction costs were approximately $28.6 million.

Norfork Lake is one of a series of five lakes in the Upper White River Basin. Norfork Dam was constructed across the North Fork River about 13 miles southeast of Mountain Home, Arkansas. The construction of Norfork Lake was authorized by the Flood Control Act of 1938, as modified by the Flood Control Act of 1941 to include the authorization for the multiple purposes of flood control, generation of hydroelectric power, and other beneficial uses. Section 4 of the Flood Control Act of 1944, as amended by Section 4 of the Flood Control Act of 1946 and further amended by Section 209 of the Flood Control Act of 1954, directed the Department of the Army to provide for recreational use of lakes under its control. The inclusion of storage for municipal and industrial water supply was authorized by the Water Supply Act of 1958.

The total area contained in the Norfork project, including both land and water surface, consists of 54,228 acres. Of this total, 53,993 acres are fee owned and 235 acres are in flowage easement. When the lake is at conservation pool (elevation 554 feet above sea level), the total exposed land area comprises 31,993 acres.

Table 3.5.2.2- 1 depicts the natural and recreational resource benefits that are derived from Norfork Lake.

Figure 3.5.2.2-1: Norfork Lake

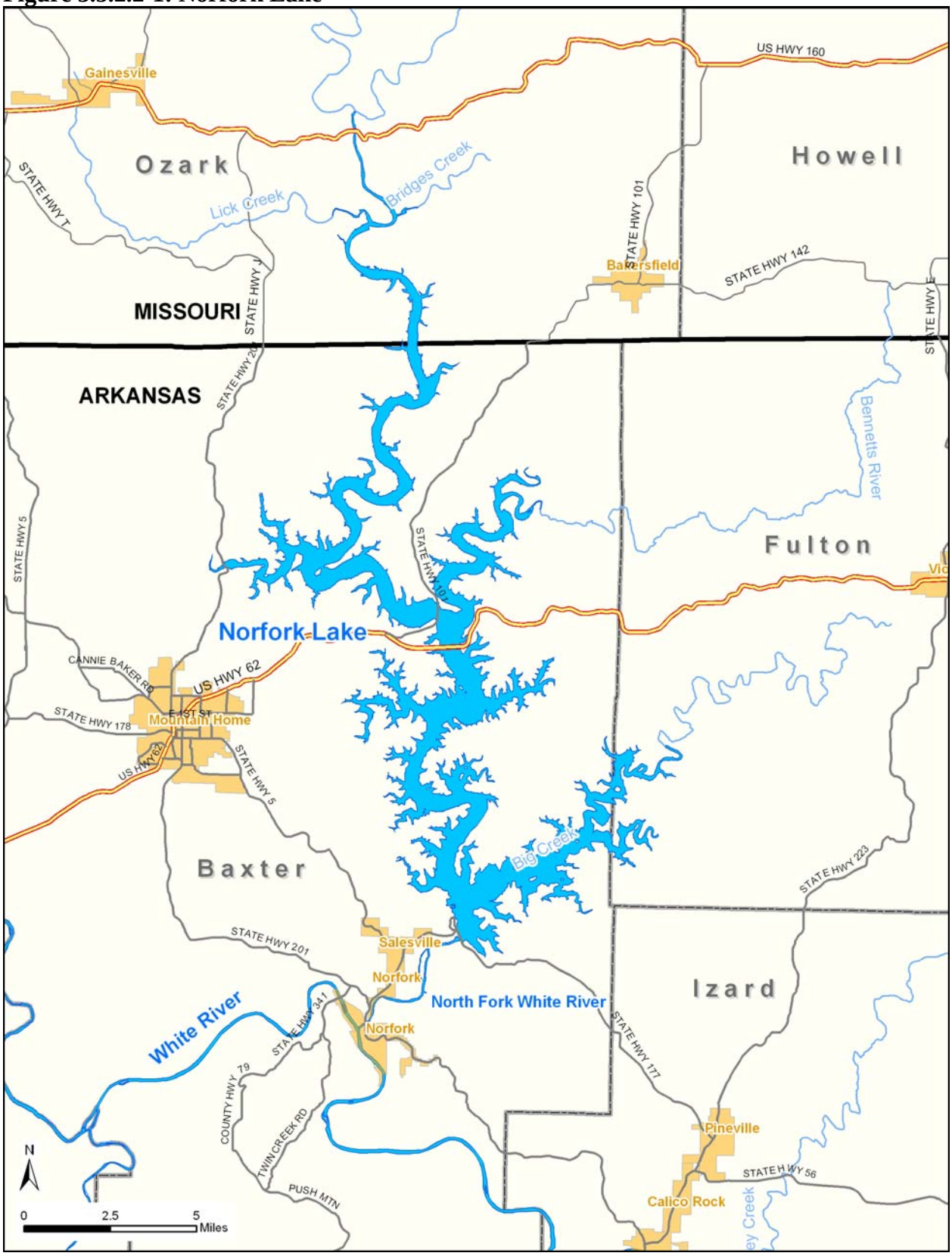


Table 3.5.2.2-1: Natural and recreational resource benefits at Norfork Lake.

Social Benefits		
Facilities	**Visits (person-trips)**	**Benefits in Perspective**
- 23 recreation areas	- 1,658,300 in total	
- 21 picnic sites	- 82,915 picnickers	By providing opportunities for active recreation, Corps lakes help combat one of the most significant of the nation's health problems: lack of physical activity.
- 716 camping sites	- 29,997 campers	
- 8 playgrounds	- 364,826 swimmers	
- 9 swimming areas	- 149,247 water skiers	
- 1 trail miles	- 795,984 boaters	
- 0 fishing docks	- 431,158 sightseers	Recreational programs and activities at Corps lakes also help strengthen family ties and friendships; provide opportunities for children to develop personal skills, social values, and self-esteem; and increase water safety.
- 31 boat ramps	- 845,733 fishermen	
- 10 marinas	- 116,081 hunters	
- 1,789 marina slips	- 248,745 others	
Economic Benefits		
1,658,300 visits per year resulted in:		**Benefits in Perspective**
- $29.67 million in visitor spending within 30 miles of the Corps lake.		The money spent by visitors to Corps lakes on trip expenses adds to the local and national economies by supporting jobs and generating income. Visitor spending represents a sizable component of the economy in many communities around Corps lakes.
- 61% of the spending was captured by local economy as direct sales effects.		
With multiplier effect, visitor trip spending resulted in:		
- $35.29 million in total sales.		
- $17.78 million in total income.		
- Supported 1,011 jobs in the local community surrounding the lake.		
Environmental Benefits		
		Benefits in Perspective
- 32,195 land acres		Recreation experiences increase motivation to learn more about the environment; understanding and awareness of environmental issues; and sensitivity to the environment.
- 22,000 water acres		
- 380 shoreline miles		
- 657 acres reforested		
- 3,300 environmental education contacts		

Source: Value to the Nation web site at www.CorpsResults.us. Use Fast Facts to view this and other reports.

Topography

A general description of Norfork Lake is gently sloped to steep inclines typical of the Ozark highlands. Bluffs of near vertical slope are present where the original North Fork River channel has eroded the residual limestone substrate. Upper reaches of several small tributaries contain small floodplains and gentle slopes of less then 5 percent. Primary ridges and connecting spur ridges have 0 to 10 percent slope with side slopes ranging from 10 to 25 percent inclines. Aspect is generally described as easterly in nature for all land occurring on the west side of the reservoir and westerly in nature for land occurring on the east side of the reservoir, however the presence of ridges and drainages create aspects of all directions.

The area around the lake is rugged and mostly wooded. Norfork Lake is very irregular in shape because of the mountainous character of the region. Many large arms and bays extend up the valleys of tributaries, and the topography is such that there are numerous small coves. Steep rocky slopes and bluffs form the shoreline. Many of the hills and flat-topped ridges in the vicinity rise to elevations of 775 to 825 feet MSL, and some of the higher peaks in the region reach an elevation of more than 1,100 feet.

Norfork Lake is located within two physiographic areas of the Ozark Highland. The Salem Plateau is exposed across northern and central Baxter County. The Springfield Plateau is

exposed in most of southern Baxter County and the Missouri county of Ozark. The Salem Plateau is characterized by gently sloping to rolling uplands, and steep, stony side slopes with outcrops of dolomite. The elevation ranges from about 700 to 1,000 feet above sea level. There are a few broad areas of uplands that have a gradient of one to 8 percent. Arkana, Doniphan, Gassville, and Moko soils are the major soils on this plateau surface.

Vegetation

The present forest of the Norfork Lake area bears little resemblance to the original forests. Those original forests included stands of high quality oak, hickory, shortleaf pine, elm and walnut on favorable soils occurring usually on a slope with a northeast aspect. Eastern red cedar and scattered stands of short-leaf pine usually occurred more successfully than hardwoods on the slopes having poor thin soils with a southwest aspect. During the mid 1800's, farmers who cleared the forests for pasture, cut lumber for building purposes and to sell, settled the area. This caused a decline of the tree quality, cutting the best and generally leaving the poorer trees as growing stock. The overgrazing of the native grasses removed much of the fuel loads for naturally occurring fire to suppress the encroachment of eastern red cedar. Annual burning in the more favorable sites for timber production further degraded the quality of the remaining forest. Today's forest is largely composed of upland oak, hickory, and eastern red cedar. The red cedar has invaded former grasslands and abandoned farmsteads.

Some of the plant communities include post oak savannas. These ecosystems exhibit an open canopy of low density stocking of trees allowing considerable light penetration to the understory. This condition permits a wide variety of shrubs and/or native grass to perpetuate under natural disturbances such as fire. Other plant communities are the dolomite/limestone glades, which are characterized by barrens-like communities of native forbs and grasses occurring on shallow soil over outcroppings of bedrock.

The shoreline areas are affected by the normal reservoir operation plan and characteristic of multipurpose project with little or no vegetation. These areas are commonly referred to as the “bathtub ring” and the display the effects of frequent elevation increases and decreases.

Fish & Wildlife

Norfork Lake was cleared of all standing timber at time of inundation. Submergent aquatic vegetation that occurs in stable reservoirs is absent from Norfork Lake due to dramatic water fluctuations associated with hydropower activities and poor substrate. Water tolerant terrestrial vegetation and early successional vegetation has established within the flood pool from 554 MSL to 580 MSL. Species include button bush, sycamore, persimmon, green briar, black willow, and serecia lespedezia. Fish attractors comprised of overlapping hardwood trees anchored to the bottom have been installed at depths ranging from 15 to 25 at conservation pool.

Norfork Lakes' fishery is managed in a cooperative effort between Missouri Department of Conservation (MDC) and the Arkansas Game and Fish Commission (AGFC). Norfork Lake is a warm water fishery with most endemic species of the Ozarks Mountains present. Black bass species, walleye, crappie, channel, flathead, and blue catfish, and various sunfish

species, are the common game fish on Norfork Lake. Stocking programs of certain game fish occur on Norfork Lake. AGFC submits an annual report of stocking rates and species as required in their lease

Forest species of wildlife present include white-tailed deer, eastern wild turkey, gray fox, southern flying squirrel, raccoon, opossum, bobcat, and skunks. Black bears were introduced into the area around Norfork Lake by the Arkansas Game and Fish Commission in the 1960's and are occasionally seen by visitors and harvested by hunters. Upland wildlife present includes bobwhite quail, coyote, red fox, and cottontail rabbit. Migratory game birds include mourning dove, greater Canada geese, and various puddle and diver ducks. Aquatic wildlife includes mink, river otter, muskrat, and beaver. Numerous non-game species are present including the Bachman Sparrow, a Missouri-listed endangered species that uses dense river cane stands for nesting areas. Riparian zones provide habitat and travel corridors for terrestrial and aquatic wildlife and are some of the most productive and important of habitat types found on the project. During the fall migration, bald eagles, osprey, red shouldered, red tailed, coopers, and sharp shinned hawks are found in abundance. During the spring mating season numerous neo-tropical migrate, passerine songbirds utilize the various habitats types surrounding the lake for breeding and rearing young.

Deer, turkey, squirrel, dove, and rabbit are the species most commonly hunted for game. Trapping for furbearers along the shoreline and upland habitat is common with mink, muskrat, raccoon, and beaver being the most common harvested. Wildlife populations on Norfork Lake are abundant and several species are expanding their number. Through proper management practices all native species of wildlife can and should continue to maintain or increase in numbers.

Threatened and Endangered Species

Table 3.5.2.2-2: Norfork Lake Threatened and Endangered Species

Common Name	Scientific Name	Status
Ozark hellbender	*Cryptobranchus alleganiensis bishopi*	candidate

The Ozark hellbender occurs in coldwater zone downstream of the Norfork and Bull Shoals dams. The best population of the hellbender in Missouri is in the North Fork River above Norfork Lake. The species does quite well in coldwater streams but cannot tolerate flooded conditions.

Water Supply

The City of Mountain Home is the only water supply user on Norfork Lake. Water supply reallocation studies are currently underway for other potential water supply users on Norfork Lake. Norfork Lake continues to provide a safe and dependable public drinking and industrial water supply, as well as aquatic habitat, and recreational opportunities. Safeguarding the water quality of the lake is of utmost importance. The cooperation of all individuals, federal, state, and local agencies is necessary in this effort.

Park Facilities

Developed parks offer campsites that range from rustic to modern with electrical hookups, playgrounds, group picnic shelters, designated swimming areas and boat-launching ramps. Fees are charged for the use of some facilities. Concessionaire-operated marinas provide boat and motor rental, fuel and other related supplies and services.

The Robinson Point National Recreation Trail and the Norfork section of the Ozark Trail enable nature observers and photographers a view of the Ozark Mountains through the change of seasons. Spring-flowering trees, shrubs and wildflowers add subtle colors, while fall brings the hills ablaze with the colors of oaks and hickories. Viewing wildlife is a popular activity on the and around the lake, and these two trails provide access to a variety of habitats.

Table 3.5.2.2.-3: Norfork Lake Recreation Areas and Amenities

Recreation Area	Boats, Motors, Bait	Public Launch Ramp	Public Picnic Grounds	Public Campgrounds	Public Drinking Water	Café or Snack Bar	Overnight Accommodation	Comfort Station	Improved Swim Beach	Change house	Group Shelter	Showers	Electrical Outlets	Marine Dump Station	Trailer Dump Station
Bidwell Point	*	X	X	X	X	*	*	X	X		X	X	X		X
Buzzard Roost	X	X				X	*	X						X	
Cranfield	X	X	X	X	X	X	*	X	X		X	X	X		X
Curley Point	Camping By Permit Only														
Gamaliel	X	X	X	X	X	X	*	X	X		X	X	X		X
George's Cove		X	X	X	X		*	X	X						X
Hand		X	LAKE ACCESS ONLY												
Henderson	X	X	X	X	X	X	*	X	X		X		X	X	X
Howard Cove	X	X	X	X	X	X	*	X					X	X	
Jordan	X	X	X	X	X	X	*	X	X		X		X		X
Panther Bay	X	X	X	X	X	X	*	X	X		X		X		X
Pigeon Creek		X					*	LAKE ACCESS ONLY							
Quarry	X	X	X	X	X	X	*	X	X		X	X	X		X
Red Bank		X	X		X		*	X							
Robinson Point	*	X	X	X	X	*	*	X	X		X	X	X		X
Talbert		X	LAKE ACCESS ONLY												
Tecumseh		X	X	X	X	*	*	X							
Tracy	X	X				X	*	X							
Udall	X	X	X	X	X	X	*	X							
Woods Point		X	X	X	X	*	*	X							X

X = Available on Project Lands * = Available Nearby

3.5.3 Bull Shoals and Norfork Water Quality

Waters in the Arkansas portion of the White River watershed have all been designated for fish and wildlife protection, primary and secondary contact recreation, and domestic, agricultural, and industrial water supplies. Bull Shoals Lake, Kings River, and Richland Creek, a tributary to the Kings River, have all been designated as Extraordinary Resource Water bodies by Arkansas Pollution Control and Ecology Commission, and are subject to stricter regulations concerning pollution discharge and instream activities. Kings River and Richland Creek are also recognized as National Scenic Rivers.

In Arkansas, larger lakes, usually several thousand acres in size, having average depths of 30 to 60 feet that are in upland forest dominated watersheds and typically having low primary

production are designated Type A. Bull Shoals Lake and Norfork Lake are classified as a Type A lakes, with low trophic status expected if in natural (unpolluted) condition. Lakes in Arkansas are classified into 5 groups by ecoregion, primary construction purpose, and morphometric features such as size and average depth (DPCE 1996).

None of the designated uses, i.e., public, agriculture or industrial water supply; propagation of fish and wildlife; primary and secondary contact uses; and navigation, have been eliminated or are impaired in any of the lakes. Similarly, the fishable/swimmable goals of the Clean Water Act have been attained in all lakes (ADEQ 2002).

The Missouri Department of Natural Resources and the Clean Water Commission are responsible for setting and enforcing the water quality standards for Missouri. Classified waters in the state of Missouri are categorized according to their beneficial water usage. Major reservoirs like Bull Shoals Lake are usually several thousand acres in size and are classified by the state as L2 (comparable to the Type A in Arkansas). Bull Shoals Lake, in addition to maintaining L2 water quality standards, is also subject to four other water quality standards, livestock and wildlife watering; protection of warm water aquatic life and human health/fish consumption, whole body contact recreation; and boating and canoeing water quality standards (MDNR 1996b).

3.5.4 Tailwater -Water Quality

The White River tailwaters are classified as trout waters by ADEQ with applicable water quality standards of 6 mg/L dissolved oxygen and temperature of 20 degrees Celsius which are sometimes violated. Three miles of the Bull Shoals and 4.2 miles of the Norfork tailwaters immediately below the dams have been listed on ADEQ's 2004 Arkansas Water Quality Limited Waterbodies 303(d) list due to violation of the 6 mg/L dissolved oxygen (DO) standard and the source is listed as hydropower (HP). The water quality in these two tailwaters is primarily influenced by the water quality in the respective lake. During the late summer and fall, the water from the lake is normally released through the hydropower turbines and originates in the hypolimnion (lower portion of the water column). This water is colder and the DO concentration is greatly reduced or even non existent at times during the summer months when compared to the surface layer (epilimnion). Due to the water density difference of the epilimnion and hypolimnion the water column does not mix vertically and is referred to as being stratified. This stratification condition is natural and occurs in many waterbodies especially deep reservoirs such as Bull Shoals and Norfork. The DO and temperature characteristics of the surface and hypolimnion vary greatly and are isolated from the other (no vertical mixing). While the colder water in the hypolimnion is essential for the trout fishery to exist, the low DO concentrations can be detrimental to the fishery. The stratified layers normally begin mixing in the late fall or winter as the surface layer begins cooling. The unstratified (mixed) water column normally contains sufficient DO and will also provide the colder temperature needed for the fishery. The low DO concentration below the dams has been a prominent issue since the early 1990s and is outside the scope of the White River Minimum Flow reallocation project. The DO issue has been and will continue to be addressed primarily through the multi agency cooperative efforts of the White River Dissolved Oxygen Committee.

Section 303(d) of the Federal Clean Water Act requires states to list waters that are not meeting water quality standards or have a significant potential not to meet standards as a result of point source discharges or nonpoint source runoff. Subsequent to 303 (d) listing the state will develop Total Maximum Daily Loads (TMDL) for waterbodies on the list within 13 years. A TMDL establishes the maximum amount of a pollutant that can enter a specific water body without violating the water quality standards. Values are normally calculated amounts based on dilution and the assimilative capacity of the water body. Calculations are performed by various models, which predict safe levels of contaminants based on worst-case conditions and providing a margin of safety. The calculated safe amounts then may be allocated to point source discharges as a waste load allocation (WLA) and to nonpoint sources as a load allocation (http://www.adeq.state.ar.us). The draft TMDL for the Bull Shoals and Norfork tailwaters was completed in July2008 and efforts towards an early 2009 final are in process.

Temperature stress, low dissolved oxygen or other water quality problems have been associated with hydropower generation in the Bull Shoals and Norfork tailwaters. Considerable work has taken place and is ongoing between the agencies responsible for water quality (ADEQ), fishery management (AGFC), hydropower production (SWPA) and reservoir management (USACE) in these waters. Cooperative efforts are ongoing between the state and Federal agencies to increase oxygen levels while maintaining adequate hydropower production. Emergency plans are in place should dissolved oxygen levels reach excessive lows.

The tailwaters of the large hydroelectric dams in the watershed support coldwater fisheries of major economic proportion. Increasing economic importance of the fisheries and changing angler desires from a harvest oriented put-and-take fishery toward better fish quality and in some instances a wild spawning fishery places emphasis in maintaining adequate water quality in the tailwaters. Concern has also developed about the future of these fisheries stemming from the water quality considering its close association with the increased human population growth and non-point source runoff in the watershed.

Since the 1960s trout kills have occurred on several occasions, normally in the fall season. Documented trout kills since 1990 are listed in Table 3.5.4 (FTN 2008). In addition to the trout kills in the table, there were 12 confirmed kills between 1963 and 1981 due to water temperatures greater than 26.5 degrees Celsius. These were presumed to be due to long periods of non-generation (Spotts 1991).

Table 3.5.4. Documented trout kills in the tailwaters since 1990.

Date	Tailwater	DO (mg/L)	Temperature	Species	Quantity
10-08-90	Bull Shoals	1.1-1.7	-	RB,BN,CT	1200-1500[B]
10-25-92	Norfork	0.4-1.6	-	RB,BN	35[C]
9-17-93	Norfork	-	-	-	24-26[B]
6-16-02	Norfork	-	-	-	
10-18-02	Bull Shoals	-	-	-	26[C]
11-01-04	Norfork	1.0-1.5	-	RB,BN,CT	162[C]

11-24-04	Norfork	<1.0	-	RB	2[C]
5-27-05	Bull Shoals	-	27		
10-31-06	Norfork	-	-	RB,BN,CT,BK	80[C]
05-04-07	Bull Shoals	-	22	BN	2
06-05-07	Bull Shoals	10.4-12.1	22.1-24.2	BN	1

Species: RB = rainbow trout, BN=brown trout, BK= brook trout, CT =cutthroat trout
B -quantity visually estimated
C -number recovered

3.6 Biological Resources

3.6.1 Terrestrial Vegetation

The main vegetation type of the Ozarks is an upland oak-hickory forest, although shortleaf pine does occur on escarpments to the north and on the drier south slopes. Red cedar glades are located on xeric exposures and beach-maple forests are found in cool, moist north-facing ravines. Bottomland hardwoods are found in the floodplain of large rivers. This large expanse of timberland provides breeding habitat for numerous species of neotropical migratory birds. Remnants of the original tall grass prairie are scattered throughout the Springfield and Salem Plateaus. Portions of the Salem and Springfield Plateaus also contain upland prairies which are now predominantly utilized as improved pasture

While much of the botanical diversity is still comparable to that of pre-settlement conditions, the area has experienced significant alteration by humans. However, because of the region's geological and ecological stability throughout much of the area, this is one of the most recoverable ecosystems in the country. Other communities represented include shortleaf pine forest; limestone, sandstone, dolomite, and rhyolite glades; and numerous "specialty" communities (e.g., fens, cliffs, sinkhole ponds).

3.6.2 Aquatic

3.6.2.1 Wetlands

The wetlands that exist within the project areas can be classified as Lacustrine wetlands. These wetlands include lakes and ponds and their margins. They generally contain less than 30 percent vegetative cover, which might include trees, shrubs, persistent emergent vascular plant species, emergent mosses and lichens. They can be either limnetic (greater than 2 meters in depth) or littoral (from shore to 2 meters in depth). Within the current projects areas the wetlands would be classified as littoral wetlands since areas of the reservoir that are 2 meters or greater in depth do not support any wetland vegetation.

Littoral wetlands exist within the reservoirs primarily in those vegetated areas, albeit scarce due to the fluctuating nature of flood control reservoirs, which exist in the floodplains of tributaries to the reservoirs (i.e. small creeks). Within the tailwaters, these wetlands exist as the wetted perimeters and main channels that support wetland vegetation.

3.6.2.2 Fisheries

The White River Basin was originally home to 163 native fish species. Of these, 126 have been collected from the river itself and seven are endemic to the basin (all Ozark species).

One, the Ozark cave fish (A*mblyopsis rosae*) is on the federal endangered species list and the harelip sucker is extinct throughout its range. The alligator gar (*Atractosteus spatula*), which once provided an excellent big game fishery in the delta has been virtually extirpated. Other rare species include the lake sturgeon (*Acipenser fulvescens*) collected only twice (1988,1992), the dollar sunfish (*Lepomis marqinatus*) and the goldstripe darter (*Etheostoma parvipinne*) each collected once in recent years; however, these three are on the edge of their range and are much more common elsewhere.

Additionally, at least 17 non-native species and three hybrids have been stocked or accidentally released into the wild. Of these only the brown trout (*Salmo trutta*) and common carp (*Cvprinus carpio*) are known to reproduce within the basin.

The changes on the Upper White River and its tributaries with major reservoirs have been much more significant. Once, the Upper White was considered the premier float stream in the U.S. with Smallmouth bass fishing considered unequaled by many. Walleye, Ozark bass, and channel catfish all added to the creel. Now, the river is a series of reservoirs, which support typical southern reservoir fisheries.

Below Bull Shoals and Lake Norfork, cold water and fluctuating water levels severely impacted the warmwater fisheries. Introduction of trout salvaged the situation. The White and North Fork Rivers have produced eight line class world record brown trout including the 17.5 kg all tackle record. Rainbow trout (*Oncorhynchus mykis*) up to 18.5 lb. have also been caught (Shirley1992).

3.6.2.3 Tailwater Areas

The Norfork Tailwater is defined as the North Fork river below Norfork Dam to the confluence with the Bull Shoals Tailwater of the White River, a total of 4.7 miles (7.6 km). The Bull Shoals Tailwater is defined as the White River below Bull Shoals Dam to Guion, a total, length of 89 miles (144 km). If they so desire, trout are able to freely move between Bull Shoals and Norfork tailwaters. Hypolimnetic releases of 4l - 58 degrees F (5 - 14 C) water from Norfork Dam hydro range in magnitude from 100 to 6,000 cubic feet per second (cfs). Stream substrate varies from bedrock to boulders, but is mostly gravel and rubble. Morphometry is characterized by alternating shoal and pool areas. Scattered beds of rooted macrophytes are present. Due to a seasonal dissolved oxygen deficit in Norfork Lake during July through November, the large volume hypolimnetic discharges are frequently poorly oxygenated and hydrogen sulfide, manganese, and iron are present. In past years several small - scale trout kills have been attributed to water quality conditions. Figure 3.6.2.3-1 depicts the locations of the tailwaters below Bull Shoals and Norfork lakes in Arkansas. Trout were first stocked below Norfork Dam in 1948 and Bull Shoals Dam in 1952. Once stocked, both rainbow and brown trout flourished. Today, not only browns and rainbow, but cutthroat and brook trout also inhabit these waters. Brown trout have established some natural reproduction in the Bull Shoals tailwater while other trout populations are maintained by stocking.

Experimental rainbow and brown trout stockings exhibited exceptional growth and survival. Within a few years exceptionally large rainbow trout, including many in the 8-12 pound

range, were being caught and an economically valuable float fishing industry started to develop (Baker 1959). The exceptional rainbow trout fishery continued throughout the 1950s and 1960s. The extraordinary size of rainbow trout during that time was due to both outstanding growth and survival of at least 1 to 2 years after stocking. The exceptional growth and survival of rainbow trout was a result of widespread aquatic vegetation, almost continuous moderate flows, and relatively low fishing pressure.

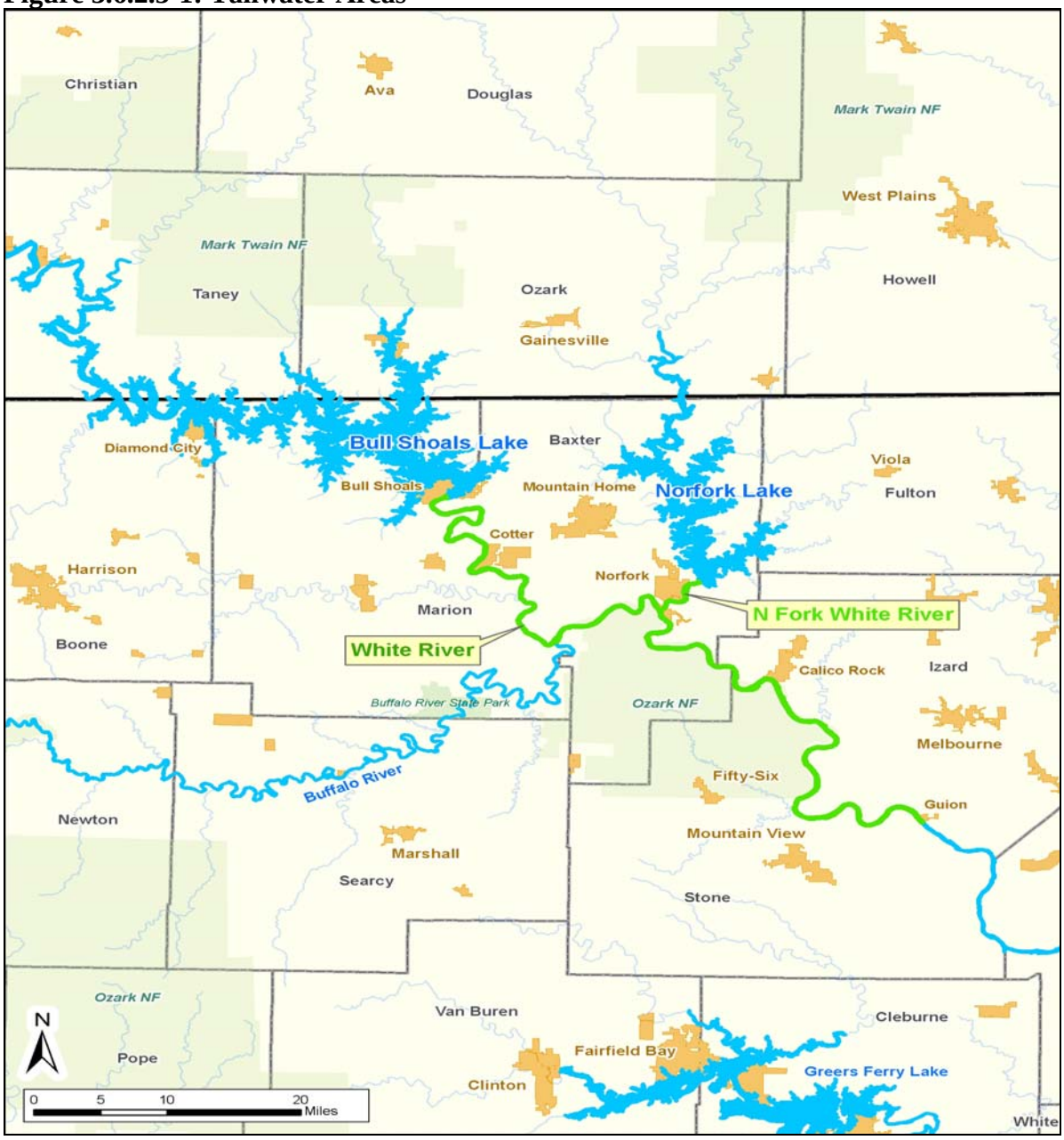
In 1963, the number of hydroelectric units supplying Bull Shoals Tailwater was increased from 4 to 8 units making large volume releases of shorter duration possible. The operational changes resulted in increased scouring, destroying both stream substrate and the once extensive aquatic vegetation (Jones and Aggus 1983). These changes caused trout growth rates to decline.

The exceptional size of rainbow trout continued up into the early 1970's, at which time increasing fishing pressure combined with changes in hydropower operations served to prevent most rainbow trout from reaching the sizes present in the 1950s and 1960s (Jones and Aggus 1983). Since the mid 1980's the brown trout fishery has become increasingly more prominent due to the production of many large brown trout including the former world record of 38 pounds, 9 ounces caught in 1989 from the North Fork River.

Both Bull Shoals and Norfork tailwaters are managed through regulation and stocking. Both are under a creel limit of five trout per day. Beginning January 1, 2009, brown trout will be managed under a 24-inch minimum length limit with 1 fish/day creel limit. Cutthroat trout are regulated with a two fish 16" minimum length limit and brook trout are regulated under a 14” minimum length limit. In 1995, two catch and release (C&R) areas were created at Bull Shoals Dam and Rim Shoals on Bull Shoals Tailwater. Two more areas were added from near Mt. Olive Access to Jacks Resort and above Calico Rock from Monkey Island to Moccasin Creek on January 1, 1998. A single catch and release area is located below Otter Creek on Norfork Tailwater. On Bull Shoals Tailwater, a portion of the upper river from the dam to the upper-most State Park campsite is closed to fishing from November 1 through January 31 to protect spawning brown trout. The remaining State Park reach is closed to night fishing and is limited to single hook, artificial lures only during the same period. From November 1 through January 31, all brown trout caught within the State Park boundaries must be immediately released.

Following the original creel survey in 1971-1973 (Aggus et.al. 1977), stocking rates and locations were adjusted to better match angler distribution although during winter months trout were stocked at rates higher than angling pressure would suggest taking advantage of good winter growth before angling pressure increased during spring. The 1980-81 creel (Oliver 1984) found few changes in angler distribution and no changes in stocking schedules were made. Following a 1993 Trout Angler Survey (Rider 1999), the number of trout allocated to Bull Shoals and Norfork tailwaters were changed to better match current use by Arkansas' trout anglers statewide.

Figure 3.6.2.3-1: Tailwater Areas



Creel surveys are requisite for proper management of these streams. Current estimates of fishing pressure and harvest rates are needed to determine rates and timing of stockings and to evaluate other management practices. At present there are ongoing creel surveys on both tailwaters.

Releases from Bull Shoals Dam range from 200 to 30,000 CFS and from 41- 65° F (5 - 18°C) in temperature. The White River from Bull Shoals Dam to Guion is characterized by alternating shoal and pool areas. Substrates are mostly gravel, but range from bedrock scoured areas to sand and silt in some pools. The stream channel is stable but armored in the upper reaches. Aquatic vegetation is relatively scarce due to the scouring effects of full

hydropower releases and frequent water level fluctuations of 8 to 10 ft. A seasonal dissolved oxygen deficit in Bull Shoals Lake during July to November results in hydro-discharges that are frequently poorly oxygenated. Several stretches within the tailwater are prone to warm water temperatures during periods of non-release in warm weather where trout kills are possible. These areas are from the confluence with the Buffalo River to the confluence with the North Fork River and from Calico Rock to Guion. Depth fluctuations between minimum flow and full turbine flow can be 10 to 13 ft throughout the Bull Shoals Tailwater and 4 to 8 ft throughout the Norfork Tailwater (Hauser 2002). Both tailwaters have average slopes of about 2.5 ft per mile. Up to two miles of the Norfork Tailwater can be inundated by backwater from the White River, depending on its stage. Mean depth increases rapidly with flow increment at low flows, and less dramatically at higher flows.

Table 3.6.2.3-1: Existing Tailwater Habitat

Tailwater	Upstream River mile	Downstream River mile	Current (CFS)	Acres
Bull Shoals	418.60	329.4	210	2517
Norfork	4.47	0.19	115	54

3.6.2.4 Tailwater Recreation

Trout fishing in northwest Arkansas and southwest Missouri is not only a favorite recreational pursuit but also generate a significant, positive contribution to state and regional economies. The trout fisheries in Arkansas are unique and considerable use of these tailwaters is by out of state users. There is little doubt that a significant number of trout fishermen originate out of the Ozark region to enjoy these 'world class' fisheries.

Numerous sport fishing magazines have described the Corps tailwaters as some of the best trout fishing streams in the world. The current all tackle world record brown trout was caught in the Greers Ferry tailwater in 1992. It weighed 40 pounds and 4 ounces. Large brown and rainbow trout are present in the White River waters in Arkansas and Missouri. The current Missouri state record brown trout was taken from Lake Taneycomo in 2005 and weighed 27 pounds 10 ounces.

Growth rates as high as three pounds per year have historically been reported in the White River system. However, these good fisheries are far short of the fishery, stream ecology, recreation and economic potentials that could be realized with increased minimum flows.

It is important to keep in mind that the life expectancy of naturally occurring trout is on the average 4 to 8 years. In put-and- take fisheries a very large portion of the rainbow trout are caught annually and replenished by stocking. The brown trout persist for longer periods since they are generally harder to catch than rainbows. The larger trout take several years to acquire memorable and trophy sizes (USACE 1989). In 1987, Barnes and Hudy indicated that more trophy size brown trout exist per mile in some reaches of the White River than any other river in the world.

Navigation hindrances exist during periods of no generation in the tailwaters. Navigation problems are most pronounced in riffle (shoal) areas. With the present minimum releases fishermen must either drag their boat over the shoals or turn back and limit their excursions. Current minimum releases are listed in Table 3.7.2.3-1. A depth of only two to five inches is common in these riffle areas with the existing conditions. Dragging shoals in these tailwaters occurs frequently because the streams typically form riffle areas every five to seven times the stream width. Theoretically, if a fishing party wanted to float downstream for 5 miles and then motor back upstream, 24 shoals would have to be traversed during the round trip. The float would be dangerous but most plausible if the fishing party motored upstream through the shoals during periods of generation. However, since power generation is unpredictable this is a gamble. When generation ceases, the fishermen are frequently stranded and unable to navigate upstream to the rental or 'put in' point. These navigation problems directly affect recreation use and economics. The existing minimum flows are: 210 cfs below Bull Shoals Dam and 115 cfs below Norfork Dam.

3.6.2.5 Lower White River

The Lower White River contains typical big river fish fauna. Blue catfish (*Ictalurus furcatus*), paddlefish (*Polyodon spathula*), shovelnose sturgeon (*Scaphirhynchus platorynchus*) and blue sucker (*Cycleptus elongatus*) are typical species. Sauger (*Stizostedion canadense*) replace the walleye of the Ozark reaches while spotted bass (*Micropterus punctatus*) replace smallmouth bass and buffalo and spotted suckers (*Minytrema melanops*) replace redhorses.

In spite of the apparent historic declines, modern Arkansans consider the Lower White an excellent fishery. The lowland tributaries and oxbows are highly productive fish factories. Natural oxbow lakes contain large numbers of buffalo, crappie, bluegill and largemouth bass. Typical species rarely found elsewhere in the basin include yellow bass (*Morone mississippiensis*), banded pigmy sunfish (*Elassoma zonatum*), cypress minnow (*Hvbognathus hayi*), taillight shiner (*Notropis maculatus*) and cypress darter (*Etheostoma proeliare*).

The White River flood plain from WRM 121 to the Mississippi contains the nation’s largest contiguous tract of oak/hickory bottomland hardwoods (494,000 acres). The ownership of much of these timberlands by U.S. Fish and Wildlife Service, AGFC, private timber companies and hunting clubs has combined with backwater flooding from the Mississippi to spare this area the destruction of the remainder of the delta. The area is designated a "Wetland of International Importance" by the Ramsar Convention, only the eighth site designated in the U.S. Protection for wildlife has saved at least a remnant to remind us of what the delta fishery could be. The sloughs and oxbows in the Lower White River flood plain are some of the finest warmwater fishing in the south.

3.6.2.6 Freshwater Mussels

Due to concerns that increased cold-water discharge could affect the endangered pink mucket mussel (*Lampsilis abrupta*) and the scaleshell mussel (*Leptodea leptodon*), the U.S. Fish and Wildlife Service requested that a mussel survey be conducted to assess the potential impacts to those species from Lock and Dam 3 (WRM 320) downstream to Lock and Dam 2 (WRM 308). The survey was conducted October 30-31, 2002.

The thermal transition zone on the White River is below Bull Shoals and Norfork dams in the vicinity of Guion, Arkansas, approximately 90 river miles downstream from the Bull Shoals dam. The added volume of cold water to the White River could extend the transition zone downstream, further reducing available habitat for aquatic species. Native fish and invertebrates cannot tolerate cold water conditions, and a downstream extension of the transition zones would further reduce available habitat. Temperature models have shown the effect the additional volume of cold water would have on these zones is minimal. A mussel survey of the remaining unsurveyed reach of the White River to the transition zone resulted in very few live mussels within this stretch, and it did not result in any listed species or species of concern (Posey 2003). Although a downstream extension of this zone could impact aquatic species, these impacts should be minimal.

No large concentrations of mussels were found in this study area. One large concentration occurs approximately 1 mile above the beginning of this study area where a total of 280 individuals were found in a 1 mile reach. Mussel densities were likely more abundant historically than can be found now. Numerous sites had small numbers of dead or relic shells, sometimes in the substrate in the "live" position or in cracks of boulders. One site contained an extensive pile of relic shells, obviously deposited on the gravel bar during high flow events.

No live, dead, or relic individuals of the pink mucket (*Lampsilis abrupta*) or scaleshell (*Leptodea leptodon*) were collected in this survey. Neither species has been recorded as numerically abundant anywhere in Arkansas nor is it likely that the hypolimnetic discharges that have affected the mussel community in the White River has eliminated these species, at least above Batesville, Arkansas. However, future projects in areas that have not been surveyed should be considered for mussel surveys.

Table 3.6.2.4-1: Results from White River Survey Sites (Live Mussels Only)

Site ID	WR04	WR05	WR06	WR14	WR16	WR17	Total	Percent Total
Species								
Actinonaias ligamentina			3		1		4	14.8
Amblema plicata	2						2	7.4
Lampsilis cardium				1			1	3.7
Potamilus purpuratus	1						1	3.7
Pleurobema rubrum			5				5	18.5
Pleurobema sintoxia			1				1	3.7
Pleurobema species		9					9	33.3
Quadrula pustulosa		2					2	7.4
Quadrula quadrula		1				1	2	7.4
	3	12	9	1	1	1	27	100.0

3.7 Air Quality

Both Bull Shoals and Norfork Lakes are located in the Ozark Mountains, remote from heavy smoke-producing industry or large mining operations. The air is very clean and smog is virtually unknown in this region.

The Clean Air Act of 1977 (CAA), as amended requires Federal facilities to comply with all Federal, state, interstate, and local requirements regarding the control and abatement of air pollution in the same manner as any nongovernmental entity, including any requirement for permits. No particular Federal requirements are involved that are not already incorporated into Arkansas State law. The "Conformity Rule" of the Clean Air Act of 1977, as amended states that all Federal actions must conform to appropriate State Implementation Plans (SIPs). This rule took effect on January 31, 1994, and at present applies only to Federal actions in nonattainment areas (those not meeting the National Ambient Air Quality Standards for the criteria pollutants in the CAA). The areas of Arkansas and Missouri where the five lakes are located are considered "attainment areas" and are therefore exempt from the "Conformity Rule" of the CAA.

3.8 Socioeconomic

The region of economic impact consists of 47 counties spread across 2 states. The majority of the counties, 33, are in Arkansas. The remaining 14 counties are in Southern Missouri. These counties represent the White River Minimum Flows Norfork and Bull Shoals survey area. Table 3.9-1 shows historical, current, and projected population counts of the counties and the states.

Population growth for the study area has been mixed over the past 20-years. Thirty-nine of the 47 counties had population increases during the past 20 years, 3 counties had decreases in population and 5 counties had population decreases in the 1980's and increases during the 1990's. Population forecasts show a similar trend through 2005; 6 counties are estimated to have population declines while the remaining counties are estimated to have increases. Data was not available for 8 of 14 Missouri counties. The states of Arkansas and Missouri have had below average growth when compared to the National statistic, 15.9 percent. Arkansas' and Missouri's populations increased 13.7 and 9.3 percent during the 1990's, respectively. Although both states had population increases that were below that of the National statistic, 32 of the 47 counties had population increases that were greater than the National increase; the range of growth for the counties is –8.2 percent (Woodruff, AR) to 66.3 percent (Christian, MO).

Table 3.8-1: County and State Populations

County / State	1980 Popualtion	1990 Popualtion	Percent Change 1980 - 1990	2000 Population	Percent Change 1990 - 2000	2005 Population Estimate[1]
ARKANSAS	*2,286,435*	*2,350,725*	*2.8%*	*2,673,400*	*13.7%*	*2,794,974*
Baxter, AR	27,409	31,186	13.8%	38,386	23.1%	39,931
Benton, AR	78,115	97,499	24.8%	153,406	57.3%	186,540
Boone, AR	26,067	28,297	8.6%	33,948	20.0%	35,846
Calhoun, AR	6,079	5,826	-4.2%	5,744	-1.4%	5,670
Carroll, AR	16,203	18,654	15.1%	25,357	35.9%	27,272
Cleburne, AR	16,909	19,411	14.8%	24,046	23.9%	26,142
Conway, AR	19,505	19,151	-1.8%	20,336	6.2%	20,655
Crawford, AR	36,892	42,493	15.2%	53,247	25.3%	58,122
Faulkner, AR	46,192	60,006	29.9%	86,014	43.3%	96,916
Franklin, AR	14,705	14,897	1.3%	17,771	19.3%	18,387
Fulton, AR	9,975	10,037	0.6%	11,642	16.0%	12,017
Independence, AR	30,147	31,192	3.5%	34,233	9.7%	35,320
Izard, AR	10,768	11,364	5.5%	13,249	16.6%	13,344
Jackson, AR	21,646	18,944	-12.5%	18,418	-2.8%	16,889
Johnson, AR	17,423	18,221	4.6%	22,781	25.0%	23,536
Logan, AR	20,144	20,557	2.1%	22,486	9.4%	22,845
Lonoke, AR	34,518	39,268	13.8%	52,828	34.5%	59,278
Madison, AR	11,373	11,618	2.2%	14,243	22.6%	15,059
Marion, AR	11,334	12,001	5.9%	16,140	34.5%	16,739
Newton, AR	7,756	7,666	-1.2%	8,608	12.3%	8,760
Perry, AR	7,266	7,969	9.7%	10,209	28.1%	10,760
Pope, AR	39,021	45,883	17.6%	54,469	18.7%	57,377
Prairie, AR	10,140	9,518	-6.1%	9,539	0.2%	9,316
Pulaski, AR	340,613	349,660	2.7%	361,474	3.4%	368,133
Searcy, AR	8,847	7,841	-11.4%	8,261	5.4%	8,196
Sebastian, AR	95,172	99,590	4.6%	115,071	15.5%	121,443
Sharp, AR	14,607	13,637	-6.6%	17,119	25.5%	17,928
Stone, AR	9,022	9,775	8.3%	11,499	17.6%	11,883
Van Buren, AR	13,357	14,008	4.9%	16,192	15.6%	16,697
Washington, AR	100,494	113,409	12.9%	157,715	39.1%	177,709
White, AR	50,835	54,676	7.6%	67,165	22.8%	72,352
Woodruff, AR	11,222	9,520	-15.2%	8,741	-8.2%	8,162
Yell, AR	17,026	17,759	4.3%	21,139	19.0%	21,943
MISSOURI	*4,916,686*	*5,117,073*	*4.1%*	*5,595,211*	*9.3%*	*N/A*
Barry, MO	24,408	27,547	12.9%	34,010	23.5%	35,179
Christian, MO	22,402	32,644	45.7%	54,285	66.3%	N/A
Dallas, MO	12,096	12,646	4.5%	15,661	23.8%	N/A
Douglas, MO	11,594	11,876	2.4%	13,084	10.2%	N/A
Greene, MO	185,302	207,949	12.2%	240,391	15.6%	N/A
Howell, MO	28,807	31,447	9.2%	37,238	18.4%	37,930
Lawrence, MO	28,973	30,236	4.4%	35,204	16.4%	N/A
McDonald, MO	14,917	16,938	13.5%	21,681	28.0%	22,128
Newton, MO	40,555	44,445	9.6%	52,636	18.4%	N/A
Ozark, MO	7,961	8,598	8.0%	9,542	11.0%	9,538
Polk, MO	18,822	21,826	16.0%	26,992	23.7%	N/A
Stone, MO	15,587	19,078	22.4%	28,658	50.2%	31,160
Taney, MO	20,467	25,561	24.9%	39,703	55.3%	44,029
Webster, MO	20,414	23,753	16.4%	31,045	30.7%	N/A

[1] Population estimates obtained from the Center for Business and Economic Research, University of Arkansas

The following discussion of environmental justice issues has been developed to address Presidential Executive Order 12898:

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority and Low-Income Populations. On February 11, 1994, President Clinton issued Executive Order 12898, Federal Actions to Address Environmental Justice in Minority and Low-Income Populations. The purpose of this executive order is to avoid the disproportionate placement of adverse environmental, economic, social, or health impacts from Federal actions and policies on minority and low-income populations or communities. An element emanating from this order was the creation on an Interagency Federal Working Group on Environmental Justice comprised of the heads of seventeen Federal departments and agencies, including the U.S. Army. Each department or agency is to develop a strategy and implementation plan for addressing environmental justice.

It is the Army's policy to fully comply with Executive Order 12898 by incorporating environmental justice concerns in decision-making processes supporting Army policies, programs, projects, and activities. In this regard, the Army ensures that it would identify, disclose, and respond to potential adverse social and environmental impacts on minority and/or low-income populations within the area affected by a proposed Army action. The initial step in this process is the identification of minority and low-income populations that might be affected by implementation of the proposed action or alternatives. For environmental justice considerations, these populations are defined as individuals or groups of individuals, which are subject to an actual or potential health, economic, or environmental threat arising from existing or proposed Federal actions and policies. Low income is defined as the aggregate annual mean income for a family of four in 2000 of $17,601.

The race and income demographics of the three counties also differ from State and National statistics. Table 3.9-2 details the race populations, per capita income, and poverty levels for the 47 counties, Arkansas, and Missouri.

The study area's race profile is predominantly white with only a few of the counties having non-white populations that make up more than 10 percent of the population. Of the 47 counties 36 have non-white populations that make up less than 10 percent of the population. This contrast is also apparent when compared to the non-white population percentages of the states and nation. Arkansas' and Missouri's non-white population percentages are 20 percent and 15.1 percent, respectively; and the National percentage is 24.9 percent. Forty-four (44) of the 47 counties have non-white populations that are less than National percentage. This difference is most likely a result of the study area's rural location. The race profile's non-white population range is from 1.8 percent (Cleburne, AR) to 36.0 percent (Pulaski, AR).

Income statistics for the study area are also well off state and national values. Forty (40) of the 47 counties in the study area have per capita income below their respective state's value. Arkansas' and Missouri's per capita income, in 1999 dollars, was $16,904 and $19,936, respectively. The National statistic is $21,587; when comparing the counties to the National value, all 47 counties have per capita income less than $21,587. The per capita income range

is from $12,536 (Searcy, AR) to $21,466 (Pulaski, AR). Again, this contrast is most likely a result of the rural location of the study area.

Lastly, the study area's poverty levels are below their respective state's value, but not to the severity of the latter two categories. The percentage of persons in poverty for 24 of the 47 counties is above that of Arkansas' and Missouri's values of 15.8 percent and 11.7 percent, respectively. When compared to the National statistic of 12.4 percent, 41 of the 47 counties have a greater percentage of poverty. The poverty statistics range is from 9.1 percent (Christian, MO) to 27.0 percent (Woodruff, AR).

Table 3.8-2: County and State Race, Income, and Poverty Data

County / State	Total Race Population	White Population	% Non-White Pop. (2000)	Per Capita Income (1999 $'s)	% Persons in Poverty (1999 %)
ARKANSAS	*2,673,400*	*2,138,598*	20.0%	$16,904	15.8%
Baxter, AR	38,386	37,547	2.2%	16,859	11.1%
Benton, AR	153,406	139,399	9.1%	19,377	10.1%
Boone, AR	33,948	33,132	2.4%	16,175	14.8%
Calhoun, AR	5,744	4,280	25.5%	15,555	16.5%
Carroll, AR	25,357	23,741	6.4%	16,003	15.5%
Cleburne, AR	24,046	23,613	1.8%	17,250	13.1%
Conway, AR	20,336	17,137	15.7%	16,056	16.1%
Crawford, AR	53,247	49,087	7.8%	15,015	14.2%
Faulkner, AR	86,014	75,973	11.7%	17,988	12.5%
Franklin, AR	17,771	17,091	3.8%	14,616	15.2%
Fulton, AR	11,642	11,371	2.3%	15,712	16.3%
Independence, AR	34,233	32,490	5.1%	16,163	13.0%
Izard, AR	13,249	12,773	3.6%	14,397	17.2%
Jackson, AR	18,418	14,840	19.4%	14,564	17.4%
Johnson, AR	22,781	21,344	6.3%	15,097	16.4%
Logan, AR	22,486	21,690	3.5%	14,527	15.4%
Lonoke, AR	52,828	48,089	9.0%	17,397	10.5%
Madison, AR	14,243	13,665	4.1%	14,736	18.6%
Marion, AR	16,140	15,740	2.5%	14,588	15.2%
Newton, AR	8,608	8,385	2.6%	13,788	20.4%
Perry, AR	10,209	9,762	4.4%	16,216	14.0%
Pope, AR	54,469	51,055	6.3%	15,918	15.2%
Prairie, AR	9,539	8,092	15.2%	15,907	15.5%
Pulaski, AR	361,474	231,211	36.0%	21,466	13.3%
Searcy, AR	8,261	8,035	2.7%	12,536	23.8%
Sebastian, AR	115,071	94,745	17.7%	18,424	13.6%
Sharp, AR	17,119	16,630	2.9%	14,143	18.2%
Stone, AR	11,499	11,185	2.7%	14,134	18.9%
Van Buren, AR	16,192	15,673	3.2%	16,603	15.4%
Washington, AR	157,715	138,796	12.0%	17,347	14.6%
White, AR	67,165	62,811	6.5%	15,890	14.0%
Woodruff, AR	8,741	5,932	32.1%	13,269	27.0%
Yell, AR	21,139	18,312	13.4%	15,383	15.4%
MISSOURI	*5,595,211*	*4,748,083*	15.1%	$19,936	11.7%
Barry, MO	34,010	31,999	5.9%	14,980	16.6%
Christian, MO	54,285	52,824	2.7%	18,422	9.1%
Dallas, MO	15,661	15,262	2.5%	15,106	17.9%
Douglas, MO	13,084	12,673	3.1%	13,785	17.5%
Greene, MO	240,391	224,859	6.5%	19,185	12.1%
Howell, MO	37,238	35,902	3.6%	13,959	18.7%
Lawrence, MO	35,204	33,682	4.3%	15,399	14.1%
McDonald, MO	21,681	19,440	10.3%	13,175	20.7%
Newton, MO	52,636	49,086	6.7%	17,502	11.6%
Ozark, MO	9,542	9,310	2.4%	14,133	21.6%
Polk, MO	26,992	26,253	2.7%	13,645	16.3%
Stone, MO	28,658	27,983	2.4%	18,036	12.8%
Taney, MO	39,703	38,202	3.8%	17,267	12.4%
Webster, MO	31,045	29,866	3.8%	14,502	14.8%

Economic activity in the study area is varied, but each county hosts a majority of North American Industry Classification System (NAICS) sectors. Table 3.9-3 lists the states and counties makeup of these sectors. Included is the number of persons employed per industry, annual payroll (in thousands of dollars), and the total number of establishments per industry. The Arkansas counties account for nearly two-thirds of the persons employed in the state; this due in part to the inclusion of Pulaski County, which accounts for 22 percent of the persons employed in the state. Annual payroll in the study area is greater than $16.8 billion; over 68 percent of total payroll in the state, and again this is in large part to Pulaski County, which accounts for 26 percent of the state's total annual payroll. Arkansas also has a total of 63,185 business establishments, of which, over 61 percent are located in the study area. Pulaski County accounts for over 12,000 establishments or 19.1 percent.

The Missouri counties account for a less robust portion of their state's profile in most part because only 14 counties from Missouri were included in the study area. The number of persons employed, annual payroll, and total business establishments are 247,423, $5.6 billion, and 16,900, respectively. This accounts for 10.3, 7.9, and 11.7 percent of Missouri's totals.

Table 3.8-3: County and State Business Patterns

State of Arkansas	Total	Forestry, fishing, hunting, and agriculture support	Mining	Utilities	Construction	Manufacturing	Wholesale trade	Retail trade	Transportation & warehousing	Information	Finance & insurance	Real estate & rental & leasing
Persons employed	990,830	6,034	3,161	7,517	48,616	235,578	44,822	135,143	44,799	22,387	33,388	11,519
Annual payroll (1,000's)	24,663,335	137,814	107,246	382,318	1,278,836	6,610,707	1,401,612	2,268,341	1,329,637	862,906	1,179,188	230,193
Total establishments	63,185	916	272	409	5,724	3,245	3,505	12,211	2,439	922	3,647	2,374
Baxter												
Persons employed	11,893	0	0	59	474	3,109	117	1,934	148	233	379	154
Annual payroll (1,000's)	273,864	0	0	2,155	10,708	81,746	2,471	32,479	2,733	6,634	14,691	2,021
Total establishments	1,039	3	1	6	102	52	27	224	22	20	49	44
Benton												
Persons employed	67,478	0	0	247	2,444	13,110	2,696	6,444	3,689	1,519	1,462	801
Annual payroll (1,000's)	2,120,595	0	0	9,174	66,525	356,606	103,685	116,566	158,050	51,636	46,955	15,973
Total establishments	3,657	8	2	10	408	183	192	544	125	51	173	142
Boone												
Persons employed	13,966	0	0	55	505	2,856	2,086	2,350	208	340	422	137
Annual payroll (1,000's)	320,956	0	0	2,720	11,660	73,306	61,393	38,873	5,165	10,839	12,982	2,709
Total establishments	948	2	1	7	90	67	43	202	48	12	50	40
Calhoun												
Persons employed	807	99	0	0	53	131	76	86	47	0	0	0
Annual payroll (1,000's)	16,571	1,698	0	0	1,068	3,413	1,344	986	1,115	0	0	0
Total establishments	93	14	2	2	7	5	3	19	8	3	1	2
Carroll												
Persons employed	8,480	17	N/A	0	255	3,541	157	1,380	160	99	234	68
Annual payroll (1,000's)	160,441	402	N/A	0	5,064	68,413	4,197	21,184	2,932	2,171	6,507	926
Total establishments	766	4	N/A	4	59	34	29	190	19	11	39	24
Cleburne												
Persons employed	5,756	5	0	69	283	1,762	239	940	252	47	179	51
Annual payroll (1,000's)	112,854	61	0	2,351	5,662	45,264	6,715	15,045	7,362	990	4,107	846
Total establishments	570	3	2	7	58	33	30	122	29	9	32	19
Conway												
Persons employed	5,695	14	0	0	608	889	266	943	300	55	118	0
Annual payroll (1,000's)	133,805	164	0	0	19,840	35,309	8,781	15,223	8,881	1,182	2,810	0
Total establishments	409	4	1	3	46	25	24	95	15	7	18	8

Crawford												
Persons employed	16,772	0	0	0	819	3,938	491	1,874	2,816	31	293	108
Annual payroll (1,000's)	390,464	0	0	0	18,654	96,489	12,657	30,355	97,462	1,257	8,369	1,907
Total establishments	915	4	4	3	128	60	59	164	53	7	49	35
Faulkner												
Persons employed	29,268	0	50	238	2,581	7,462	937	4,080	349	2,253	699	241
Annual payroll (1,000's)	777,624	0	1,410	9,307	73,299	227,014	23,456	66,765	8,547	156,784	20,843	3,529
Total establishments	1,783	2	9	9	251	92	85	338	45	26	91	69
Franklin												
Persons employed	3,144	0	0	162	166	1,045	65	475	59	0	141	27
Annual payroll (1,000's)	61,872	0	0	6,035	3,860	21,855	752	6,885	1,353	0	2,914	509
Total establishments	281	2	3	8	30	18	7	57	11	7	22	6
Fulton												
Persons employed	1,275	N/A	N/A	0	89	310	0	186	0	0	65	9
Annual payroll (1,000's)	20,674	N/A	N/A	0	2,481	4,407	0	2,373	0	0	997	253
Total establishments	164	N/A	N/A	2	10	12	9	42	4	2	6	7
Independence												
Persons employed	14,475	14	43	0	398	5,036	624	1,776	716	190	289	66
Annual payroll (1,000's)	333,871	307	1,297	0	8,161	142,330	16,927	27,805	16,224	4,937	7,097	1,230
Total establishments	826	4	5	8	54	52	43	198	44	7	41	28
Izard												
Persons employed	2,200	0	0	0	60	401	65	448	83	0	96	44
Annual payroll (1,000's)	38,459	0	0	0	1,176	14,082	990	6,081	2,140	0	2,305	476
Total establishments	239	2	1	1	26	13	11	50	9	2	17	9
Jackson												
Persons employed	5,176	47	N/A	49	662	888	238	743	195	0	164	179
Annual payroll (1,000's)	111,275	1,425	N/A	1,352	12,963	28,639	5,882	12,685	4,624	0	4,608	2,380
Total establishments	430	9	N/A	6	27	22	30	98	18	5	24	15
Johnson												
Persons employed	7,430	12	0	11	70	3,370	0	883	136	38	172	38
Annual payroll (1,000's)	137,607	223	0	294	1,279	65,618	0	13,949	2,632	869	3,670	1,003
Total establishments	398	4	2	3	22	39	6	93	4	5	22	15

Logan												
Persons employed	4,876	24	0	0	108	2,213	71	717	55	32	194	10
Annual payroll (1,000's)	94,596	467	0	0	2,657	51,119	1,021	10,598	1,024	947	4,612	115
Total establishments	381	5	4	6	29	30	10	85	19	9	26	10
Lonoke												
Persons employed	8,855	67	N/A	24	704	1,656	371	1,866	185	161	353	117
Annual payroll (1,000's)	174,357	1,916	N/A	911	17,640	46,965	7,556	29,563	4,256	6,435	10,010	1,448
Total establishments	943	15	N/A	7	132	40	43	190	53	17	51	36
Madison												
Persons employed	1,944	32	N/A	35	61	827	0	333	77	37	83	25
Annual payroll (1,000's)	40,002	709	N/A	875	1,120	19,721	0	5,079	1,769	1,343	2,091	491
Total establishments	198	11	N/A	3	19	19	3	52	10	4	10	6
Marion												
Persons employed	3,006	0	N/A	0	63	1,673	0	396	25	0	116	13
Annual payroll (1,000's)	55,020	0	N/A	0	864	34,894	0	5,410	430	0	2,716	137
Total establishments	233	1	N/A	2	22	23	6	42	11	3	15	12
Newton												
Persons employed	636	8	N/A	0	0	124	50	127	4	0	0	7
Annual payroll (1,000's)	9,651	39	N/A	0	0	2,012	505	1,744	92	0	0	66
Total establishments	108	3	N/A	4	5	15	8	17	6	1	3	3
Perry												
Persons employed	617	0	0	0	82	40	0	158	3	0	56	7
Annual payroll (1,000's)	10,468	0	0	0	1,901	679	0	1,597	31	0	1,301	46
Total establishments	121	2	2	2	24	6	5	22	4	1	7	3
Pope												
Persons employed	21,769	753	0	0	1,069	4,255	772	3,523	907	322	561	174
Annual payroll (1,000's)	527,056	11,686	0	0	28,302	112,699	25,327	57,477	29,243	8,065	16,182	2,897
Total establishments	1,463	16	1	15	129	80	92	307	64	25	92	52
Prairie												
Persons employed	1,330	33	N/A	0	28	377	62	273	60	17	36	9
Annual payroll (1,000's)	26,184	587	N/A	0	423	11,149	1,183	4,116	1,647	341	603	151
Total establishments	182	7	N/A	1	10	5	8	47	16	5	5	4

Pulaski												
Persons employed	223,972	94	282	1,519	10,743	19,653	14,671	26,272	14,564	7,816	12,724	3,091
Annual payroll (1,000's)	6,520,359	2,957	10,743	80,147	334,054	646,020	527,546	496,338	429,106	347,274	579,554	78,728
Total establishments	12,043	15	10	39	941	410	863	1,796	242	194	896	485
Searcy												
Persons employed	1,195	0	N/A	20	0	177	0	240	0	0	64	0
Annual payroll (1,000's)	14,904	0	N/A	373	0	2,700	0	2,661	0	0	1,080	0
Total establishments	126	2	N/A	4	4	9	5	36	1	4	7	5
Sebastian												
Persons employed	72,929	0	435	384	3,283	23,950	2,311	8,347	1,517	1,472	1,748	1,081
Annual payroll (1,000's)	1,860,678	0	16,780	15,424	78,881	710,842	64,156	147,907	44,155	49,357	57,003	21,632
Total establishments	3,305	2	43	16	250	216	234	612	100	54	212	137
Sharp												
Persons employed	3,179	N/A	0	39	174	224	83	652	85	0	176	33
Annual payroll (1,000's)	59,070	N/A	0	1,087	2,936	6,743	2,196	9,234	2,438	0	3,845	514
Total establishments	375	N/A	1	7	39	19	14	81	9	8	21	16
Stone												
Persons employed	2,302	0	N/A	20	104	929	53	485	23	0	68	4
Annual payroll (1,000's)	36,594	0	N/A	733	1,506	14,931	1,095	8,505	378	0	1,740	56
Total establishments	240	1	N/A	5	19	23	9	63	11	3	12	3
Van Buren												
Persons employed	2,927	0	N/A	103	125	708	0	505	143	52	120	49
Annual payroll (1,000's)	51,727	0	N/A	2,223	2,608	15,823	0	7,055	2,767	1,504	2,574	1,428
Total establishments	317	2	N/A	4	35	14	11	67	22	7	23	6
Washington												
Persons employed	71,286	0	0	440	3,999	16,612	3,321	10,706	3,837	1,289	1,864	990
Annual payroll (1,000's)	1,732,367	0	0	18,841	113,471	430,105	125,862	183,502	104,680	39,749	62,382	20,054
Total establishments	4,229	6	3	13	384	205	261	770	151	61	242	222
White												
Persons employed	21,756	37	0	140	1,166	5,109	578	3,494	1,193	152	527	164
Annual payroll (1,000's)	479,149	581	0	6,588	26,874	147,815	14,060	54,492	31,467	4,037	12,135	2,674
Total establishments	1,425	12	5	11	151	91	82	341	71	18	72	52

Woodruff												
Persons employed	1,641	0	N/A	0	43	416	172	254	85	0	0	0
Annual payroll (1,000's)	36,002	0	N/A	0	731	10,403	5,267	3,148	2,030	0	0	0
Total establishments	149	2	N/A	2	5	8	11	39	14	4	4	3
Yell												
Persons employed	5,912	88	0	0	377	2,882	98	578	145	0	181	0
Annual payroll (1,000's)	109,208	1,632	0	0	6,705	53,966	1,349	8,289	2,981	0	4,822	0
Total establishments	375	14	1	2	50	22	13	77	20	3	17	16

State of Missouri	Total	Forestry, fishing, hunting, and agriculture support	Mining	Utilities	Construction	Manufacturing	Wholesale trade	Retail trade	Transportation & warehousing	Information	Finance & insurance	Real estate & rental & leasing
Persons employed	2,398,979	1,460	5,056	17,242	142,349	347,772	145,528	317,839	86,877	82,396	130,420	36,619
Annual payroll (1,000's)	72,195,796	28,303	178,427	1,022,684	5,178,244	11,662,038	5,458,046	6,257,818	2,740,591	3,868,710	5,660,416	965,710
Total establishments	144,755	301	304	405	15,590	7,307	9,072	23,911	4,932	2,491	9,275	5,775
Barry												
Persons employed	13,880	0	0	64	394	7,062	414	1,557	227	181	319	0
Annual payroll (1,000's)	362,507	0	0	2,064	6,820	179,545	12,296	24,251	3,860	6,729	7,505	0
Total establishments	814	2	1	4	80	65	45	166	41	17	55	28
Christian												
Persons employed	11,166	0	0	97	1,531	2,863	416	2,028	177	0	386	194
Annual payroll (1,000's)	220,644	0	0	4,534	38,124	63,709	11,315	37,027	3,408	0	8,997	1,961
Total establishments	1,205	1	2	9	233	106	61	191	46	10	70	50
Dallas												
Persons employed	2,786	N/A	0	0	197	540	92	447	30	21	129	0
Annual payroll (1,000's)	31,582	N/A	0	0	2,977	4,372	1,406	7,137	493	704	2,820	0
Total establishments	273	N/A	1	1	27	13	9	55	22	5	14	13
Douglas												
Persons employed	2,045	0	0	0	137	656	60	342	52	27	70	4
Annual payroll (1,000's)	32,107	0	0	0	2,578	11,141	1,178	4,935	808	468	1,122	48
Total establishments	195	3	1	1	15	12	9	38	26	4	12	4
Greene												
Persons employed	137,129	112	52	341	5,590	18,532	9,911	20,451	6,795	4,696	6,566	2,004
Annual payroll (1,000's)	3,367,003	2,097	1,684	13,015	152,929	563,206	296,448	392,903	201,153	131,857	194,243	42,622
Total establishments	7,653	13	3	5	718	366	545	1,326	296	124	551	368

Howell												
Persons employed	13,439	20	0	0	457	3,976	507	2,278	290	243	301	207
Annual payroll (1,000's)	251,800	319	0	0	9,317	81,622	13,461	34,362	6,248	4,754	7,814	3,218
Total establishments	1,018	5	6	2	87	81	59	235	48	23	51	38
Lawrence												
Persons employed	6,679	0	0	158	304	1,506	98	1,065	596	151	152	47
Annual payroll (1,000's)	144,160	0	0	8,015	7,821	40,632	2,555	22,964	11,885	2,665	3,745	630
Total establishments	643	1	2	4	71	57	20	118	47	17	29	22
McDonald												
Persons employed	4,845	N/A	32	0	200	2,993	248	480	60	40	93	16
Annual payroll (1,000's)	92,575	N/A	560	0	5,490	59,352	5,322	6,453	1,007	2,326	2,429	175
Total establishments	339	N/A	4	2	37	31	16	74	8	6	14	11
Newton												
Persons employed	16,073	0	0	98	615	4,438	511	1,695	704	0	433	106
Annual payroll (1,000's)	378,589	0	0	4,852	15,571	108,828	11,688	31,998	21,749	0	11,559	1,624
Total establishments	1,002	4	3	4	98	67	49	188	73	19	70	36
Ozark												
Persons employed	1,006	0	0	0	0	139	26	347	60	0	83	18
Annual payroll (1,000's)	15,759	0	0	0	0	2,405	415	4,575	921	0	1,888	310
Total establishments	179	4	1	2	17	9	10	40	15	4	9	5
Polk												
Persons employed	7,672	0	0	91	351	1,025	883	1,070	120	96	202	59
Annual payroll (1,000's)	130,730	0	0	3,400	6,415	17,565	9,988	18,653	1,577	2,530	4,071	667
Total establishments	593	2	2	4	68	34	28	110	34	7	32	23
Stone												
Persons employed	5,293	0	0	0	1,157	266	50	930	56	81	178	57
Annual payroll (1,000's)	120,462	0	0	0	35,676	5,064	1,414	16,133	961	1,858	4,046	1,033
Total establishments	635	1	1	2	122	22	17	114	19	11	30	30
Taney												
Persons employed	20,068	0	0	159	877	734	494	3,501	127	544	372	1,878
Annual payroll (1,000's)	425,697	0	0	6,601	22,947	15,399	9,963	63,709	3,107	11,641	10,136	33,643
Total establishments	1,729	1	3	8	125	59	41	425	27	29	57	96
Webster												
Persons employed	5,342	0	0	0	403	1,224	139	1,106	141	58	274	39
Annual payroll (1,000's)	104,207	0	0	0	8,147	33,177	2,900	17,228	2,387	1,760	5,983	427
Total establishments	622	1	2	2	118	48	29	113	33	6	36	20

3.9 Cultural Resources

The Arkansas Historic Preservation Program, Department of Arkansas Heritage, was consulted regarding cultural resources issues in the vicinity of the five lakes under consideration. The consultation letter and the response letter are provided in Appendix A. The Missouri Historic Preservation Program, Missouri Department of Natural Resources, and the Osage Nation were also consulted. The consultation letters are also provided in Appendix A. The Missouri Historic Preservation Program and the Osage Nation both chose not to respond. There have been no changes to the project area since formal consultation with the sate historic preservation agencies. The agencies have also been provided copies of the EIS during the review process. No comments have been made by the agencies.

Paleo-Indian (10,000-8,000 B.C.)

Around 12,000 years ago, nomadic hunter-gathers referred to as the Paleo-Indians entered North America via a land bridge connecting modern day Siberia and Alaska. Very little is known of the Paleo Indians since very little was left behind. It is known that the population of North America was small at this time. These nomadic bands followed herds of big game such as the extinct Mastodon. Plant foods were also collected. The Paleo Indian tool assemblages consisted of stone drills and perforators, burins, gravers, knives, and other flaked stone tools. The most recognizable part of their tool assemblage was the fluted projectile point such as Clovis.

Archaic (8,000-500 B.C.)

Around 8,000 years ago, the climate began to change. The Pleistocene epoch gave way top the Holocene. Warmer temperatures, along with increased hunting efficiency, brought about the extinction of the megafauna that the Paleo Indians had followed. Archaic people relied on the animals and plants that we see today. Settlement patterns were seasonal, with bands of people staying in one area for entire seasons before moving on to the next settlement. From these base camps, hunting parties were sent out, sometimes for days, to kill game. Archaic period hunting camps abound in the White River area.

Woodland (500 B.C. – A.D. 900)

One major technological change marks the beginning of the Woodland period- pottery. Ceramics had begun to appear during the Archaic period, but their proliferation marks the beginning of the Woodland period. Pottery signifies an increasing reliance on domesticated plants. Horticulture had now spread throughout most of the Eastern Woodlands, with the White River area being no exception. The bow and arrow became a part of the tool assemblage, further increasing the efficiency of hunting game. For the most part, however, the Woodland period is very poorly understood in the White River area. Unfortunately, only a few sites containing Woodland period components have been studied.

Mississippian (A.D. 900 – 1541)

The Mississippian period generally marks the transition to full-scale agriculture and a chiefdom level of politics. An influence of religion from Mesoamerica spread rapidly throughout the southeastern U.S. Large mound sites were constructed, elaborate trade networks were established, and populations dramatically increased. Ozark adaptations,

however, were unique during the Mississippian period. Domesticated crops were grown in the river valleys, but hunting and gathering likely made up the bulk of the food supply. Small Mississippian period mound sites did exist in the White River area, such as the Loftin Site, inundated by Table Rock Lake. Other Mississippian sites in the area include open-air village sites and rock shelters. It had been speculated that these communities were "outposts" of the Caddo culture located to the southwest. Recently, however, researchers have demonstrated that these societies simply interacted with one another on a frequent basis, with no evidence of Caddo colonization (Sabo et al.1988: 99).

Protohistoric / Historic Periods (A.D. 1541 –1865)

The Protohistoric period began with the De Soto expedition into the Southeastern U.S. Generally speaking, De Soto did not enter the Ozarks, but the aftermath of his expedition definitely did enter the area. Diseases the Spaniard and his men brought with them, such as smallpox and influenza, had a devastating effect. The tribes inhabiting the area had no immunity against these diseases, and up to 90percent of the populations were decimated. During this time period, the Ozarks were primarily being used as a hunting ground for the Osage, who were centered more to the north.

Euro-American settlement began in the Ozarks in the late 18th century. People generally subsisted on a combination of hunting wild game and herding domesticated animals. With the creation of the Arkansas Territory in 1819, people from the upland South, or Appalachia, began to move into the Ozarks. These people brought with them many aspects of their culture, including fundamentalist religion, unique architectural styles, and an aptitude for farming rocky terrain. Although slave holding was not unheard of, it certainly was not the norm. A few major battles, such as Pea Ridge, were fought in the area. Theoretically, the battle of Pea Ridge solidified Union control over southern Missouri. In reality, the entire Ozark region was hostage to Bushwhackers, or outlaws that roamed the land and robbed people indiscriminately.

3.8.1 Previous Investigation on the White River Area

Numerous cultural resource surveys, archeological site excavations, and other investigations have taken place in the White River region. Indeed, many of these studies were done due to the construction of reservoirs and the impending resource destruction. Given the large number of studies, it would be next to impossible to discuss each one of these studies here. Many of these studies are summarized in *Human Adaptation in the Ozark and Ouachita Mountains* (Sabo et al. 1988).

3.8.2 Recorded Cultural Resources in the Lake Area

The last cultural resources inventory for the White River area was conducted in 1988 for the *Cultural Resources Priority Plan for the U.S. Army Engineer District, Little Rock,* 1988 (Blakely and Bennet, Jr. 1988). It should be kept in mind that his inventory only represents sites recorded before 1988 and many have been recorded since that date. In addition, many more sites have yet to be recorded. The following tables summarize the previously recorded resources on Bull Shoals and Norfork lakes.

Table 3.9-1: Bull Shoals Lake Prehistoric Archeological Sites

National Register Eligibility Status	Number of Sites
Not Evaluated	162
Not Eligible	5
Eligible	1
Inundated?	112
Total	280

Table 3.9-2: Bull Shoals Lake Historic Archeological Sites

National Register Eligibility Status	Number of Sites
Not Evaluated	17
Not Eligible	5
Eligible	1
Total	23

Table 3.9-3: Norfork Lake Prehistoric Archeological Sites

National Register Eligibility Status	Number of Sites
Not Evaluated	80
Not Eligible	8
Total	88

Table 3.9-4: Norfork Lake Historic Archeological Sites

National Register Eligibility Status	Number of Sites
Not Evaluated	4
Not Eligible	1
Total	5

4.0 Environmental Consequences

Under the "No Action" alternative, there will be no change in the existing conditions. Frequently a No Action alternative doesn't necessarily mean continuation of the status quo but it does in this project. The sub-optimal trout fishery conditions that currently exist within the tailwaters of the Bull Shoals and Norfork reservoirs will remain in the current condition and the lake fishery will continue to be subject to the current operation plan. As previously stated the No Action alternative does not meet the purpose or need as identified in the November 2008, White River Basin, Arkansas, Minimum Flows Project Report (Project Report) or comply with 2006 EWDAA.

The Proposed action: The following analysis consist of a quantitative and qualitative summary of impacts identified in the development of the draft EIS. The H&H analyses and SUPER model output were the primary tools used in this evaluation. Bull Shoals lake elevations will be generally higher in every month with a tendency for elevations to be 0.60 feet lower in October and November at the 95 percent time equaled or exceeded with minimum flows implemented. At Norfork, elevations are higher in every month below the 85 percent time equaled or exceeded; and are on average 2.3 feet lower in every month above the 85 percent time equaled or exceeded with minimum flows implemented. See Appendix B of the Project Report for pool conservation elevation –duration results.

The outflow-frequency curves for each of the alternatives for each of the lakes shows an increase in exceedance probability for the lower flows than the current plan. At Bull Shoals outflows are on average 4,570 cfs higher below the 10 percent frequency; and 900 cfs lower above the 10 percent frequency with minimum flow (at the 0.2 percent frequency the outflow is 8,610 cfs higher at 81,980 cfs); at Norfork outflows are on average 1,770 cfs higher below the 10 percent frequency; and 400 cfs lower above the 10 percent frequency with minimum flow (at the 0.2 percent frequency the outflow is 3,620 cfs higher at 31,620 cfs). See Appendix B of the Project Report for pool outflow-frequency curves. The pool elevation-frequency alternative curves show little to no effect in the maximum pool elevation frequencies for the longer recurrence intervals, but shows significant impact on the minimum pool elevation-frequencies. At Bull Shoals elevations are on average 3.3 feet higher between 10 percent and 90 percent frequency with a maximum of 4.4 feet higher at the 80 percent frequency with minimum flow; at Norfork elevations are on average 1.0 foot higher between 5 percent and 80 percent frequency with a maximum of 1.4 feet higher at the 10 percent frequency; and 0.6 feet lower above the 90 percent frequency with a maximum of 1.1 feet lower at the 90 percent frequency with minimum flow. The conservation reallocation causes the greatest decrease in minimum pool elevation followed by the split reallocation. Reallocation from the flood pool actually produces a higher minimum pool elevation frequency than the current plan for all lakes. See Appendix B of the Project Report for pool elevation-frequency curves.

In general, the physical affects associated with minimum flows storage reallocation will be limited to the areas around the lake that are currently affected by the existing water management plan. However, albeit minor, additional elevations will be flooded because of flood pool and 50/50 reallocations. This flood pool increase due to a flood event translates to

0.3 and 0.1 feet higher at Bull Shoals and Norfork respectively. The duration of flood events at elevations that currently flood may differ slightly from durations caused by the current operation plan. The Corps currently has the right-to-flood through fee ownership or easement all lands involved in this operational change.

For Bull Shoals Lake (BS-3) reallocation the construction costs needed to relocate roads, bridges, and park facilities is estimated to be approximately $12,494,000, and is a non-Federal cost. The minimum flow operation at Bull Shoals Lake would improve 66 miles of trout fishery along the White River with an annual improvement to the trout fishing recreation of $3.46M per year.

For Norfork Lake (NF-7) reallocation the construction costs needed to relocate roads, bridges, and park facilities is estimated to be approximately $5,609,000, and is a non-Federal cost. The minimum flows operation at Norfork Lake would improve 29 miles of trout fishery along the North Fork and White Rivers with an annual improvement to the trout fishing recreation of $1.52M per year.

A complete listing of lake facilities impacted at Bull Shoals and Norfork Lake can be viewed in Appendix F of the White River Basin, Arkansas, Minimum Flows Project Report, dated November 2008. SWPA's hydropower evaluation for all plans studied is shown in Appendix C of the November 2008 Project Report.

4.1 Land Use

The land use within the project area will not be affected by the "No Action" alternative or any of the reallocations considered in the study. The lands around each reservoir that might be affected are currently flooded annually. These areas are affected by the normal operation plan at each reservoir and characteristic of multipurpose projects with little or no vegetation. These areas are commonly referred to as the "bathtub ring" and the area displays the effects of frequent elevation increases and decreases.

4.2 Geology & Soils

4.2.1 Geology

Under the "No Action" alternative, there will be no change in the geologic resources of the study area.

Implementation of the Proposed Action will affect the geology associated with the area around the lakes by increases or decreases in the duration of karst area flooding. These areas are currently affected annually by the frequent fluctuation in water elevations.

4.2.2 Soils

Under the "No Action" alternative there will be no change in the soils of the study area.

No soils will be affected by the Proposed Action that is not currently inundated annually. These affected areas around the lakes are commonly referred to the "bathtub ring" and displays the characteristics of frequent fluctuation in water elevations.

4.3 Water Resources

4.3.1 Lakes

Table 4.3-1 shows the area of change to the conservation pool at each reservoir. Implementation of BS-3 at Bull Shoals (Flood Pool reallocation) will result in a 5 feet increase to the top of conservation pool to 659 ft. MSL resulting in a 2,565 surface acre increase to the pool and reduce the flood pool volume by 233,000 AF. The NF-7 reallocation at Norfork will increase the conservation pool elevation from 552 to 553.75 ft. MSL with an increase of 464 surface acres to the pool and reduce the flood pool volume by 38,900 AF..

Table 4.3-1. Change in Conservation Pool Relative to Bull Shoals and Norfork Lakes

LAKE	REALLOCATION (feet)	REALLOCATION TAKEN FROM	CONSERVATION POOL				
			ELEVATION (feet MSL	SURFACE AREA (acres)	SURFACE AREA INCREASE (acres)	PERCENT CHANGE FROM EXISTING	STORAGE (acre ft)
Bull Shoals	5	No Action*	654.00	45,440	0	0	3,048,000
		**BS-3	659.00	48,005	2,565	5.6	3,281,000
Norfork	3.5	No Action*	552.00	21,990	0	0	1,251,200
		**NF-7	553.75	22,454	464	2.1	1,290,138

* Existing condition
**Congressionally authorized plans

4.3.1.1 Bull Shoals

Under the "No Action" alternative, there would be no change in the water resources of Bull Shoals Lake.

The Proposed Action at Bull Shoals (BS-3), 5 feet reallocated from the flood pool, would result an increase of five feet to the top of conservation pool from 654 to 659. This will result in lake levels that are generally higher than current conditions. Figure 4.3.1.1 illustrates pool durations under the current operating plan and from a flood pool reallocation. Tables 4.3.1.1-1 and 4.3.1.1-2 lists the percent of time a specific elevation of interest will be met or exceeded under the current and proposed operating plan annually and seasonally.

Figure 4.3.1-1. Annual Pool Elevation Durations – Current and Proposed Plans

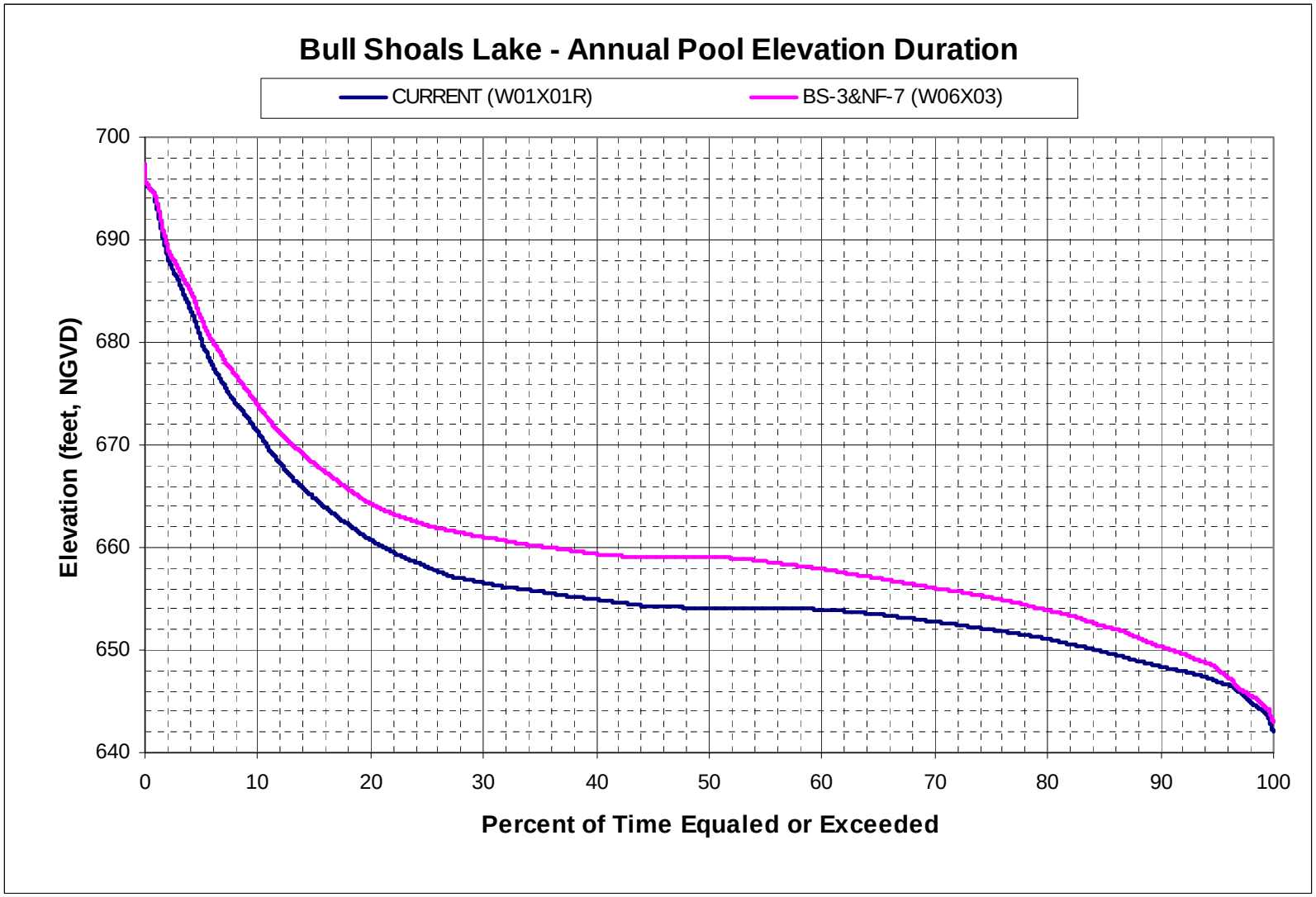


Table 4.3.1.1-1
Bull Shoals - Annual Pool Elevation-Duration for Elevations of Interest (365-day period)

Elevation (feet)	Interest	Current (%)	Proposed Action BS-3 (%)	Percent Difference	Increased Days
654	Current Top of Conservation Pool	59.1	79.6	20.5	75
657	[1]Current Seasonal Pool	28.0	65.0	37.0	135
659	Proposed Top of Conservation	23.0	51.5	28.4	104
660	[2]Proposed Lake Facility Filter Elevation	21.2	35.9	14.7	54
662	[3]Proposed Seasonal Pool	18.4	25.7	7.3	27
670	[4]Fish and Wildlife Service	10.8	13.1	2.3	9
675		7.5	9.3	1.8	7
690		1.6	1.9	0.2	1
695	Top of Flood Pool	0.4	0.4	0.0	0

1–Seasonal pool May 15 - June 15 then 30 day transition to 656 Seasonal Pool through September 30.
2– Proposed Filter Elevation for determining reasonable continued use of Lakeside Facilities.
3–Proposed Seasonal pool May 15 - June 15 then 30 day transition to 661 Seasonal Pool through September 30.
4- USFWS identified elevations of interest relevant to Tumbling Creek Cave Snail

Table 4.3.1.1-2. Seasonal Pool Elevation-Duration for Elevations of Interest

Bull Shoals Lake

Jan-Mar Pool Elevation-Duration for Pool Elevations of Interest (90-day period)

Elevation (feet)	Current (%)	Proposed Action BS-3 (%)	Difference (%)	Increased Days
654	61.1	75.4	14.3	13
657	14.7	62.4	47.7	43
659	11.3	50.6	39.3	35
660	9.7	18.8	9.1	8
662	7.6	12.8	5.2	5
670	2.2	3.5	1.4	1
675	0.9	1.4	0.4	0
690	0.0	0.0	0.0	0
695	0.0	0.0	0.0	0

Apr-Jun Pool Elevation-Duration for Pool Elevations of Interest (91-day period)				
Elevation (feet)	Current (%)	Proposed Action BS-3 (%)	Difference (%)	Increased Days
654	85.7	91.3	5.5	5
657	55.5	88.5	33.1	30
659	44.1	80.7	36.6	33
660	40.7	67.8	27.1	24
662	34.9	51.5	16.5	15
670	20.0	25.2	5.1	5
675	15.1	18.9	3.8	3
690	4.7	5.5	0.7	1
695	1.6	1.7	0.1	0

Jul-Sep Pool Elevation-Duration for Pool Elevations of Interest (92-day period)				
Elevation (feet)	Current (%)	Proposed Action BS-3 (%)	Difference (%)	Increased Days
654	56.8	86.9	30.1	27
657	27.4	67.0	39.6	36
659	24.4	49.8	25.3	23
660	23.4	41.2	17.8	16
662	21.8	25.9	4.1	4
670	16.4	18.1	1.7	2
675	12.5	14.0	1.6	1
690	1.8	2.0	0.1	0
695	0.0	0.0	0.0	0

Oct-Dec Pool Elevation-Duration for Pool Elevations of Interest (92-day period)				
Elevation (feet)	Current (%)	Proposed Action BS-3 (%)	Difference (%)	Increased Days
654	33.2	64.8	31.6	28
657	14.5	42.3	27.8	25
659	12.2	25.1	12.8	12
660	11.0	15.9	4.9	4
662	9.1	12.5	3.4	3
670	4.4	5.6	1.2	1
675	1.3	2.9	1.5	1
690	0.0	0.0	0.0	0
695	0.0	0.0	0.0	0

4.3.1.2 Norfork

Under the "No Action" alternative there will be no change in the water resources of Norfork Lake.

The "split" reallocation at Norfork (NF-7) would result in lake levels that are generally higher than current conditions but lower than if totally taken from the flood control pool. The Figure 4.3.1.2-1 illustrates pool durations under the current operating plan and from a flood pool reallocation. Tables 4.3.1.2-1 and 4.3.1.2-2 lists the percent of time a specific elevation of interest will be met or exceeded under the current and proposed operating plan annually and seasonally.

Figure 4.3.1.2 -1. Annual Pool Elevation Durations – Current and Proposed Plans

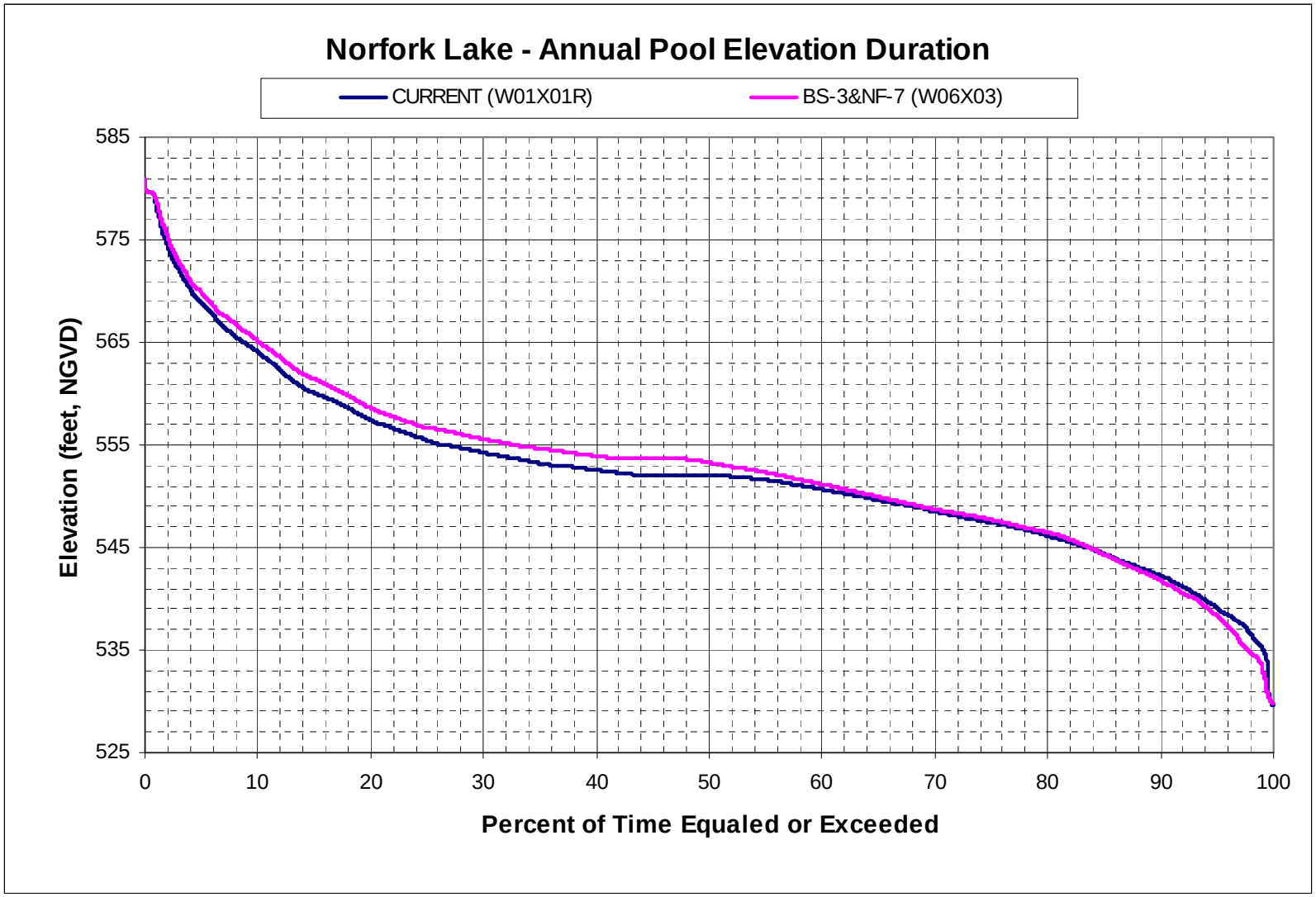


Table 4.3.1.2-1
Norfork - Annual Pool Elevation-Duration for Elevations of Interest (365-day period)

Elevation (feet)	Interest	Current (%)	Proposed Action NF-7 (%)	Percent Difference	Increased Days
552.00	Current Top of Conservation Pool	51.0	56.4	5.5	26
554.50	[1] Proposed Lake Facility Filter Elevation	29.1	36.1	7.0	33
555.00	[2]Current Seasonal Pool	26.7	32.9	6.1	26
553.75	Proposed Top of Conservation	32.4	41.4	9.0	22
556.75	[3]Proposed Seasonal Pool	21.7	24.6	2.9	11
580.00	[4]Top of Flood Pool	0.1	0.1	0.0	0

1– Proposed Filter Elevation for determining reasonable continued use of Lakeside Facilities.
2– Seasonal pool May 15 - June 15 then 30 day transition to 554 Seasonal Pool through September 30.
3--Proposed Seasonal pool May 15 - June 15 then 30 day transition to 555.75 Seasonal Pool through Sept30.
[4]– USFWS elevation of concern for Ozark hellbender is above the top of Flood Pool (580 msl) and will not be affected.

Table 4.3.1.2-2 Seasonal Pool Elevation-Duration for Elevations of Interest

Norfork Lake				
Jan-Mar Pool Elevation-Duration for Pool Elevations of Interest (90-day period)				
Elevation (feet)	Current (%)	Proposed Action NF-7 (%)	Difference (%)	Increased Days
553.75	16.3	29.9	13.6	12
554.50	15.1	21.0	5.9	5
555.00	13.9	16.4	2.5	2
556.75	10.4	13.0	2.6	2
580.00	0.0	0.0	0.0	0
Apr-Jun Pool Elevation-Duration for Pool Elevations of Interest (91-day period)				
Elevation (feet)	Current (%)	Proposed Action NF-7 (%)	Difference (%)	Increased Days
553.75	65.4	74.4	9.0	8
554.50	59.8	69.9	10.2	9
555.00	53.4	66.5	13.2	12
556.75	42.1	48.9	6.8	6
580.00	0.2	0.2	0.0	0

Jul-Sep Pool Elevation-Duration for Pool Elevations of Interest (92-day period)				
Elevation (feet)	Current (%)	Proposed Action NF-7 (%)	Difference (%)	Increased Days
553.75	32.7	41.6	8.9	8
554.50	27.7	37.8	10.0	9
555.00	26.9	34.6	7.7	7
556.75	24.5	25.8	1.3	1
580.00	0.0	0.0	0.0	0
Oct-Dec Pool Elevation-Duration for Pool Elevations of Interest (92-day period)				
Elevation (feet)	Current (%)	Proposed Action NF-7 (%)	Difference (%)	Increased Days
553.75	15.3	19.7	4.4	4
554.50	13.7	15.7	2.0	2
555.00	12.8	14.0	1.2	1
556.75	9.8	10.7	0.9	1
580.00	0.0	0.0	0.0	0

Comparison of Extreme Events At Bull Shoals and Norfork

Flood Events.

When considering the impacts of the proposed project, it is prudent to review the impacts upon operations at each project for extreme flood events. When annualized during the period of record, the single event impacts can be spread out and seem less significant. Impacts at Bull Shoals and Norfork were analyzed based upon SUPER model runs W01X01R for existing conditions and W06X03 for the proposed project (BS-3 & NF-7). Five historic flood events were investigated to compare pool elevation and downstream flows: 1945, 1957, 1973, 1990, and 2002. See Table 4.3.1.3 for impacts. In addition, due to the "System" operation of the White River 5-Lake System (Beaver, Table Rock, Bull Shoals, Norfork and Greers Ferry Lakes), impacts at all the lakes were investigated. There were some minor impacts to the other lakes for the proposed plan (BS-3 & NF-7). Because these impacts were deemed insignificant, they are not shown.

Drought Events

Similar to flood events, the impacts of the proposed project should be analyzed for impacts upon operations at each project for drought events. For this study, four time periods were analyzed: 1953-1957, 1962-1965, 1980-1982, and 1999-2002. See Table 4.3.1.3 for impacts.

Again, the impacts to Beaver, Table Rock, and Greers Ferry Lakes were investigated and deemed to be insignificant.

In summary from a hydrologic and hydraulic perspective, the proposed project would have slightly higher flood pool elevations and minimal impacts to pool durations above the conservation pool at Bull Shoals and Norfork Lake when considering operations during extreme events. During droughts, it would be expected that Bull Shoals would have less severe minimums and Norfork would have slightly lower minimum pool elevations. At both lakes it would be expected that it will take longer to refill the lakes to conservation pool. Minor increases in maximum stage throughout the projects' tailwater are expected; with no increase in durations above flood stage is expected.

Table 4.3.1.3-1 Impacts on Bull Shoals and Norfork Lake Pool Elevations and Downstream Flows based on SUPER Model Runs W01X01R (Existing) and W06X03 (Proposed) for the Period of Simulation 1940-2003

The Current Operation Plan and the Minimum Flow Plan BS-3 (5-ft with 100% from flood pool: new Conservation Pool @ 659) and NF-7 (3.5 ft - with 50% from flood pool: new Conservation Pool @ 553.75)						
FLOOD EVENTS	**BULL SHOALS LAKE**					
	Pool Elevation (Existing) W01X01R	Pool Elevation (Proposed) W06X03	Pool Elev Plan Change	No. of Days (Existing) W01X01R	No. of Days (Proposed) W06X03	No. of Days Plan Change
	Max Pool EL	Max Pool EL	Difference	Cons Pool	Cons Pool	Above
	Top of FCP 695 feet	Top of FCP 695 feet	feet	Above 654	Above 659	Cons Pool
1945	697.37	697.40	0.03	288	288	0
1957	695.88	695.89	0.01	216	206	-10
1973	695.31	695.54	0.23	245	230	-15
1990	694.06	694.75	0.69	212	212	0
2002	690.02	690.90	0.88	211	205	-6
	NORFORK LAKE					
	Pool Elevation (Existing) W01X01R	Pool Elevation (Proposed) W06X03	Pool Elev Plan Change	No. of Days Existing) W01X01R	No. of Days (Proposed) W06X03	No. of Days Plan Change
	Max Pool EL	Max Pool EL	Difference	Cons Pool	Cons Pool	Above
	Top of FCP 580 feet	Top of FCP 580 feet	feet	Above 552	Above 553.75	Cons Pool
1945	580.94	580.95	0.01	286	288	2
1957	580.09	579.84	-0.25	217	247	30
1973	580.38	580.43	0.05	253	255	2
1990	577.88	579.14	1.26	221	220	-1
2002	575.38	576.33	0.95	214	212	-2
DROUGHT EVENTS	**BULL SHOALS LAKE**					
	Pool Elevation (Existing) W01X01R	Pool Elevation (Proposed) W06X03	Pool Elev Plan Change	No. of Days (Existing) W01X01R	No. of Days (Proposed) W06X03	No. of Days Plan Change
	Min Pool EL	Min Pool EL	Difference	Cons Pool	Cons Pool	Below
	Bot. Power Pool 628.5 feet	Bot. Power Pool 628.5 feet	feet	Below 654	Below 659	Cons Pool
1953-1957	642.11	642.94	0.83	1148	1221	73
1962-1965	642.79	644.88	2.09	657	647	-10
1980-1982	643.62	644.21	0.59	577	607	30
1999-2002	644.86	644.37	-0.49	800	857	57
	NORFORK LAKE					
	Pool Elevation (Existing) W01X01R	Pool Elevation (Proposed) W06X03	Pool Elev Plan Change	No. of Days (Existing) W01X01R	No. of Days (Proposed) W06X03	No. of Days Plan Change
	Min Pool EL	Min Pool EL	Difference	Cons Pool	Cons Pool	Below
	Bot. Power Pool 510 feet	Bot. Power Pool 510 feet	feet	Below 552	Below 553.75	Cons Pool
1953-1957	529.63	529.78	0.15	1308	1363	55

1962-1965	534.91	532.27	-2.64	1032	1059	27
1980-1982	535.84	536.50	0.66	612	615	3
1999-2002	534.37	534.04	-0.33	949	957	8

CONTROL POINTS	Downstream Impacts for the Maximum Flood Event (1945)*									
	Flow in cfs		Plan Change	Max Stage	Max Stage	Stage Diff	Flood Stage		No. Days	
	(Existing) W01X01R	(Proposed) W06X03	cfs	(Existing) W01X01R	(Proposed) W06X03	feet	Stage (feet)	Flow (cfs)	Above Flood Stage	
Bull Shoals Outflow	127,053	130,905	3,852	455.67	455.78	0.1	N/A	N/A	N/A	N/A
Norfork Outflow	42,395	42,747	352	390.05	390.15	0.1	N/A	N/A	N/A	N/A
Calico Rock	249,831	255,292	5,461	43.1	43.6	0.5	19	62,150	9	9
Batesville	299,823	305,574	5,751	28.7	29.0	0.3	15	62,500	9	9
Newport	312,533	318,360	5,827	33.7	33.8	0.1	26	74,000	19	19
Georgetown	253,968	259,120	5,152	32.7	33.0	0.3	21	60,200	96	96

*The 1945 event represented the greatest impacts above flood stage for the simulation period 1940-2003 and visual examination of the 1957, 1973, 1990 and 2002 events showed less impacts than 1945 event for the maximum flows.

4.3.1.3 Water Quality

Under the "No Action" alternative there will be no change in the water quality of the study area.

There is no significant effect expected on the water quality of the reservoirs or outflows due to the implementation of the Proposed Action. This conclusion is based largely on Temperature and Dissolved Oxygen Hydrodynamics models completed by the U.S. Geological Survey (Galloway et al. 2002).

In an effort to assess the impact of increased minimum flows on temperature and dissolved oxygen concentrations of reservoir and outflow water quality, the USGS developed hydrodynamic temperature and dissolved oxygen models for Bull Shoals and Lake Norfork to evaluate: (1) the impact of additional minimum flows on tailwater temperature and dissolved oxygen qualities (current conditions) and (2) increasing the water surface elevation to account for the proposed reallocated storage (proposed action). In scenario (1), the no action alternative, water temperatures appeared to increase (<1°C) and dissolved oxygen appeared to decrease (<2.2 mg/l). Conversely, scenario (2), proposed action, apparently lowered the outflow water temperature and dissolved oxygen concentrations slightly at Bull Shoals during the stratification season. The Norfork model showed a lower outflow water temperature and increased the dissolved oxygen concentrations slightly. However, both model results were within the boundaries or similar to the error between measured and simulated water column values. The dissolved oxygen in the Norfork tailwaters should increase from a siphon and aeration valve combination release (NF-7) during non-generation periods.

Under the proposed actions (BS-3 and NF-7) the tailwater water quality should improve from a siphon release at Norfork (NF 7) which should result in dissolved oxygen (DO) increases during non-generation periods. Selective withdrawal using a siphon release should allow for selection of better DO concentrations while maintaining temperature requirements of the

outflow. An aeration mechanism would be used with a siphon release to increase the DO concentration. In addition to the DO concentration upon release, the shear volume of the proposed minimum releases will result in reaeration to increase as the flow passes through riffle/shoal areas. Reaeration rates will be more efficient in the upper areas of both tailwaters. Maintenance of more optimum temperatures will improve in the both tailwaters by avoiding periods of non-release. The plan for Bull Shoals (BS7) involves releasing minimum flows through the main turbines which does not have the flexibility of a siphon to select water at levels of higher DO concentrations. However, in the past, through joint efforts with the Southwestern Power Administration, "vents" have been placed in the turbines at Bull Shoals which allows ambient air to be added to the water thereby increasing the DO.

4.3.2 Tailwater Areas

Under the "No Action" alternative minimum flow releases will remain in their current state therefore there will be no change in the current low flow wetted area

Increases in wetted area (amount of bottom substrate that is always covered) and duration will increase at each tailwater under the implementation of Proposed Action (BS-3 and NF-7). The wetted area is important but the duration increase of this area is a critical component of increased ecological function. Increasing wetted area (primarily riffle areas) are the sources of aquatic invertebrate production. Wetted area would substantially increase the area available for aquatic invertebrate (particularly aquatic insects) production. Increased aquatic insect production would not only provide a direct increase in forage available for trout but also for species such as sculpins, dace, stonerollers, and crayfish that are essential to the production of fish species. The increase in abundance of primary forage levels should translate to increased growth rates for trout.

Implementation of the target flows will result in wetted area increases ranging from 33 percent in Bull Shoals tailwater to 53.7 percent in the Norfork tailwater. Table 4.3.2 shows the length of each tailwater and wetted area increase for each.

Table 4.3.2 Tailwater Wetted Area Changes for Target Minimum Flows.

Tailwater	Up Stream River Mile	Down Stream River Mile	Current Minimum Flow (cfs)	Current Wetted Area (acres)	Target Minimum Flow (cfs)	Wetted Area (acres)	Percent Increase In Wetted Area
Bull Shoals	418.6	329.4	210.0	2517	800	3366	33.73
Norfork	4.468	0.185	115	54	300	83	53.70

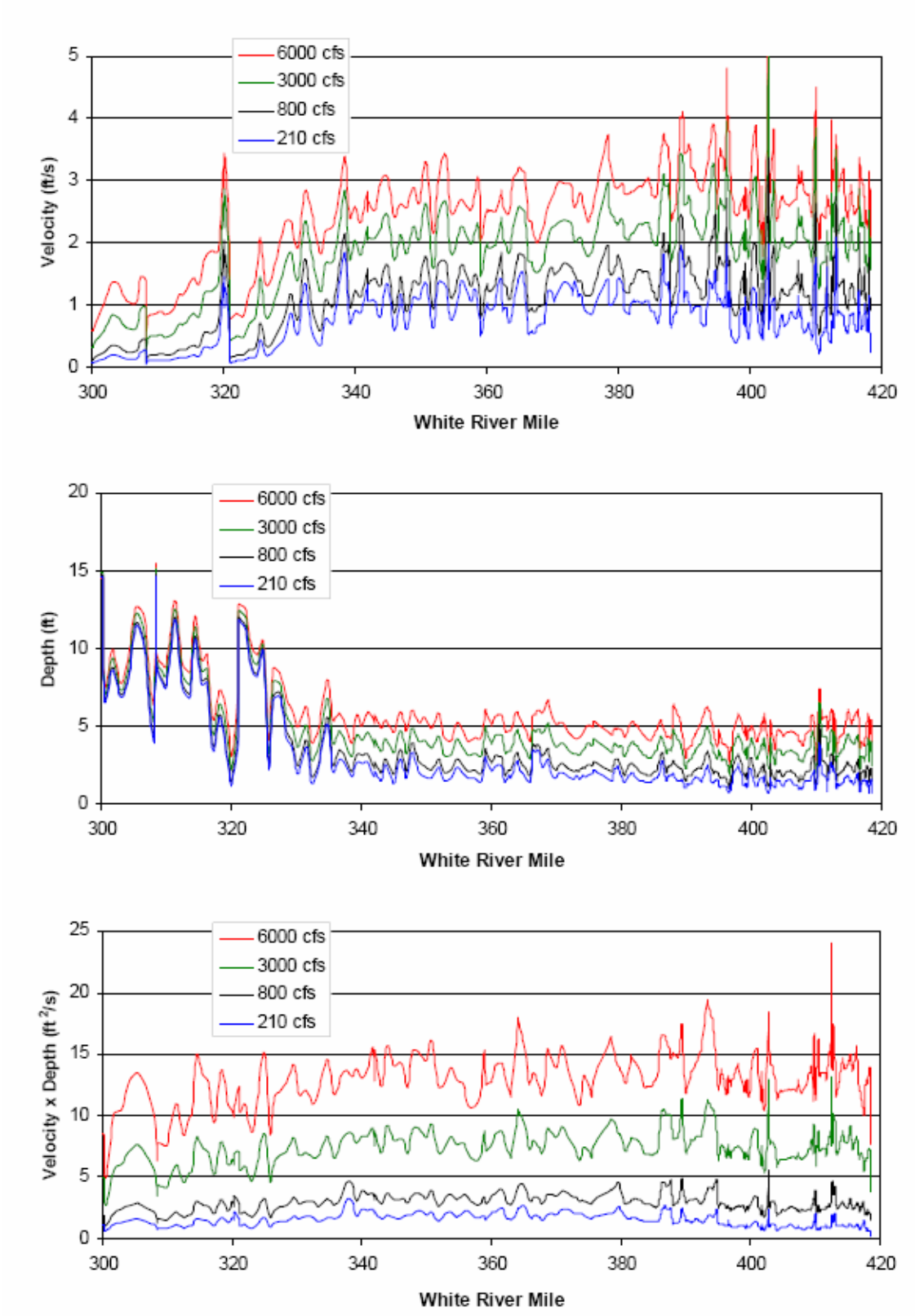
4.3.2.1 Wadeability

The "No Action" alternative will result in no change to water releases in the tailwater from their current conditions, therefore no effect on wadeability will result in this alternative is implemented.

The Proposed Action: Most wade-fishing occurs during minimum flow (i.e., between periods of Hydropower generation), so it is important to understand the effect of flow on wadeability. The product of velocity and depth (VD) is a measure of stream power that strongly correlates to wading danger. As reported by Hauser and Schohl (2003), values of VD<4 are conservatively considered "safely wadeable", while values of VD>10 are considered definitely "unwadeable". A more rigorous wadeability index by Hauser and Schohl (2003), based on drag, resistance, wader weight, and wader size, indicates that values of VD>8 are unwadeable for an average wader. In the range of VD between 4 and 8, wadeability depends on the size and skill of the wader and slickness of the channel bottom.

Figure 4.3.2.1-1 shows velocity, depth, and the product of velocity and depth (VD) throughout the White River modeled reach at 210 cfs (house unit and leakage), 800 cfs (proposed minimum flow), 3000 cfs, and 6000 cfs. It should be noted that depths greater than chest-high or wader high (about 4-5 ft) are not wadeable regardless of how low the velocity, so the VD measures need to be understood in this context. Figure 4.3.2.1 shows that 800 cfs is about the highest flow that could be considered safely wadeable at all locations using the conservative VD<4 criterion. At 3000 cfs, parts of the reach are wadeable by experienced waders (4<VD<8). At 6000 cfs, the reach is essentially unwadeable (VD>8). Thus, 800 cfs represents an effective upper limit for a minimum flow that is safely wadeable at all locations by the conservative VD<4 criterion. Higher minimum flows can probably be safely waded, because the VD<4 criterion is considered conservative, but at VD>4, wadeability becomes more dependent on the wader and local channel conditions. Depths would increase by about 0.1 ft. per 100 cfs on Bull Shoals tailwater and 0.2 ft per 100 cfs on Norfork tailwater for the first few hundred cfs increases in minimum flow above current levels or approximately 7 inches and 5 inches respectively. Mean depth increases more rapidly with flow increment at low flows, and less dramatically at higher flows. (Hauser et. al)

Figure 4.3.2.1-1 Velocity, Depth, and Velocity x Depth vs. Mile



4.4 Biological Resources

4.4.1 Terrestrial Resources

The terrestrial resources in the lakes and tailwater areas should not be affected by the "No Action" alternative.

The proposed action would cause some minor vegetation loss in the lakes due to higher pool elevations. However because of the "Bathtub" effect most of the area impacted is already devoid of vegetation.

4.4.2 Aquatic Resources

4.4.2.1 Wetlands

Within the reservoirs the proposed action will have no significant affect on wetlands due to the continued flood control management of the lakes.

In the tailwaters below Bull Shoals and Norfork dams, the purpose of the minimum flow project is to increase the wetted perimeter. Therefore it is anticipated that there will be an increase in littoral wetlands as these "new" areas are inundated and wetland vegetation becomes established. This increase in wetted perimeter or littoral wetlands will provide an increase in food sources for the trout and other aquatic species and additional spawning and reproduction areas for fish and aquatic insects, respectively.

4.4.2.2 Lake Fishery Effects

Fisheries management options of large multipurpose reservoirs are limited due to the water level management objectives (flood control, hydropower generation, etc.). Many times, lakes of this nature exemplify the "boom or bust" condition in standing crops. The shorelines of the White River reservoirs are characterized by bluffs, shelf-rock, boulder, and cobble. Clay, silt, and sandy substrates are limited but occasionally occur in tributary areas. There is very little aquatic vegetation and vegetative cover increases when terrestrial vegetation is inundated.

Under the "No Action" alternative, the lake fishery will remain at its current condition and no change is anticipated.

When considering the effects of the Proposed Action on the in-lake fisheries, effects can generally be categorized as minor beneficial with any reallocation that results in decreased durations of elevations suitable for vegetation establishment. The benefit would be short term and eventually the habitat would revert to the current conditions due to the operation plan. A critical factor for the fishery is stable water levels that inundate the vegetation during the spawning and recruitment periods but does not result in vegetation mortality.

When analyzing the effects of the reallocation, the top of Conservation pool (TOC) is used as the measuring elevation. The current TOC is an elevation were vegetation is present (but minimal) and a noticeable line is present between vegetation growth and the inundated lake level due to water management for flood control purposes. By comparing the duration at the

existing TOC with the resulting Alternative Top of Conservation pool (ATOC) it is possible to evaluate the potential for short term vegetation development. Comparisons will largely rely on duration differences during the growing season of April thru October. While the elevation duration is modeled, a reduction will not guarantee vegetation development due to lake operation.

In general, reallocation from the flood control pool such as proposed for Bull Shoals could temporarily provide beneficial effects to the lake fishery if vegetation exists above the current TOC providing needed fish habitat when inundated. However due to the topography of the White River Lakes, with their steep shorelines, the beneficial effects would be less than lakes with a definite flood plain around its shoreline. These areas would eventually exhibit the characteristics of the current TOC due to the operation of the lakes as multipurpose reservoirs including flood control. It is plausible that reduced duration at or below the TOC would allow the development of vegetation in areas suitable for growth but a significant increase would not be expected.

A “split” reallocation of 50 percent from the flood pool and 50 percent from the conservation pool such as proposed for Norfork would result in lake levels that are generally higher than current conditions but lower than if taken out of the flood control pool. From an in-lake fishery viewpoint, this alternative would provide some beneficial effects through higher lake levels but less than a flood pool reallocation.

Reallocation from the flood control pool will provide limited minor benefits to the in-lake fishery by potentially providing only temporary limited additional spawning habitat. This habitat will result from the inundation of potentially vegetated areas that will soon be lost due to the increased flooding duration over the current conditions. The “split” alternative would potentially provide less benefit than the flood control reallocation. It should be noted that much of the time during the spawning and growing season the water level duration differences are minor compared to current conditions therefore these effects are minimal or may not exist in some years.

Regardless of the minimum flow reallocation, the productivity of the lake fisheries is currently, and will continue to be, largely influenced by water level management of the multipurpose reservoirs. Flood control reservoirs are inherently not conducive to maintain stable fisheries due there fluctuating water levels and rapid water releases. After a period of 2-3 years the characteristics of the ATOC will be similar to that of the current TOC which is commonly known as the “bathtub ring”.

4.4.2.3 Tailwater Fishery Effects

The White River Tailwater Model completed by Loginetics in 2005 evaluated physical habitat for the series of steady flow runs using plots of wetted area and wetted usable area (WUA) versus discharge from Bull Shoals Dam (WRM 418.41) to Guion (WRM 329.4). In general, flows less than 1000 cfs appear best for all but adult rainbows, which continue to accrue habitat benefits for flows up to 1500 cfs.

In both tailwaters the proposed action benefits include: Increased food production from increased continual riffle coverage; large scale trout habitat increases; potential trout reproduction; an increase in trout growth rates, potential increase of DO concentration and navigation improvements from mean depth increases. Increases in wetted area (amount of bottom substrate that is covered) and duration will increase at each tailwater. The wetted area is important but the duration increase of this area is a critical component of increased ecological function. The wetted area (primarily riffle areas) is the source of aquatic invertebrate production. Increased wetted area would substantially increase the area available for aquatic invertebrate (particularly aquatic insects) production. Increased aquatic insect production would not only provide a direct increase in forage available for trout but also for organisms such as sculpins, dace, stonerollers, and crayfish that are essential forage species. The increase in abundance of primary forage levels should translate to increased growth rates for trout.

Tables 4.4.2.3-1 and 4.4.2.3-2 compare the current percentage of time that the target minimum flow is met or exceeded (duration) and the resulting duration of the proposed action. The actual load is the percentage of time the hydropower generators are in operation. The other column shows the dependable percentage of time the target minimum flow could be met or exceeded. Implementation of the proposed actions at Bull Shoals and Norfork would result in increases of 45.7 percent and 39.9 percent respectively.

Table 4.4.2.3-1 Bull Shoals target flow durations.

Bull Shoals		
Target Flow (cfs)	Percentage of time the target is met or exceeded (Pool Outflow - Duration)	
800	ACTUAL LOAD (Current)	BS-3
ANNUAL	52%	97.7%
JANUARY	41%	96.2%
FEBRUARY	53%	96.9%
MARCH	55%	98.4%
APRIL	50%	100.0%
MAY	49%	99.0%
JUNE	55%	98.3%
JULY	61%	97.3%
AUGUST	64%	99.7%
SEPTEMBER	53%	97.6%
OCTOBER	48%	96.4%
NOVEMBER	53%	96.3%
DECEMBER	44%	96.2%
JANUARY - MARCH	50%	97.2%
APRIL - JUNE	51%	99.1%
JULY - SEPTEMBER	59%	98.2%
OCTOBER - DECEMBER	48%	96.3%

Table 4.4.2.3-2 Norfork target flow durations.

Norfork		
Target Flow (cfs)	Percentage of time the target is met or exceeded (Pool Outflow - Duration)	
300	ACTUAL LOAD (Current)	NF-7
ANNUAL	50%	89.9%
JANUARY	32%	89.8%
FEBRUARY	45%	91.6%
MARCH	58%	90.5%
APRIL	51%	91.6%
MAY	49%	96.7%
JUNE	56%	94.6%
JULY	50%	93.5%
AUGUST	52%	89.6%
SEPTEMBER	52%	84.0%
OCTOBER	54%	85.4%
NOVEMBER	49%	85.1%
DECEMBER	44%	86.3%
JANUARY - MARCH	45%	90.6%
APRIL - JUNE	52%	94.3%
JULY - SEPTEMBER	51%	89.1%
OCTOBER - DECEMBER	49%	85.6%

4.4.2.4 Tailwater Temperature

The AGFC target temperature maxima considered stress thresholds for trout fisheries are listed in Table 4.4.2.4. The Arkansas water quality standards establishes a maximum water temperature of 20°C (68°F) for trout waters on the White River from Bull Shoals Dam to Dam 3 (WRM320) and the Norfork Tailwater. The model completed by Hauser in 2005 shows the minimum flow cools water temperatures during the hottest period from June 10-15 by 1 - 6 °C at WRM 400, by 2 – 3 °C at WRM 380, by about 2 °C at WRM 359, and by 1 °C at WRM 329 and is presented in Figure 4.4.2.4-1. Thus, temperature improvement from minimum flow additions will be felt closer to the dams, and it diminishes in the downstream direction. This suggests the temperature at WRM 388 (Buffalo National River confluence)

will be reduced by approximately 3 - 4 °C during the described June modeled period. The cold water barrier that affects the migration pattern of some warm water species of the Buffalo National River and the intrusion of the non native cold water species will continue to occur. Figures 4.4.2.4-1 and 4.4.2.4-2 show modeled temperature changes throughout the tailwater.

Table 4.4.2.4 Approximate Thermal Ranges for Trout.

Description	°F	°C
AGFC White River Target ceilings	71 - 73	22 - 23
lethality (short term exposure)	74 - 78	23 - 26
optimum growth	62 - 68	17 - 20
egg development	45 - 66	7 - 19l

It is apparent from results shown in Figure 4.4.2.4-2 that, even with the 800 cfs and 300 cfs minimum flows at Bull Shoals and Norfork, respectively, water temperatures could reach undesirable levels from Calico Rock to Guion. This occurs due to warm air temperatures, low dam releases, and low local inflows, all conditions that occurred in early June 2000. Based on further simulation results, to maintain temperatures during June 2000 within the AGFC thermal ceilings (<22-23 °C per Table 4.6-3), the upstream dams would have had to provide a combined daily volume of up to about 3000 dsf.

Figure 4.4.2.4-1 shows the longitudinal patterns of maximum, mean, and minimum temperatures that were simulated for each modeled flow case. In the maximum temperature plot, the minimum flow case maintains temperature within AGFC limits down to about WRM 395 above the Buffalo National River confluence (WRM 388). The 2000 dsf flow case maintains temperature within AGFC limits down to the North Fork confluence.

Increasing flows from the base case to the 8K flow case (8000 dsf) reduced Guion temperatures by about 10 °C, demonstrating the substantial influence of generation flows on water temperature at this downstream location. Based on these results, to maintain temperatures during June 2000 within the AGFC thermal ceilings (<22-23 °C), the upstream dams would have had to provide a combined daily volume of up to about 3000 dsf.

It is apparent from the simulations that large flow volumes are required for hot-day temperature control in the reach from Calico Rock (WRM 359) to Guion (WRM 329.4). Fortunately, generation demands are usually higher on hot days, so generation is often high enough on these days to also provide temperature control.

Figure 4.4.2.4-1 Effects of Minimum Flow on Water Temperature at Four locations.

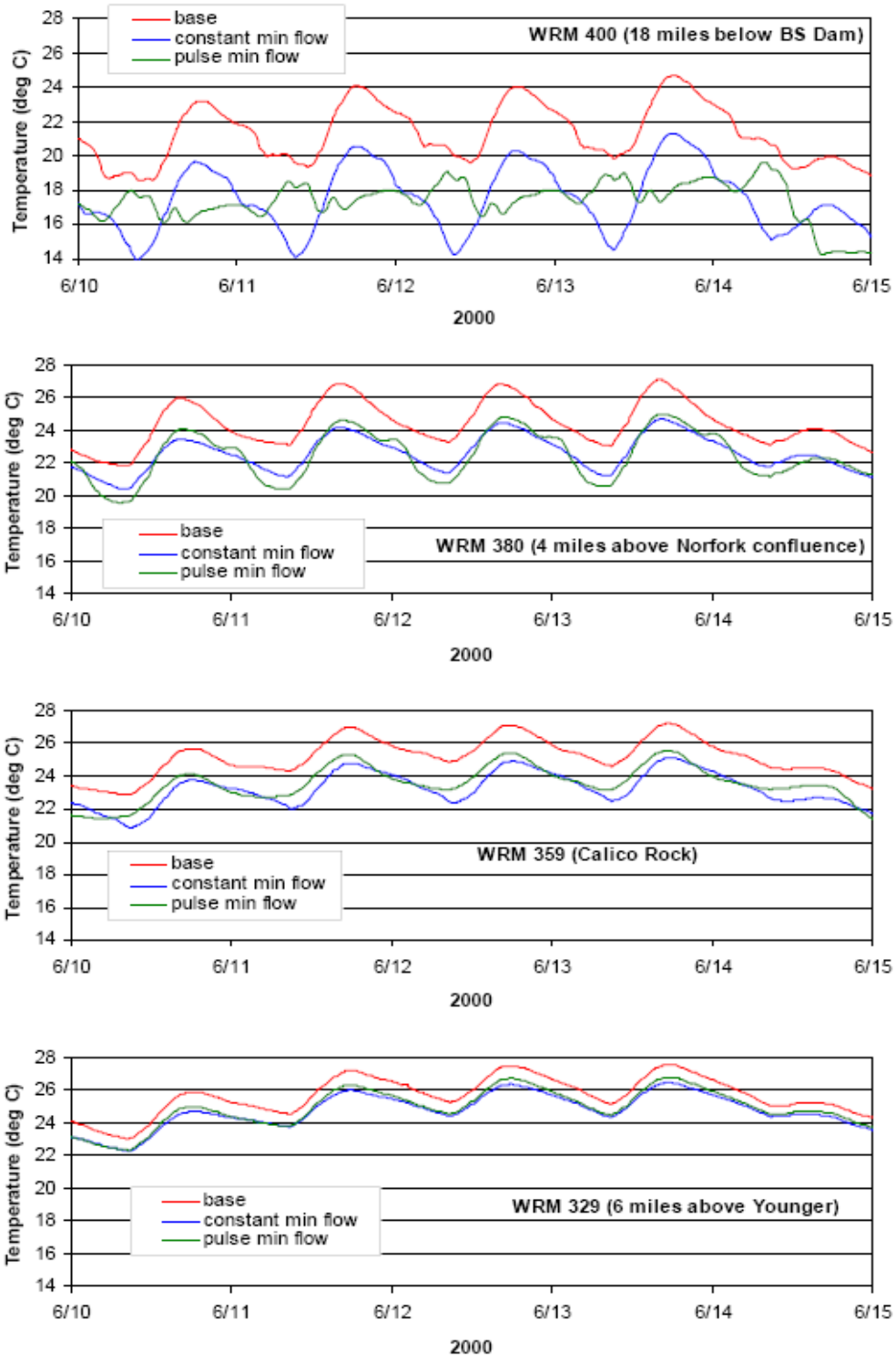
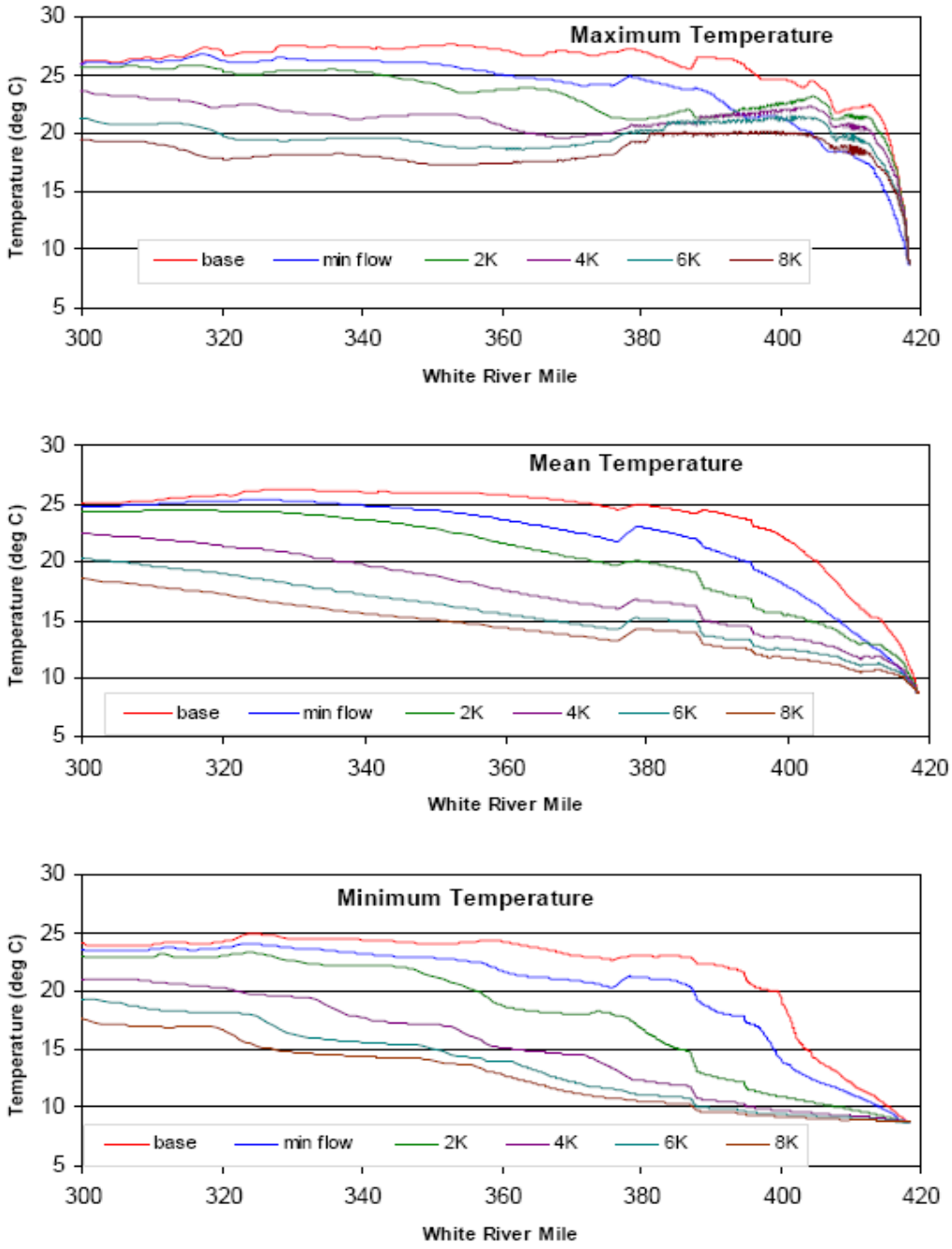


Figure 4.4.2.4-2 Effects of Daily Dam Releases (dsf) on Water Maximum, Mean, and Minimum Temperature vs. River Mile (June 11-13, 2000)



4.5 Threatened and Endangered Species

The "No Action" alternative will have no effect on any threatened or endangered species (T&E) within the study area.

The duration data generated from the SUPER model simulations were used to evaluate potential effects on Threatened and Endangered species considering the Elevations of Concern (EOC) identified by USFWS. The differences observed annually and seasonally were evaluated for each EOC.

4.5.1 Bull Shoals

The USFWS identified 670, 675, & 690 as elevations of concern on the Bull Shoals project relative to the potential impacts on the endangered Tumbling Creek Cave Snail and its habitat. The concern is that the velocities of the drainage system of the Tumbling Creek cave (and resulting sedimentation) are affected at the higher lake levels. There will be a 2.3 percent increase in duration annually at the 670 elevation and < 2 percent increase at 675 and 690 with BS-3 implementation (refer to Table 4.5.1-1). Tables 4.5.1-2 to 4.5.1-4 list these elevations of concern and the percent of time these will be met or exceeded on a monthly basis under the current and proposed operating plans.

The Biological Assessment (BA) completed by the USACE concluded that any reallocation of 5 feet of storage from the proposed storage alternatives may affect, but is not likely to adversely affect the Tumbling Creek Cavesnail. The USFWS concurred with these findings in their letter dated July 13, 2004. The complete Tumbling Creek Cavesnail BA and USFWS concurrence letter can be found in Appendix F.

Table 4.5.1-1 Annual Pool Elevation-Duration for Pool Elevations of Interest

Bull Shoals Lake			
Annual Pool Elevation-Duration for Pool Elevations of Interest (365-day period) (Percent of Time met or Exceeded)			
Elevation (feet)	Current (W01X01R)	BS-3&NF-7 (W06X03)	Difference
670	10.8	13.1	2.3
675	7.5	9.3	1.8
690	1.6	1.9	0.2

Table 4.5.1-2. Bull Shoals Elevation 670 (% time met or exceeded)

Bull Shoals Lake			
Target Elevation (feet)	Percentage of time the target is met or exceeded (Duration)		Percent Increase
670	CURRENT)	BS-3	
ANNUAL	10.8	13.1	2.3
JANUARY	2.2	3.1	1.0
FEBRUARY	1.6	3.0	1.5
MARCH	2.7	4.4	1.6
APRIL	8.4	12.2	3.8
MAY	23.4	31.1	7.7
JUNE	28.3	32.0	3.8
JULY	23.6	25.3	1.8
AUGUST	18.5	21.0	2.5
SEPTEMBER	6.7	7.5	0.7
OCTOBER	4.2	4.8	0.6
NOVEMBER	2.4	3.7	1.3
DECEMBER	6.5	8.1	1.7
JANUARY - MARCH	2.2	3.5	1.4
APRIL - JUNE	20.0	25.2	5.1
JULY - SEPTEMBER	16.4	18.1	1.7
OCTOBER - DECEMBER	4.4	5.6	1.2

Table 4.5.1-3. Bull Shoals Elevation 675 (% time met or exceeded)

Bull Shoals Lake			
Target Elevation (feet)	Percentage of time the target is met or exceeded (Duration)		Percent Increase
675	CURRENT (W01X01R)	BS-3&NF-7 (W06X03)	
ANNUAL	7.5	9.3	1.8
JANUARY	1.3	1.5	0.2
FEBRUARY	0.5	1.1	0.6
MARCH	1.0	1.5	0.6
APRIL	5.2	7.5	2.3
MAY	17.9	22.3	4.4
JUNE	22.0	26.7	4.8
JULY	19.4	21.4	2.0
AUGUST	12.9	15.4	2.5
SEPTEMBER	4.9	5.0	0.1
OCTOBER	1.9	3.3	1.4
NOVEMBER	0.5	1.4	0.8
DECEMBER	1.5	3.9	2.4
JANUARY - MARCH	0.9	1.4	0.4
APRIL - JUNE	15.1	18.9	3.8
JULY - SEPTEMBER	12.5	14.0	1.6
OCTOBER - DECEMBER	1.3	2.9	1.5

Table 4.5.1-4 Bull Shoals Elevation 690 (% time met or exceeded)

Bull Shoals Lake			
Target Elevation (feet)	Percentage of time the target is met or exceeded (Duration)		DIFFERENCE (BS-3&NF-7 minus CURRENT)
690	CURRENT (W01X01R)	BS-3&NF-7 (W06X03)	
ANNUAL	1.6	1.9	0.2
JANUARY	0.0	0.0	0.0
FEBRUARY	0.0	0.0	0.0
MARCH	0.0	0.0	0.0
APRIL	1.7	1.9	0.2
MAY	4.0	4.3	0.3
JUNE	8.5	10.3	1.8
JULY	4.8	5.2	0.4
AUGUST	0.6	0.6	0.0
SEPTEMBER	0.0	0.0	0.0
OCTOBER	0.0	0.0	0.0
NOVEMBER	0.0	0.0	0.0
DECEMBER	0.0	0.0	0.0
JANUARY - MARCH	0.0	0.0	0.0
APRIL - JUNE	4.7	5.5	0.7
JULY - SEPTEMBER	1.8	2.0	0.1
OCTOBER - DECEMBER	0.0	0.0	0.0

4.5.2 Norfork Lake

The best population of Ozark hellbenders in Missouri is currently in the North Fork of the White River above Norfork Reservoir at elevations > 580 NGVD. Therefore the USFWS has identified this elevation as critical. These elevations are above the top of the flood pool and will not be affected by implementation of NF-7 or the No Action alternative.

4.6 Air Quality

Other than the “No Action” alternative the reallocation alternatives may result in a decrease in hydropower production in a worst-case scenario drought condition. Should this happen, this power would have to be provided by alternative sources such as other hydropower

plants, combustion plants (gas, coal, oil) or nuclear power plants. Even if all additional power were required from combustion plants, air quality would not be significantly impacted.

The reallocation of storage from either conservation, flood control, or 50:50 will decrease both dependable capacity and energy available from the lake power plants. This power would have to be provided by alternative sources such as other hydropower plants, combustion power plants (gas, coal, oil), or nuclear power plants. If the increased power generation were provided by combustion power plants, the increase in emissions could potentially affect the air quality in the region of production. Assuming the weight of pollutants emitted by a fossil fuel generation plant to be proportional to power production, the increase in pollutants for this increase in power production would be minor based on the following analysis. To analyze this potential impact, the following tables reflect information gathered from the Department of Energy and the Environmental Protection Agency.

Table 4.6-1. Year 2004 State Emissions and output emission rate (data from the EPA's E-GRID2006).

	Annual CO_2 (tons)	**Output emission rate (lb/MWh)**	**Annual $S0_2$ (tons)**	**Output emission rate (lb/MWh)**	**Annual NO_x (tons)**	**Output emission rate (lb/MWh)**
Arkansas	33,174,715	1280	87,555	3.379	44,717	1.726
Missouri	82,049,736	1,881	288,669	6.619	128,865	2.955
U.S	2,681,753,803	1,363	10,695,446	5.436	4,138,481	2.103

Using the SWD-SUPER simulation output for each of the reallocation alternatives, the net reduction in average annual generation was determined at each project. The energy losses are shown in Table 4.6-2 for each project based on the BS-3 and NF-7 reallocation alternatives.

Table 4.6-2. Average Annual Energy Loss Due to Reallocation of Storage

Project	(MWh)
Bull Shoals (BS-3)	47,137
Norfork (NF-7)	12,190
Total	59327

Assuming that annual energy losses in Table 4.6-2 and the emission rates from combustion power plants (Table 4.6-1), table 4.6.3 reflects the annual emission increase due to the Bull Shoals and Norfork reallocations, if the potential energy loss was replaced by combustion power generation.

Table 4.6-3. Annual increase in emissions

	CO_2 (tons)	SO_2 (tons)	No_x (tons)
Arkansas	30,167.680	79.638	40.679
Missouri	44332.349	156.000	69.645
US	32123.866	128.118	49.565

Table 4.6-4. Total percentage of emission increase for the states of Arkansas and Missouri if energy replacement were generated from combustion power sources.

	Arkansas			Missouri		
	Percent Annual Increase in Emissions			Percent Annual Increase in Emissions		
Reallocation	CO_2	SO_2	$N0_x$	CO_2	SO_2	$N0_x$
Bull Shoals (BS-3)	0.091	0.091	0.091	0.054	0.054	0.054
Norfork (NF-7)	0.024	0.024	0.024	0.014	0.0001	0.0001

The data presented in Table 4.6-5 displays the projected cumulative effects on air emissions of pending water reallocation projects in the Little Rock District. All of these projects await authorization. Totals from each alternative were summed, and the emissions for the 50/50 alternative of the present project were added to the flood and conservation alternatives separately. Again, the excess emissions would not significantly increase the health risks to humans associated with exposure to the pollutants. Therefore, the impact to the air quality of the project area and region would be considered minor.

Table 4.6-5. Cumulative Effects of potential water reallocation at SWL projects

		Arkansas			Missouri		
		Percent Annual Increase in Emissions			Percent Annual Increase in Emissions		
Project	Reallocation Source	CO_2	SO_2	$N0_x$	CO_2	SO_2	$N0_x$
White River Min. Flow	Flood	0.091	0.091	0.091	0.054	0.054	0.054
	50/50	0.024	0.024	0.024	0.014	0.0001	0.0001
Carroll-Boone	Flood	0.001	0.002	0.002	0.001	0.001	0.001
Mountain Home	Flood	0.021	0.034	0.043	0.009	0.009	0.009
	Conservation	0.021	0.033	0.043	0.009	0.009	0.009
Benton-Washington County	Flood	0.006	0.009	0.012	0.002	0.003	0.003
	Conservation	0.006	0.010	0.012	0.002	0.003	0.003
Total		0.289	0.339	0.375	0.157	0.1461	0.1461

4.7 Socioeconomic

Under the no action alternative, it is expected that there will be no disruption to the study area. Populations, income, poverty, and economic activity are expected to continue along their current trends.

Implementation of Minimum Flows could lead to some short-run increase in economic activity. Some of the implementation alternatives require some construction and this will require skilled labor, leading to a small boost in welfare to those individuals and those who supply them. Long-run conditions could be more fruitful. Under Minimum Flows the study area could experience a significant increase in economic activity. Minimum Flows is expected to bring in over $4 million annually in benefits (see Table 4.7-1). These benefits would be mostly attributable to freshwater sportsmen. Increased visitations to the study area would undoubtedly lead to increased benefits to business owners and those employed by them.

The economic benefits of increased minimum flows were calculated for the White, Norfork, and Little Red Rivers as part of the original White River Minimum Flows Reallocation Study, dated July 2004. The contingent valuation method (CVM) and statistical inference was used to determine respondent's willingness-to-pay, and then extrapolated those values to a broader population. Two sets of values were identified that corresponded to tailwater recreation benefits associated with the proposed Minimum Flows releases. Since the CVM focused only on Bull Shoals Lake, it was necessary to allocate the benefits to Norfork Lake. This was accomplished by assigning the aggregate benefit according to the miles of downstream trout fishery. The trout stream miles below Bull Shoals and Norfork Lakes are

shared and were computed by splitting the river miles below the confluence of the Norfork and White Rivers.

Table 4.7-1 Potential Recreational Benefits From Tailwaters.

Project	Downstream Trout Fishery Miles	Percent of Total Fishery	Benefits
Bull Shoals Lake	66	0.695	$3,458,678
Norfork Lake	29	0.305	$1,519,722
Total	95	1.000	$4,978,400

Lake recreation activities at Bull Shoals and Norfork Lakes will continue to be available to the public. While impacts to some Lakeside Facilities, such as campsites and day use facilities, are expected through the increased pool elevations, the non-Federal Sponsor (AGFC) will provide relocations or modifications for roads, parking lots, restrooms, picnic areas, boat ramps, and electrical facilities to allow for reasonable continued use. This commitment to ensure reasonable continued use for Lakeside Facilities is reflected in the provisions of EWDAA Section 132(a).

The reallocations that will occur at Bull Shoals and Norfork reservoirs will result in an increase in water surface elevation of the seasonal and normal conservation pools, due to the reallocation of the flood control storage. When water is reallocated out of the flood control storage, the average water surface elevation of the conservation pool is increased. The increase in the water surface elevation of the conservation pool results in rare instances in which recreation facilities and the roads and bridges which lead to those facilities, are non-usable. When these facilities are not available for use there is a recreation benefit loss. This reduction in recreation benefits was calculated using the SUPER model scenarios. Table 4.7-2 shows the annual loss to lake recreation benefits if none of the facilities were modified.

Facilities that would be affected by higher lake elevations already experience periods of inundation during the year. On-site oberservations and increases in pool elevation-duration (shown annually in Tables 4.3.1.1-1 and 4.3.1.2-1, and by three-month periods in Tables 4.3.1.1-2 and 4.3.1.2-2) were evaluated to identify which facilities might require relocations or modifications to maintain reasonable continued use. Facilities located above the “filter elevations” of 660 ft at Bull Shoals and 554.5 ft at Norfork will experience little noticeable change from current inundations, and therefore, do not need to be modified. Those facilities located at or below the “filter elevation” were futher evaluated for their current use and whether relocation or modification was needed for their reasonable continued use. For instance floating docks accommodate changes in lake level and are not likely to require further modification for reasonable continued use.

Table 4.7-2 shows the annual loss to lake recreation benefits if none of the facilities were modified is actually a low amount (Bull Shoals -$139,000; and Norfork -$26,000). None-the-less, because of the importance of the lake recreation to the region, modications and relocations will be made to roads, parking lots, restrooms, picnic areas, boat ramps, and electrical facilities to maintain the reasonable continued use. The design and construction cost of these Lakeside Facilities is $12,494,000 at Bull Shoals and $5,609,000 at Norfork

Lake. As shown in Table 4.7-2, with these modifications, use of the facilities can continue with no expected loss of recreation benefits. Refer to Appendix F of the White River Basin, Arkansas, Minimum Flows Project Report, dated November 2008, for detailed information regarding Lakeside Facilities data.

Table 4.7-2: Recreation Facility Costs and Benefits Foregone

	Number of Campsites & Day Use Facilities Affected	If Facilities were Not Modified or Relocated	With Facilities Modified or Relocated	
		Change in Recreation Benefits	Change in Recreation Benefits	Fully Funded Cost to Relocate or Modify Lakeside Facilities
Bull Shoals	106	$ (139,000)	$ 0	$ 12,494,000
Norfork	42	$ (26,000)	$ 0	$ 5,609,000

Table 4.7-3 summarizes the benefit and cost information related to the Minimum Flows Project that is presented in Appendix A of the Project Report.

Table 4.7-3: Lake Benefit Summary

	First Costs	**Annual Costs[2]**	**Annual Hydropower Benefits[3]**	**Annual Flood Benefits[1]**	**Annual Tailwater & In-Pool Rec. Benefits**	**Total Annual Benefits**	**Annual Net Benefits**
BS-3	$ 12,306,600	$ 635,400	$ (1,169,100)	$ (62,000)	$ 3,441,700	$ 2,210,600	**$ 1,575,200**
NF-7	$ 10,628,596	$ 548,800	$ (977,500)	$ (6,000)	$ 1,511,700	$ 528,200	**$ (20,600)**

[1] Includes Downstream Flood Benefits Only
[2] Annual Costs are the annualized first costs. First costs are comprised of construction costs, O&M, and interest during construction.
[3] Energy and capacity losses, as calculated by SWPA. BS-3 hydropower benefit losses include hydropower losses associated with Empire Electric (FERC Lic. # 2221.)

4.8 Cultural Resources

The "No Action" alternative will have no impacts on any cultural resources in the study area.

Regarding the reallocation alternatives, in 2002, SWL consulted with the Arkansas State Historic Preservation Office, the Missouri State Historic Preservation Office, and the appropriate Native American Tribes. It was determined that the resulting minimum flow would be much less than that released during power generation. Therefore, there would be no additional damage to cultural resources, including archeological sites and standing structures, in the tailwaters of the dams. There would also be no significant changes in pool elevation frequency and duration.

4.9 Cumulative Impacts

Cumulative effects or impacts can result from individually minor, but collectively significant actions taking place over a specified time period. Cumulative effects are the impacts on the environment that could result from the incremental effect of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. The geographical boundary for the proposed action consists of Bull Shoals and Norfork lakes, land immediately adjacent to or surrounding the lakes, and the confined channel area of their respective tailwaters. The Bull Shoals project area consists of 101,196 acres including land and water surfaces. The total area contained in the Norfork project, including both land and water surface, consists of 54,228 acres. The Bull Shoals Tailwater is defined as the White River below Bull Shoals Dam to Guion, a total, length of 89 miles (144 km). The Norfork Tailwater is defined as the North Fork river below Norfork Dam to the confluence with the Bull Shoals Tailwater of the White River, a total of 4.7 miles.

Past, present, and reasonably foreseeable future actions are diverse and too numerous to list each individual activity but can be categorized by the following types of activities:

- Water supply reallocations
- Reservoir operations by the Corps of Engineers
- Corps Planning Projects such as Ecosystem Restoration Projects
- Corps Regulatory (i.e. Section 404 permitting - CWA)
- Fish and Wildlife Management activities by the U.S Fish and Wildlife Service, Arkansas Game and Fish Commission, and the Missouri Department of Conservation as well as other agencies.
- Source point and non-point source pollutant activities by the public and industrial sectors.

Table 4. 9-1 summarizes the potential impacts from the current reallocation alternatives as well as any past, present, or reasonably foreseeable activities within the study area.

With respect to cumulative impact analysis, no environmental resources within the Bull Shoals and Norfork geographic project boundaries were found to be significantly adversely impacted. However, projects in the Bull Shoals and Norfork Lake areas will create increased recreation opportunities and urbanization, which may well increase the completion for land use surrounding the lakes. Increased demand for water uses will eventually reach the Corps 50,000 acre-foot limit and require Congressional authorization for future water supply.

Table 4.9-1. Cumulative Impacts Assessment

Resource Area	Minimum Flow Reallocation Alternatives (BS-3 & NF-7)	Past Actions	Present Actions	Reasonably Foreseeable Future Actions	Cumulative Impact
Land Use	No additional lands will be flooded that is not currently flooded annually. Increase in wetted perimeter of tailwaters	Increased urbanization of land surrounding reservoirs.	Increased urbanization of land surrounding reservoirs.	Increased urbanization of land surrounding reservoirs.	Lands inundated from original reservoir construction eliminated from human use and converted to other purposes such as aquatic habitat
Water Resources	Reduction of flood control storage and hydropower benefits.	Water Supply Reallocations could possibly reduce flood control storage and /or hydropower benefits.	Water Supply Reallocations could possibly reduce flood control storage and /or hydropower benefits.	Water Supply Reallocations could possibly reduce flood control storage and /or hydropower benefits.	Increased demand for water uses will eventually reach the Corps 50,000 acre-foot limit and require Congressional authorization for future water supply
Biological Resources					
Terrestrial	Minor adverse effect to the vegetation . The effects will occur due to duration increases in the near lake area. This vegetation is currently sparse and inundated annually.	Minor adverse effect to vegetation and wildlife habitat. Significant impacts are required to be mitigated.	Minor adverse effect to vegetation and wildlife habitat. Significant impacts are required to be mitigated.	Minor adverse effect to vegetation and wildlife habitat. Significant impacts are required to be mitigated.	Minor adverse effect to vegetation and wildlife habitat. Significant impacts are required to be mitigated.
Fishery	Minimum flow reallocations and releases are not expected to have any adverse impacts to lake fishery. Operation of multipurpose reservoirs is normally not conducive to providing good fish habitat due to fluctuating water levels. Tailwater trout fishery will benefit from releases due to increased wetted perimeter.	Construction of reservoirs resulted in the conversion of riverine habitat to lake habitat and the conversion of the rivers (tailwaters) from warmwater streams to coldwater streams. Operation of multipurpose reservoirs is normally not conducive to providing good fish habitat due to fluctuating water levels.	Operations of multipurpose reservoirs are normally not conducive to providing good fish habitat due to fluctuating water levels.	Operations of multipurpose reservoirs are normally not conducive to providing good fish habitat due to fluctuating water levels.	Operations of multipurpose reservoirs are normally not conducive to providing good fish habitat due to fluctuating water levels. Tailwater trout fishery will benefit from releases due to increased wetted perimeter.

T & E species	T&E resources at the critical elevations will not be affected by this project.	T&E species impacts were mitigated from past actions.	Impacts to T&E species are mitigated through the ESA..	Impacts to T&E species are mitigated through the ESA..	Impacts to T&E species are mitigated through the ESA..
Recreation	The in lake recreation activities will continue to be available. Temporary impacts are to facilities such as swim beaches and boat launch areas (impacts to these facilities will be compensated). There could be an increase competition for use of the available facilities until the impacted facility's use is restored.	Increased recreational opportunities from original construction of and selected projects on the reservoirs.	Increased recreational opportunities from selected projects & management from various agencies on the reservoirs	Increased recreational opportunities from selected projects & management from various agencies on the reservoirs. This issue may well increase the competition for use of the resources.	Increased recreational opportunities from selected projects & management from various agencies on the reservoirs
Socioeconomic	Benefit to local area growth potential because of an increase in area recreation opportunities.	Original authorization and construction provided benefits to local & regional area due to growth potential from increased recreation opportunities.	Original authorization and construction provided benefits to local & regional area due to growth potential from increased recreation opportunities.	Original authorization and construction provided benefits to local & regional area due to growth potential from increased recreation opportunities.	Activities at the reservoirs are designed to benefit the economics of the local area and region.
Cultural Resources	It was determined that the resulting minimum flow would be much less than that released during power generation. Therefore, there would be no additional damage to cultural resources, including archeological sites and standing structures, in the tail-waters of the dams. .	Cultural resources are protected by state and federal law. Any significant adverse effects are required to be mitigated.	Cultural resources are protected by state and federal law. Any significant adverse effects are required to be mitigated	Cultural resources are protected by state and federal law. Any significant adverse effects are required to be mitigated	Cultural resources are protected by state and federal law. Any significant adverse effects are required to be mitigated

Air Quality	A minor negative affect due to an increase in air emissions from the additional thermal generation of electricity to compensate for the loss of hydropower capacity. Annual emission increases of $\leq$0.030 percent SO_2, $\leq$0.017 percent NO_x and CO_2 is possible regardless if emissions are increased in Arkansas or Missouri. Complete air quality information is located in section 4.6.	Past construction activities and actions have produced minor adverse impacts to air quality in the form of fugitive dust and emissions. State and federal laws restrict the type of activities that can occur.	Present construction activities and actions can produce minor adverse impacts to air quality in the form of fugitive dust and emissions. State and federal laws restrict the type of activities that can occur.	Future construction activities and actions may produce minor adverse impacts to air quality in the form of fugitive dust and emissions. State and federal laws restrict the type of activities that can occur.	Construction activities and actions produced minor adverse impacts to air quality in the form of fugitive dust and emissions. State and federal laws restrict the type of activities that can occur.

4.10 Irreversible and Irretrievable Commitment of Resources

Irreversible and irretrievable resource commitments would include the loss of the funds, labor, energy, and construction materials used to plan, design, construct, and monitor the effects of the minimum flow releases.

4.11 Unavoidable Adverse Environmental Effects

Unavoidable adverse impacts, although insignificant would include such things as the loss of terrestrial habitat around the lakes due to increased duration and frequency of flooding depending on which pool the reallocation is taken from.

4.12 Compliance with Environmental Requirements

This EIS has been developed in accordance with the procedural provisions of NEPA, the CEQ's Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Part 1500), and the USACE's regulation ER 200-2-2, Environmental Quality: Policy and Procedures for Implementing NEPA (33 CFR Part 230). The following section presents a summary of environmental laws, regulations, and coordination requirements applicable to this EIS.

Bald Eagle Protection Act

Compliance with this Act is obtained by complying with the Endangered Species Act. Please refer to the information in that heading below. The Bald Eagle was delisted on June 28, 2007 but consideration of the species will continue and effort to minimize disturbance of nesting sites will continue.

Clean Air Act of 1972

This act is intended to protect and enhance the quality of the nation's air resources, to initiate and accelerate research and development to prevent and control air pollution, to provide technical and financial assistance for air pollution prevention and control programs, and to encourage and assist regional air pollution prevention and control programs. This project is located in the Central Arkansas Intrastate Air Quality Region. This region is classified as an attainment area for all parameters. However, a CAA general conformity determination is not required because the project emissions would include only minor temporary construction related emissions and would not compose a significant portion of the area's emissions.

Clean Water Act, as amended

Compliance with the CWA was obtained by performing analysis to determine if any water quality parameters would be impacted due to the project. The purpose of the project is to increase wetted area, and also partially improve dissolved oxygen and temperatures, in the tailwaters of Bull Shoals and Norfork Lakes.

Endangered Species Act of 1973, as amended

This act provides a program for the protection of threatened and endangered animals and plants and the habitats in which they reside. Through coordination with the USFWS and preliminary site reconnaissance, it is the Corps position that the proposed project would not adversely affect federally listed threatened and endangered species. A biological assessment (BA) was prepared to comply with Section 7 consultation procedures under the ESA. The BA and the USFWS letter of concurrence can be found in Appendix E.

Federal Water Project Recreation Act of 1995

This act requires consideration of opportunities for outdoor recreation and fish and wildlife enhancement in planning water resource projects. Although specific recreational opportunities are not proposed as part of the project, consideration of the existing resources were part of the planning process and mitigating any impacts to these resources is an integral part of the proposed alternatives.

Fish and Wildlife Coordination Act of 1958, as amended

This act requires the USFWS to prepare an official Fish and Wildlife Coordination Act Report (FWCAR) which is presented in Appendix E. The Report and EIS have been coordinated with the USFWS , state agencies and other federal resource agency representatives. Coordination with the USFWS has occurred throughout the development of the project to address federally listed threatened and endangered species for the project. Significant weight was given to the FWCAR and other USFWS coordination documents concerning the proposed project.

National Environmental Policy Act of 1969

NEPA is the cornerstone legislation that acts as an umbrella for other federal and state laws regulating environmental compliance. This EIS has been prepared in accordance with CEQ regulations in compliance with NEPA provisions. All impacts to existing resources of concern have been identified and appropriate mitigation if applicable has been proposed.

National Historic Preservation Act (NHPA) of 1966, as amended

The intent of the NHPA is to protect significant cultural resources that might be threatened by actions that are federally funded and/or permitted, or which occur on federal property. The act requires the identification of all properties that are listed or eligible for listing on the NRHP in the project area, as well as the development of mitigation measures for those adversely affected, in coordination with the SHPO and the Advisory Council for Historic Preservation (ACHP). Both the Arkansas and Missouri SHPO’s have concurred that no cultural or historic resources will be impacted by this project.

Rivers and Harbors Act of 1899

This act is applicable to this project as it states that "it shall not be lawful to excavate or fill, or in any manner to alter or modify the course, location, condition, or capacity of, any port, roadstead, haven, harbor, canal, lake, harbor of refuge, or enclosure within the limits of any breakwater, or of the channel of any navigable water of the United States, unless the work has been recommended by the Chief of Engineers and authorized by the Secretary of War prior to beginning the same."

Executive Order 11988: Floodplain Management (May 24, 1977)

This Executive Order requires agencies to take action to reduce the risk of flood loss; to minimize the impact of floods on human safety, health, and welfare; and to restore and preserve the natural and beneficial values served by floodplains. Such actions should not be undertaken that directly or indirectly induce growth in the floodplain unless there is no practical alternative. Hydrology and hydraulic analyses of the proposed project indicate that there would be no permanent change to the floodplain.

Executive Order 11990: Protection of Wetlands (May 24, 1977)

This Executive Order requires agencies to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands. The proposed project is in full compliance with this Executive Order and the project will actually result in a slight increase in wetlands due to an increase in the wetted perimeter in the tailwaters of Bull Shoals and Norfork Lakes.

Executive Order 13186: Responsibilities of Federal Agencies to Protect Migratory Birds (January 10, 2001)

This Executive Order directs federal agencies to increase their efforts under the Migratory Bird Treaty Act, Bald and Golden Eagle Protection Acts, the Fish and Wildlife Coordination Act, the ESA of 1973, NEPA of 1969, and other pertinent statutes as they pertain to migratory birds to avoid measurably negative take of migratory bird populations. The proposed project has been designed to avoid impacts to migratory birds and potential habitats in the project area.

Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations

This Executive Order directs federal agencies to determine whether the proposed project would have a disproportionate adverse impact on minority or low-income population groups within the project area. The proposed project would not affect any low-income or minority population.

ENVIRONMENTAL OPERATING PRINCIPLES

In assessing the environmental impacts and developing mitigation for those impacts, the Corps has implemented the following Environmental Operation Principles (EOP's) as part of this study:

Environmental Sustainability: Attempted to avoid and/or minimize direct and indirect impacts to all valuable fish and wildlife and their associated habitats during the plan formulation process. Developed mitigation measures such as identifying lake facilities that have significantly impacted with corresponding facility modifications to maintain "reasonable continued use".

Seek Balance Between Development and Natural Systems: Looked for alternatives that would support the multiple project purposes of flood control, hydropower, water supply, recreation, and fish & wildlife while minimizing the adverse impacts to authorized purposes and the natural systems in the project area. This was accomplished by screening out alternatives that would most negatively impact authorized purposes, was technically unsound, or would be detrimental to the environment.

Build and Share an Integrated Scientific, Economic and Social Knowledge: Several resource agencies worked together as an "Environmental Team" to share knowledge of the study area and develop the necessary studies and data collection required for this study. Some of the scientific studies include a Biological Assessment of the Tumbling Creek Cave Snail, Gray Bat, and Indiana Bat, an Arkansas Game and Fish Commission White River Mussel Survey in transition zones, and congressionally mandated plans to compensate losses to lake recreation and hydropower. As part of their normal lake project operation and maintenance activities, the Corps is also committed to developing a long-term monitoring program which would continually add information to the knowledge base of the study area.

Respect the Views of Individuals and Groups Interested in Corps Activities: The Corps has met numerous times with the resource agencies, navigation industry, and environmental interests through scoping, teleconference calls and impact/mitigation meetings and attempted to be responsive in addressing all of their concerns. All interested agencies were asked to participate as "Cooperating "Agencies" in the development of the Environmental Impact Statement (EIS) and the U.S.G.S., National Park Service (Buffalo River Office), U.S. Fish and Wildlife Service, and Arkansas Game and Fish Commission have assumed these roles. All problems were addressed as they arose and solutions were developed.

Table 4.12-1: Environmental Compliance

Item	Compliance
Federal Statutes	
Bald Eagle Protection Act, 16 U.S.C. §§ 668, 668 note, 668a-668d	Full
Clean Air Act of 1977, as amended, 42 U.S.C. 7609, et. seq.	Full
Clean Water Act, as amended, (Federal Water Pollution Control Act) 33 U.S.C. 1251, et. seq.	Full
Endangered Species Act, 16 U.S.C. 1531, et. seq.	Full
Farmland Protection Policy Act, 7 U.S.C.§§ 4201 et seq.	Full
Fish and Wildlife Coordination Act, 16 U.S.C. 661, et. seq.	Full
Migratory Bird Conservation Act, 16 U.S.C. § 715 to 715s	Full
National Environmental Policy Act, 42 U.S.C. 4321, et. seq.	Ongoing
National Historic Preservation Act, 16 U.S.C. 470a, et. seq.	Full
Rivers and Harbor Act, 33 U.S.C. 401, et. seq.	Full
Executive Orders, Memorandums, etc.	
Executive Order 11988, Floodplain Management, May 24, 1977 (42 CFR 26951; May 25, 1977)	Full
Executive Order 11990, Protection of Wetlands, May 24, 1977 (42 CFR 26961; May 25, 1977)	Full
Executive Order 13186 of January 10, 2001 – Responsibilities of Federal Agencies to Protect Migratory Birds	Full
Executive Order 12898 of February 11, 1994 – Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations	Full
State and Local Policies	
Arkansas & Missouri Water Quality Standards	Full

5.0 List of Preparers

Name	Education & Experience	Primary Responsibilities
Mike Biggs USACOE	B.S. Civil Engineering; P.E.; 14-years H&H experience, 6-years Study & Project Management	Project Manager; Supervision of all work elements
Mike Rodgers USACOE	B.S. Fish & Wildlife Management; 15 years environmental investigation and analysis	Senior Biologist; senior report preparation
Michael Collis USACOE	B.S. Economics, M.A. Economics 4-years Corps experience	Economist; socioeconomic& recreational resources data collection and report preparation
William Penn USACOE	B.S. Biology; 3 years laboratory & field experience, 11 years environmental assessment experience, 8 years GIS experience.	GIS Coordinator; spatial analysis development
Chris Davies USACOE	B.A. , M.A. Anthropology; 16 years experience cultural resource management	Archeologist, cultural resources data collection and report preparation
Jonathan Long USACOE	B.S. Civil Engineering	Civil Engineer; water supply data collection and report preparation
Dana Needham USACOE	B.S. Biology; 6 years study management	Biologist/Study Manager; biological data collection
David Mott DOI/NPS		National Park Service Resource Manager; Buffalo National River data collection
Faron Usery DOI/NPS		National Park Service Resource Manager; Buffalo National River data collection
Jim Ellis USACOE	M.S., B.S. Biology; 18 years experience environmental investigation and analysis	NEPA Specialist; document review and editing

6.0 Public Involvement

Public Involvement: A Notice of Intent (NOI) was published in the Federal Register on May 30, 2000 announcing the Corps intent to prepare an EIS.

The U.S. Army Corps of Engineers held public workshops at the following locations in 2000. A presentation was made by Corps personnel regarding details of the White River Minimum Flow Study with a question, answer, and comment period following. The workshops were held as part of the scoping process to notify the public of the study and gather input related to reallocation of storage from Beaver, Table Rock, Bull Shoals, Norfork, and Greers Ferry Lakes for the purpose of maintaining minimum flows on the White, North Fork, and Little Red Rivers for the downstream trout fisheries. News releases were issued to announce each workshop.

June 9, 2000	Branson, MO
June 12,2000	Rogers, AR
July 24, 2000	Mountain Home, AR
July 25, 2000	Heber Springs, AR

A copy of all scoping materials including responses to scoping inquiries are held on file at the U.S. Army Corps of Engineers, Little Rock District.

Status and Update briefings were given in the following public forums throughout the study and EIS process.

DATE	AUDIENCE & LOCATION
06/05/01	Beaver Dam Min. Flow test release, Beaver Tailwater
06/06/01	Table Rock Dam Min. Flow test release, Table Rock Tailwater
06/07/01	Bull Shoals Dam Min. Flow test release, Bull Shoals Tailwater
06/08/01	Norfork Dam Min. Flow test release, Norfork Tailwater
06/09/01	Greers Ferry Dam Min. Flow test release, Greers Ferry Tailwater
07/23/01	Canoeing – Outdoor Enthusiasts, Table Rock Project Office
07/25/01	Rose Law Firm, Little Rock Corps Offices
08/09/01	Pleasant Valley Bass Club, Shorty Smalls – Little Rock, AR
08/28/01	Trout Unlimited, Branson, MO
01/08/02	Trout Unlimited, Springfield, MO
03/21/02	Nature Conservancy, Little Rock, AR
03/15/02	Hydropower Conference, Branson, MO
07/31/02	White Rivers Fisheries Partnering, Branson, MO
08/02/02	Nature Conservancy, Little Rock, AR
10/02/02	Arkansas Game & Fish Commission, Mountain Home, AR
10/22/02	Arkansas-Missouri Fisheries Meeting, Eureka Springs, AR
11/05/02	Meeting with SRPA (Ted Coombes), Little Rock, AR
12/16/02	Marina Owners (MAMA) Meeting, North Little Rock, AR
02/21/03	Associated Electric Cooperative Incorporated, Branson, MO
04/07/03	Trout Unlimited, Springdale, AR

06/09/03	Beaver Water District, Springdale, AR
06/16/03	Arkansas Game & Fish Commission, Little Rock, AR
10/20/03	Arkansas Fly Fishers, Little Rock, AR
12/11/03	Ozark Underground Lab (Tom Alley), Missouri
12/18/03	Friends of the Norfork River, Mtn. Home, AR
01/14/04	Hydropower, Missouri Con. Staff, Missouri Resource Agencies, Branson, MO
06/09/04	Society of American Military Engineers, Little Rock, AR
09/16/04	Sierra Club Regional Meeting, Mtn. View, AR
03/14/05	Jacksonville Shrine Club, Jacksonville, AR
06/30/05	U.S. Park Service (David Mott), Little Rock, AR
11/03/05	Dissolved Oxygen Committee, Theodosia, MO

A Notice of Availability (NOA) of the Draft EIS appeared in the Federal Register on June 2, 2006. Draft EIS comments received and responses to those comments were incorporated into the Draft EIS as Appendix B.

The Draft EIS was supplemented and a new Notice of Availability (NOA) for the Supplemental Draft EIS appeared in the Federal Register on September 19, 2008. Following a 45-calendar day public review period that ended on November 3, 2008, Supplemental Draft EIS comments and responses were placed in Appendix B of this Final EIS.
No substantial comments were received that would significantly alter the analysis and conclusions found in the Final EIS.

Copies of the Final EIS were distributed to the following agencies, individuals, and organizations as part of the 30-day Administrative Review Period.

Mr. Sam D. Hamilton
Regional Director
U.S. Fish and Wildlife Service
1875 Century Boulevard
Atlanta, GA 30345

Mr. Charlie Scott
Field Supervisor
U.S. Fish and Wildlife Service
101 Park Deville Drive, Suite A
Columbia, MO 65203-0007

Mr. Steve Mahfood
Director
Missouri Department of Natural Resources
P.O. Box 176
Jefferson City, MO 65102-0176

Mr. Michael P. Jansky
Regional Env Review Coordinator
U.S. Environmental Protection Agency
1445 Ross Avenue, Suite 1200
6ENXP
Dallas, TX 75202-2733

Mr. Frances McSwain
Director
Arkansas Historic Preservation Program
1500 Tower Building
323 Center Street
Little Rock, AR 72201

Mr. Tracy L. Copeland
Department of Finance & Administration
1515 West 7th Street, Room 412
P.O. Box 3278
Little Rock, AR 72203

Mr. J. Randy Young
Executive Director
Arkansas Natural Resources Commission
101 E. Capitol Avenue, Suite #350
Little Rock, AR 72201-3827

Mr. George Rheinhardt
Arkansas Forestry Commission
3821 W. Roosevelt Road
Little Rock, AR 72204-6396

Mr. Craig Uyeda
Arkansas Game and Fish Commission
#2 Natural Resources Drive
Little Rock, AR 72205

Ms. Teresa Marks
Director
Arkansas Dept of Environmental Quality
5301 Northshore Drive
North Little Rock, AR 72118-5317

Mr. Scott Henderson
Director
Arkansas Game and Fish Commission
2 Natural Resources Drive
Little Rock, AR 72205

Ms. Karen Smith
Director
Arkansas Natural Heritage Commission
1500 Tower Building
323 Center Street
Little Rock, AR 72201

Mr. John E. Terry
District Chief
U.S. Geological Survey
401 Hardin Road
Little Rock, AR 72211

Mr. Gary Jones
Acting Regional Director
FEMA, Region VI
800 North Loop 288
Denton, TX 76210

Mr. Earl Smith
Chief
Arkansas Natural Resources Commission
101 E. Capitol, Suite 350
Little Rock, AR 72201

Mr. Richard W. Davies
Executive Director
Arkansas Department of Parks and Tourism
#1 Capitol Mall, Rm 4A-900
Little Rock, AR 72201

Dr. Paul K. Halverson
Director of Health
Arkansas Department of Health
4815 West Markham
Little Rock, AR 72205

Mr. Kalven L. Trice
State Conservationist
U.S. Department of Agriculture
700 West Capitol Ave.
Room 3416, Federal Building
Little Rock, AR 72201

Dan Hall
County Judge
Baxter Coutny
1 E. 7th St.
Suite 303
Mountain Home, AR 72653

Mike Moore
County Judge
Boone County, AR
100 N. Main St.
Suite 300
Harrison, AR 72601

Mark Depoy
Chief Resource Management
Buffalo National River
402 North Walnut
Suite136
Harrison, AR 726015

Charles Willett
County Judge
Fulton County AR
P.O. Box 278
Salem, AR 72576

Kenneth Oxford
County Judge
Marion County, AR
P.O. Box 545
Yellville, AR 72687

David Morrison
Presiding Commissioner
Ozark County, MO
P.O. Box 247
Gainesville, MO 65655

Chuck Pennel
Presiding Commissioner
Taney County, MO
P.O. Box 1086
Forsyth, MO 65653

Mr. Ernest Quintana
Regional Director
National Park Service, Midwest Region
601 Riverfront Drive
Omaha, NE 68102

Mr. Scott Simon
State Director
The Nature Conservancy, Arkansas Field Office
601 North University Ave.
Little Rock, AR 72203

Ms. Melinda Nickason
Environmental Scientist
U.S. Environmental Protection Agency, Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Ms. Jeanene Peckham
NEPA Specialist
U.S. Environmental Protection Agency, Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Mr. Ted Coombes
Executive Director
Southwestern Power Resources Administration
P.O. Box 471827
Tulsa, OK 74147-1827

Mr. Mark Sattelberg
Field Supervisor
U.S. Fish and Wildlife Service
110 South Amity Road, Suite 300
Conway, AR 72032

Mr. Steven R. Spencer
Regional Environmental Officer
U.S. Department of the Interior
P.O. Box 26567 (MC-9)
Albuquerque, NM 87125-6567

Mr. Robert Lawrence
U.S. Environmental Protection Agency
Region 6
1445 Ross Avenue
Dallas, TX 75202

Mr. John Hoskins
Director
Missouri Department of Conservaton
P.O. Box 180
Jefferson City, MO 65102

Ms. Loretta Sutton
U.S. Department of the Interior
1849 C Street NW
(MS 2342)
Washington, DC 20240

Mr. Michael Deihl
Administrator
Southwestern Power Administration
One West Third Street
Room 1400
Tulsa, OK 74103-3519

Mr. George Robbins
Southwestern Power Administration
One West Third Street
Tulsa, OK 74103-3519

Taneyhill Community Library
200 S. 4th Street
Branson, MO 65616

Central Arkansas Main Library
100 Rock Street
Little Rock, AR 72201

Baxter County Main Library
424 West 7th Street
Mountain Home, AR 72653

Forsyth Public Library
162 Main St.
Forsyth, MO 65653

Baxter County Library Gassville Branch
6469 Highway 62 SW
Gassville, AR 72635

Central Arkansas Roosevelt Thompson Library
38 Rahling Circle
Little Rock, AR 72223

Mountain Home Project Office
324 West 7th St
Mountain Home , AR 72653-4306

Greers Ferry Project Office
700 Heber Springs Rd North
PO Box 1088
Heber Springs, AR 72543-1088

Table Rock Project Office
4600 State Hwy 165 Suite A
Branson, MO 65616-8980

Beaver Project Office
2260 North 2nd St
Rogers, AR 72756-2439

US Army Corps of Engineers-SWL
700 West Capitol
PO Box 867
Little Rock AR72203-0867

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