US Army Corps
Engineers
Little Rock District

US Army Corps
Engineers
Southwestern Division

DRAFT Integrated Beaver Lake Water Supply Storage Reallocation Report and Environmental Assessment

DRAFT REPORT FOR REVIEW– AUGUST 2017

DEPARTMENT OF THE ARMY
LITTLE ROCK DISTRICT, SOUTHWESTERN DIVISION
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P.O. BOX 867
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FINDING OF NO SIGNIFICANT IMPACT

The Beaver Lake Water Supply Storage Reallocation Study Area is located in northwest Arkansas and lies within portions of Benton, Washington, Carroll, and Madison Counties. Beaver Lake is situated in the Ozark Highlands and is the first reservoir on the upper end of the White River watershed. Beaver Dam was constructed across the White River about six miles west of Eureka Springs, Arkansas. The Beaver Lake Project Area contains 40,463 acres. The surface acreage of Beaver Lake consists of 28,220 acres at the top of the conservation-water supply pool, which is at the 1,120.42 feet National Geodetic Vertical Datum (NGVD) elevation. The surface acreage increases to 31,700 acres at the top of the flood-control pool (1,130.00 feet NGVD). Beaver Lake provides storage capacity of 1.95 million acre-feet of water, which includes 300,000 acre-feet for flood control and the remainder for water supply and power generation.

The Little Rock District, Corps of Engineers conducted this Water Reallocation Study to evaluate requests received by current water districts utilizing Beaver Lake water supply.

- The Benton/Washington County Water Association (BWCWA) request for an additional 12.0 million gallons per day (MGD) to meet immediate needs of users.
- The Carroll-Boone Water District (BCWD) request for an additional 6.0 MGD of water to meet immediate needs of users.
- The Madison County Rural Water Authority (MCRWA) request for an additional 4.0 MGD of water to meet immediate needs of users.

The storage is for municipal and industrial (M&I) purposes and is needed to provide for an immediate need estimated at 22.0 MGD, which requires that 41,960.7 acre-feet (AF) of storage be reallocated to water supply.

The Environmental Assessment (EA) included in the report evaluated the impacts associated with reallocation of storage to provide the immediate need of 22 MGD for water supply. Impacts assessed for the recommended plan included, but were not limited to, those related to water, biological, cultural, and geologic resources, land use/recreation/transportation, socioeconomics, and hazardous and toxic substances. The recommended plan will not adversely affect any federally listed threatened and endangered species or critical habitat. In lieu of providing a summary of impacts, the EA included in the report is incorporated here, by reference.

Based on a review of the information, it is determined that the implementation of the Recommended Action is not a major federal action which would significantly affect the quality of the human environment within the meaning of Section 102(2)(c) of the National Environmental Policy Act of 1969, as amended.

Therefore, the preparation of an Environmental Impact Statement is unwarranted and a "Finding of No Significant Impact" (FONSI) is appropriate. The signing of this document indicates the Corps' final decision of the proposed action as it relates to NEPA.

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Date	ROBERT G. DIXON Colonel, EN Commanding

EXECUTIVE SUMMARY

Reallocation of Storage at Beaver Lake, Arkansas for Benton Washington Regional Public Water Authority (BWRPWA or Benton Washington), Carroll Boone Water District (CBWD or Carroll Boone), and Madison County Rural Water Authority (MCRWA or Madison County)

This report presents the results of a study to reallocate additional water supply storage in Beaver Lake for Benton Washington, Carroll Boone, and Madison County for Municipal and Industrial (M&I) water supply. This reallocation study is in response to these three separate requests:

- Benton Washington's request for an additional 12.0 million gallons per day (mgd) or approximately 22,887 acre-feet of storage;
- Carroll-Boone's request for an additional 6.0 mgd or approximately 11,444 acre-feet of storage; and
- Madison County's request for an additional 4.0 mgd or approximately 7,629 acre-feet of storage.

Located in the upper north-western section of Arkansas, Beaver Lake is a U.S. Army Corps of Engineers multi-purpose reservoir authorized for flood control, hydroelectric power, water supply, recreation, and fish & wildlife.

In 1977, Carroll Boone contracted for 9,000 acre-feet (af) of conservation storage and congress allocated an additional 2,396 af to Carroll-Boone in 2006 from the conservation storage. In 1992, Madison Country acquired 3,882 af of flood pool storage. Likewise, Benton-Washington Regional Public Water Authority contracted for 7,643 af of flood pool storage in 1996. The total reallocations from flood pool storage has raised the top of conservation pool from 1,120.00 feet-NGVD by 0.43 feet to 1,120.43 feet, NGVD. With these flood pool reallocations, the storage capacity in the lake resulted in 287,300 af for flood storage, 937,400 af for conservation storage for water supply and hydropower and 727,800 af of inactive storage for Commander approved emergency uses, including hydropower, fish habitat, recreation, water supply, and sediment storage. Total Project Storage is 1,951,500 af.

Beaver Lake's original 1960 design included water supply storage of 108,000 af for the Beaver Water District. Congress has allocated an additional 28,757 af to Beaver Water District in 2006 from conservation storage.

The team evaluated a suite of alternatives and screened to the final three alternatives:

1. No Action/Future without Project (FWOP), Non-federal sponsor constructs a new reservoir.
2. Beaver Lake – Reallocation of Storage from the conservation pool.
3. Beaver Lake – Combined reallocation from the conservation and inactive pools.

As a test of financial feasibility, the annual cost of the reallocated storage at Beaver Lake, was compared to the annual cost of the next most likely, least costly alternative that would provide the water needs of the three requesters in the absence of utilizing a reallocation at Beaver Lake. The next most likely, least costly alternative was determined to be construction of a single-purpose reservoir by the water users.

The results of the comparison indicate reallocating from Beaver Lake has the least total annual cost for the requesters $ 579,467 compared to the $ 14,003,838 total annual cost of construction of a new reservoir.

Hydrologic and hydraulic (H&H) studies were performed to determine, frequency and duration for pool elevation, lake-outflow, river stage, and river discharge for each of the respective reallocation alternatives. The reallocation of storage in Beaver Lake for water supply will provide firm yield (dependable yield) of 12 MGD for Benton-Washington Regional Public Water Authority, 6 MGD for Carroll-Boone Water District, and 4 MGD for Madison County Rural Water Authority. Hydrologic analysis showed minimal impact if reallocated from conservation or inactive pool; however, a reallocation from flood pool increased damaging releases and downstream lake elevations during extreme events. For H&H, environment and dam safety consideration, the flood pool was screened from further analysis.

An Environmental Assessment (EA) is integrated within this report as directed by the National Environmental Policy Act. The Table of Contents has denoted those sections by placing an (*) beside the heading. The Environmental Assessment for the recommendation to reallocate 41,960 acre-feet from the conservation pool was prepared in accordance with NEPA requirements. A Finding of No Significant Impact was drafted and is included above. Due to the impacts to hydroelectric power production, a credit to the accounting records for Southwestern Power Administration would be made in accordance with ER-1105-2-100, Appendix E-57d(3).

The conclusion for this water supply storage reallocation study is to reallocate 41,960 acre-feet of storage, consisting of 22,887 acre-feet for Benton Washington, 11,444 acre-feet for Carroll Boone; and 7,629 acre-feet for Madison County at Beaver Lake from the conservation pool.

In consideration of the right to utilize the storage space at Beaver Lake for Municipal and Industrial water supply, the two water authorities will pay the Government for each proportional share of the cost of the storage. The total 22,887 acre-feet of storage providing a total of 12 million gallons per day for Benton Washington, the cost is $316,069. For the 11,444 acre-feet storage to provide approximately 6.0 million gallons per day for Carroll Boone, the cost is $158,041. Lastly, for the 7,629 acre feet storage to provide approximately 6.0 million gallons per day for Carroll Boone, the cost is $105,356. Each of these water users will also be responsible for their proportional shares of the annual Operations and Maintenance costs calculated for this reallocated storage to be 55%; 27%; and 18%, respectively.

To provide the requested additional water supply storage in Beaver Lake, supplemental water supply storage agreements between the water authorities and the U.S. Army Corps of Engineers will be required. Draft Agreements have been prepared and accompany this storage reallocation report under separate cover.

Please address any comments via email to: CESWL-BeaverLakeWaterSupply@usace.army.mil or via U.S. Mail to Mr. Craig Hilburn, Environmental Regional Technical Specialist, U.S. Army Corps of Engineers, Regional Planning & Environmental Center, Post Office Box 867, Little Rock, AR., 72203-0867 or Ms. Tacy Jensen, Study Manager, U.S. Army Corps of Engineers, Regional Planning & Environmental Center, 1645 S 101st E Avenue, Tulsa, OK 74128.

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Abbreviations and Acronyms

ACE	Annual Chance Exceedance
AF	Acre-feet
Ag Census	Census of Agriculture
BWRPWA	Benton Washington Regional Public Water Authority
CBWD	Carroll-Boone Water District
CII	Commercial, Industrial, and Institutional
EA	Environmental Assessment
EPA	United States Environmental Protection Agency
FONSI	Finding of No Significant Impact
Gal	Gallons
GED	Gallons of Water Use per Employee per Day
GPCD	Gallons per Capita per Day
GPD	Gallons per Day
Gpm	Gallons per Minute
M&I	Municipal and Industrial
MCRWA	Madison County Rural Water Authority
Mgd	Million Gallons per Day
NAICS	North American Industrial Classification System
NCDC	National Climate Data Center
NEPA	National Environmental Policy Act
NRW	Non-Revenue Water
NGVD	National Geodetic Vertical Datum
OMRR&R	Operations, Maintenance,
PS	Public-Supply
SWD	United States Corps of Engineers Southwest Division
SWL	United States Corps of Engineers Little Rock District
SWPA	Southwestern Power Administration
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	US Geological Survey

1.0 PURPOSE AND AUTHORITY

1.1 Study Overview – Purpose and Need *

This is an integrated reallocation report completed by the U.S. Army Corps of Engineers (USACE or the Corps), Little Rock District (SWL) presenting the results of a water supply storage reallocation study that evaluates storage reallocation requests from three public water providers in northwest Arkansas that rely on Beaver Lake for municipal and industrial (M&I) water supplies. The report documents the potential alternatives to provide reliable water supply storage for the three public water providers including the impacts of those alternatives. The report also discusses the cumulative analysis and findings of no serious effects to other authorized purposes at Beaver Lake, ultimately not requiring Congressional approval.

*PURPOSE AND NEED **

In accordance with Corps Guidance, the purpose of this study is to meet the water needs of the designated users and their partners. The Corps' policy for "immediate need" is a water demand study showing the need for the water and the sponsor's ability and willingness to pay for the storage of the water. (*See* Attachment (Letters of Intent) to Appendix A – Water Demand Needs Model) Long term planning needs should be identified for reallocation in the future. The study will provide a summary of the overall 50-year planning needs (2015 to 2065). The water demand analysis model was approved for use by HQ Panel on September 2, 2016.

1.2 Authority and federal interest

Authority for the Corps to reallocate existing storage space to M&I water supply is contained in Public Law 85-500, Title III, Water Supply Act of 1958, as amended, 33 U.S.C. 390b.

Section 301(a) of Water Supply Act of 1958, states: "It is declared to be the policy of the Congress to recognize the primary responsibilities of the States and local interests in developing water supplies for domestic, municipal, industrial, and other purposes and that the Federal Government should participate and cooperate with States and local interests in developing such water supplies in connection with the construction, maintenance, and operation of Federal navigation, flood control, irrigation, or multiple purpose projects." This established a policy and federal interest in development of water supplies for domestic, municipal, industrial and other purposes and established the federal interest in development of water supply storage from the Corps of Engineers' reservoirs.

2.0 HISTORY OF THE PROJECT.

2.1 PROJECT BACKGROUND AND STUDY AREA

Beaver Lake is one of five lakes in a system constructed in the White River Basin. The lake is located in northwest Arkansas and lies within portions of Benton, Washington, Carroll, and Madison Counties. Beaver Dam was constructed across the White River about six miles west of Eureka Springs, Arkansas. It is the first reservoir on the upper end of the White River basin.

The study area for this reallocation study are made up of the counties: Benton County, Washington County, Carroll County, and Madison County contained in the Beaver Project area. (See Figure 2-1 below).

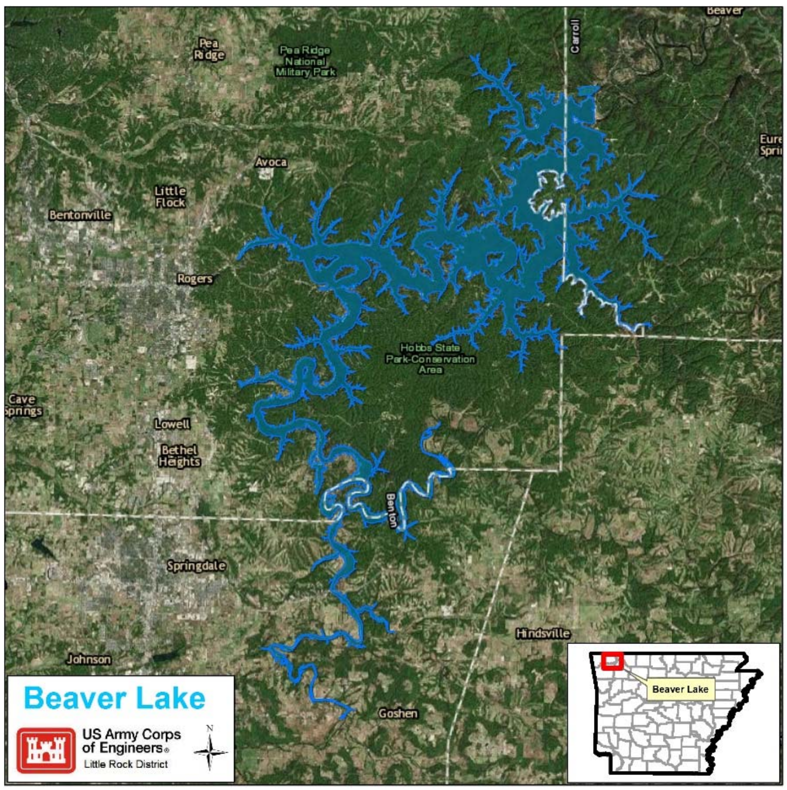


Figure 2-1: Beaver Lake Map – Study Area

In addition, the team evaluated the cumulative effects of discretionary reallocations for the White River Basin. (See Figure 2-2 below).

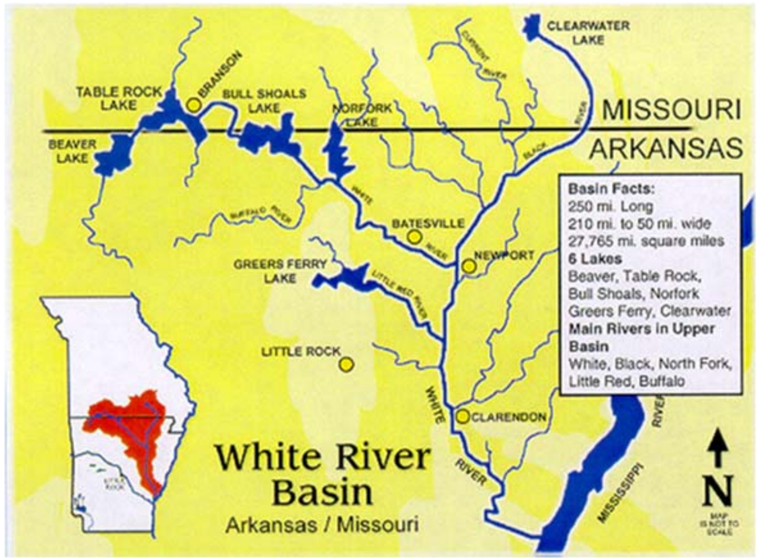


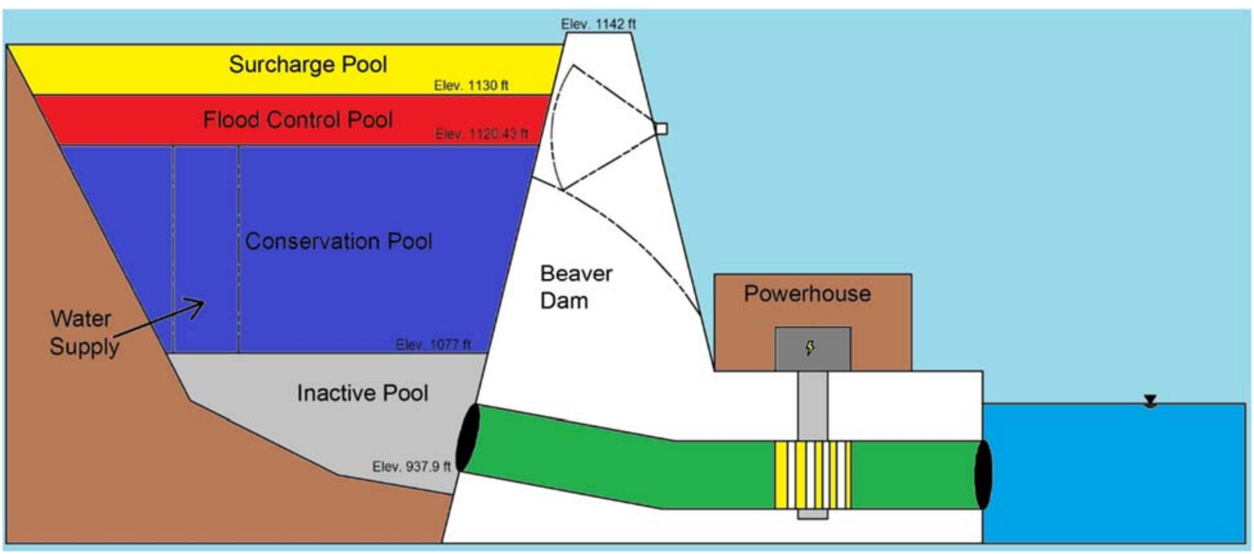
Figure 2-2: White River Basin Map – Cumulative Impacts

Construction of the Beaver Project began in November 1960 and was completed in June 1966. The main dam has a maximum height above the river bed of 228 feet and extends approximately 2,575 feet, of which 1,333 feet are concrete monoliths and 1,242 feet are earthen embankments. Beaver Lake has 7 gated spillway crest gates. Beaver Lake encompasses 28,370 acres at the top of the conservation pool (1,120.43 feet-National Geodetic Vertical Datum (NGVD)). Beaver's drainage basin is 1,186 square miles. Table 2-1 and Figure 2-3 summarizes the pertinent data of Beaver Dam.

Table 2-1: Pertinent Data of Beaver Dam

Feature	Elevation[1]	Area (acres)	Storage Volume (ac-ft)	Cumulative Equivalent Runoff[2] (inches)
Top of dam	1142.00	36,260	2,358,700	13.10
Design pool	1137.00	34,290	2,182,500	9.94
Top of flood risk management pool	1130.00	31,700	1,951,500	7.05
Spillway crest	1093.00	19,690	1,007,200	4.48
Top of conservation pool	1120.43	28,371	1,664,198	3.15
Top of inactive pool	1077.00	15,540	726,800	0.96
Probable maximum drawdown	1075.00	15,540	726,850	
Sluice invert	937.90	237	1,279	
Streambed	914.00	0	0	
Total storage			2,182,500	
Flood risk management storage	1120.43-1130.00		286,880	
Conservation storage	1077.00-1120.43		937,398	
Inactive storage	914.00-1077.00		726,800	

(1) Feet, msl
(2) 1,186 sq mi of drainage area upstream of dam



Source: U.S. Army Corps of Engineers Little Rock District, HTS Division

Figure 2-3: Beaver Dam

2.2 CONGRESSIONAL AUTHORIZATIONS AND OTHER APPLICABLE LAWS FOR BEAVER LAKE INCLUDE:

Congress authorized Beaver Lake for flood control, hydroelectric power, and other purposes as further discussed below. The Water Supply Act of 1958 authorized municipal and industrial (M&I) water supply as a project purpose.

The Flood Control Act of 1938 approved, "The general comprehensive plan for flood control and other purposes in the White River Basin, the reservoirs to be selected and approved by the Chief of Engineers."

The applicable laws and authorizations for Beaver Lake include:

1) Flood Control Acts of 1944, Flood Control Act of 1946, and Flood Control Act of 1962.
2) Rivers and Harbors Flood Control Act of 1968 authorized the Corps to develop the lake for recreation.
3) Section 6, Public Law 78-534 (the 1944 Flood Control Act) allows the Corps to enter into agreements for surplus water with states, municipalities, private concerns, or individuals at any reservoir under the control of the Department of the Army at agreed to price and terms. Agreements may be for domestic, municipal, and industrial uses, but not for crop irrigation.
4) The Water Supply Act of 1958 section 301(a), established a policy of cooperation in development of water supplies for domestic, municipal, industrial, and other purposes. Section 301(b) is the authority for the Corps to include municipal and industrial water storage in reservoir projects and to reallocate storage in existing projects for municipal and industrial uses. However, as specified in Section 301(d), modifications to a planned or existing reservoir project to add water supply, which would seriously affect the project, its other purposes, or its operation, requires congressional authorization.
5) Section 10 of Public Law 87-88 (the Federal Water Pollution Control Act Amendments of 1961) modified the 1958 Water Supply Act. This modification permitted the acceptance of assurances for future water supply to accommodate the construction cost payments for future water supply.
6) Section 932 of Public Law 99-662 (the Water Resources Development Act 1986), amended the Water Supply Act of 1958, as amended. This amendment applies to Corps projects but not to Bureau of Reclamation projects. The amendment eliminated the 10-year interest free period for future water supply, modified the interest rate formula, limited repayment to 30 years, and required annual operation, maintenance and replacement costs to be reimbursed annually. This latter requirement had always been a part of Corps policy and repayment procedures.
7) Public Law 88-140, approved 16 October 1963, extended to the non-federal sponsor of water supply storage the right to use the storage for the physical life of the project subject to repayment of costs. This removed an uncertainty as to the continued availability of the storage space after the 50-year maximum period previously allowed in contracts.
8) Public Law 104-303 (the Water Resources Development Act of 1996). Authorizes recreation and fish and wildlife mitigation as purposes of the project, to the extent that the additional purposes do not adversely affect flood control, power generation, or other authorized purposes of the project.

9) Public Law 106-53, approved 17 August 1999, states: ". . . at no time shall the bottom of the conservation pool be at an elevation that is less than 1,076 feet, NGVD [National Geodetic Vertical Datum]."

10) Public Law 109-103 White River Minimum Flows Section 132(a) of the 2006 Energy and Water Development Appropriations Act authorizes and directs implementation of two of the reallocation plans described in the July 2004, White River Minimum Flows Reallocation Report: BS-3 at Bull Shoals and NF-7 at Norfork Lake.

2.3 PREVIOUS WATER SUPPLY STORAGE ALLOCATIONS AT BEAVER LAKE

Over the years, there have been many studies and proposals addressing issues of water storage at Beaver Lake. The planning process for this study has relied on these past studies (as shown in Table 2-2 below) to obtain information about the watershed to guide the analysis.

Beaver Lake's original 1960 design included water supply storage of 108,000 acre-feet (AF) for the Beaver Water District. Congress has allocated an additional 28,757 AF to Beaver Water District and 2,396 AF to Carroll-Boone Water District in 2006 from conservation storage. In 1977, Carroll Boone Water District contracted for 9,000 AF of conservation storage. In 1992, Madison Country Water acquired 3,882 AF of flood pool storage. Likewise, Benton-Washington Regional Public Water Authority contracted for 7,643 AF of flood pool storage in 1996. The total reallocations from flood pool storage has raised the top of conservation pool from 1,120.00 feet-NGVD by 0.43 feet to 1,120.43 feet, NGVD. With these flood pool reallocations, the storage capacity in the lake resulted in 287,300 AF for flood storage, 937,400 AF for conservation storage for water supply and hydropower and 727,800 AF of inactive storage for Commander approved emergency uses, including hydropower, fish habitat, recreation, water supply, and sediment storage. Total Project Storage is 1,951,500 AF.

Table 2-2: Municipal and Industrial (M&I) Water Supply Storage from Beaver Lake

Water User	Pool	Acre-feet (af)
Beaver Water District (1960)	Originally Design	108,000
Beaver Water District (2006)	Conservation	28,757
Carroll Boone Water District (2006)	Conservation	2,396
Congressional Subtotal:		**139,153 af**
Carroll Boone Water District (1977)	Conservation	9,000
Madison Co Water District (1992)	Flood	3,882
Benton/Washington Co WD (1996)	Flood	7,643

Discretionary Subtotal:		***20,525 af***
Benton/Washington Co WD (2000)	Conservation	22,887
Carroll Boone Water District (2001)	Conservation	11,444
Madison Co Water District (2006)	Conservation	7,629
Current Reallocation Request Subtotal:		***41,960 af***
CUMULATIVE DISCRETIONARY TOTAL:		***62,485 af***

3.0 CURRENT AND FUTURE WITHOUT CONDITIONS.

This section establishes a baseline for each of the following resources within the study area; land use, air quality, climate, geologic resources, water resources, biological resources, cultural resources, recreation and aesthetics, transportation, socioeconomics and environmental justice and hazardous, toxic, and radiologic waste.

Based on the environment as described, future without project conditions were projected for the study period of analysis (50 years beginning in 2015). The section concludes with descriptions of the future without project (no action) conditions, which will be used as a baseline for measuring the impacts and benefits of alternative plans.

The purpose of this chapter is to describe the existing condition in the project area and the future condition without implementation of a project (the No Action condition forecast). These analyses will be described in terms of the following:

- Land Use
- Air Quality
- Climate
- Geologic Resources
- Water Resources
- Biological Resources
- Cultural Resources
- Recreation and Aesthetics
- Transportation
- Socioeconomics and Environmental Justice
- Hazardous, Toxic, and Radioactive Waste (HTRW)

3.1 EXISTING CONDITION

This chapter establishes a baseline for each of the following resources within the study area; land use, air quality, climate, geologic resources, water resources, biological resources, cultural resources, recreation and aesthetics, transportation, socioeconomics and environmental justice and hazardous, toxic, and radiologic waste.

3.2 STUDY LOCATION AND DESCRIPTION

Beaver Lake is located in northwest Arkansas and lies within portions of Benton, Washington, Carroll, and Madison Counties. Beaver Lake is situated in the Ozark Highlands and is the first reservoir on the upper end of the White River watershed. Beaver Dam was constructed across the White River about six miles west of Eureka Springs, Arkansas. The Beaver Lake Project area contains 40,463 acres. There are 38,039 acres owned in fee, and 2,424 acres are in flowage easement. The surface acreage of Beaver Lake consists of 28,220 acres at the top of the conservation-water supply pool, which is at the 1,120.42 feet National Geodetic Vertical Datum (NGVD) elevation. The surface acreage increases to 31,700 acres at the top of the flood-control pool (1,130.00 feet NGVD). Beaver Lake provides storage capacity of 1.95 million-acre feet of water, which includes 300,000 acre feet for flood control and the remainder for water supply and power generation. In addition to the surface water acreage, the USACE manages over 449 miles of shoreline, 11 parks, 39 miles of road, numerous structures, and 9,827 acres of public land above the conservation pool elevation (1,120.42 feet NGVD).

3.3 LAND USE*

Forest land and agriculture are the predominant land uses in the Beaver Lake watershed- approximately 68 percent forestland, 27 percent agricultural (primarily pasture with some row crop production), 4 percent water (including Beaver Lake and Lake Sequoyah), and 1 percent urban (Figure 3-1 below). Significant development is occurring in the urban areas along the west side of the lake, while most of the eastern side remains relatively undisturbed. The area around the lake is owned by the Corps of Engineers and, except for parks and marinas, consists mostly of undeveloped uplands. The Arkansas Department of Parks and Tourism and Arkansas Natural Heritage Commission own a relatively small percentage of property adjacent to Corps land. The majority of adjacent property is privately owned, including some housing developments. Private floating docks and walkways are authorized at various locations around the lakeshore.

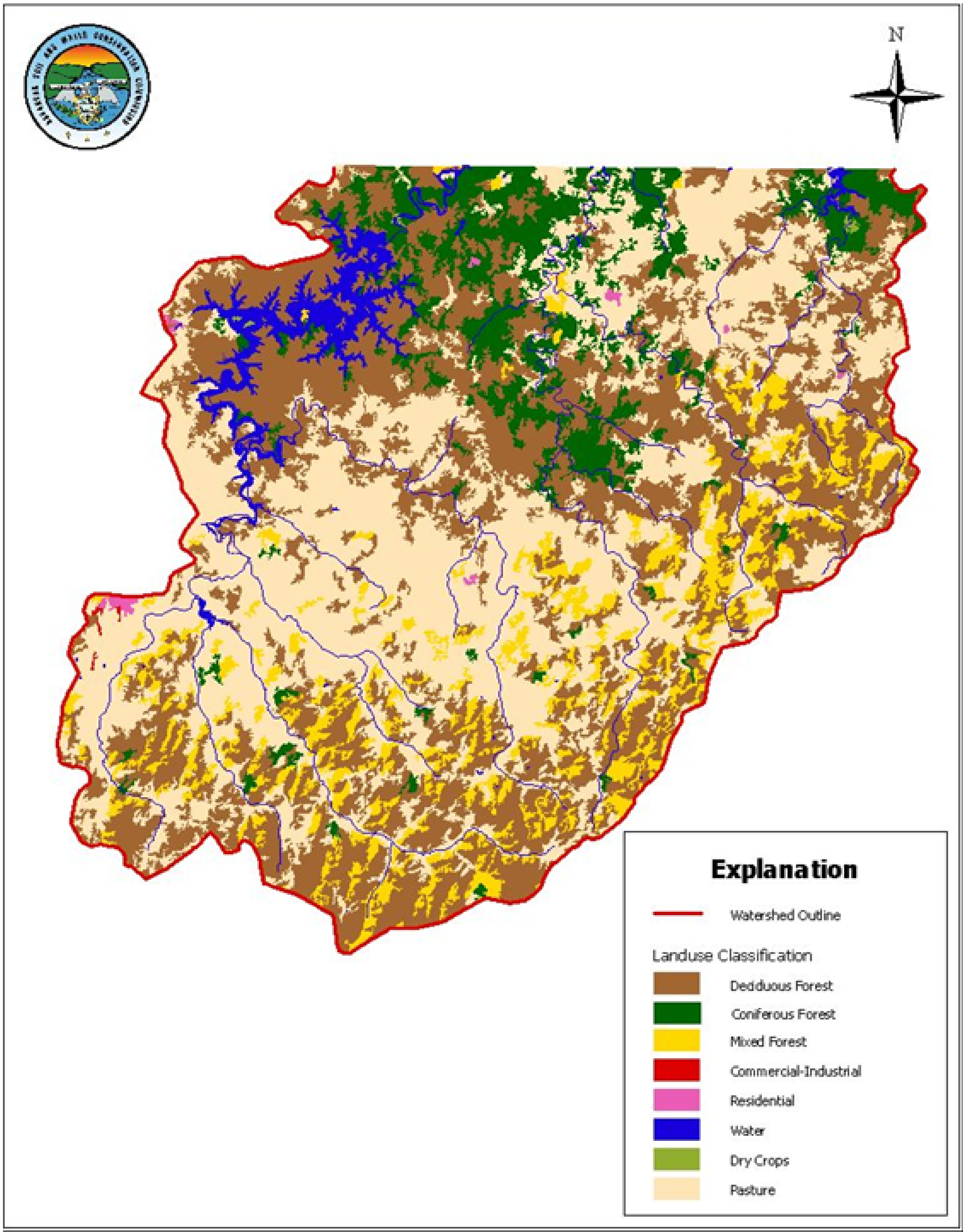


Figure 3-1: Land Use in the Beaver Watershed

3.4 Air Quality*

The U.S. Environmental Protection Agency (EPA) has the primary responsibility for regulating air quality nationwide. The Clean Air Act (42 U.S.C. 7401 *et seq*.), as amended, requires the EPA to set National Ambient Air Quality Standards (NAAQS) for wide-spread pollutants from numerous and diverse sources considered harmful to public health and the environment. The Clean Air Act established two types of national air quality standards classified as either “primary” or “secondary.” Primary standards set limits to protect public health, including the health of at-risk populations such as people with pre-existing heart or lung diseases (such as asthmatics), children, and older adults. Secondary standards set limits to protect public welfare, including protection against visibility impairment, damage to animals, crops, vegetation, and buildings.

EPA has set NAAQS for six principal pollutants, which are called “criteria” pollutants. These criteria pollutants include carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate matter less than 10 microns (PM_{10}), particulate matter less than 2.5 microns ($PM_{2.5}$), sulfur dioxide (SO_2) and lead (Pb). If the concentration of one or more criteria pollutants in a geographic area is found to exceed the regulated “threshold” level for one or more of the NAAQS, the area may be classified as a non-attainment area. Areas with concentrations of criteria pollutants that are below the levels established by the NAAQS are considered either attainment or unclassifiable areas.

The study area is located within the Northwest Arkansas Intrastate Air Quality Control Region (40 CFR §81.140). The area is classified as being in attainment for all NAAQS.

The Current Air Data Air Quality Index Summary Report for the Fayetteville, Rogers, Springdale area show that the area had 338 good days and 27 moderate days of air quality in 2016 (EPA 2016). Situated between the cities of Rogers (west) and Eureka Springs (east), Beaver Lake is east of the Fayetteville area in a relatively rural setting with no nearby heavy emissions producing manufacturing or large mining operations. Air in the region is very clean and smog is virtually unknown, and none of the present purposes of the project contribute to air pollution. Other sources of air quality impairment such as open burning are not a problem. Arkansas state laws restrict open burning, which is allowed in only residential areas and for certain controlled agricultural, forestry, wildlife, and industrial activities. The law does not apply to ceremonial fires and campfires.

3.5 Climate*

Located in a subtropical zone, the climate in the Beaver Lake area is relatively mild with normal temperatures ranging from a high of 88°F and low of 27°F. Extreme temperatures rarely exceed 96°F and 13°F. Summers tend to be dry and hot (but not as hot as lower elevations in Arkansas), while winters are fairly wet and mild with daytime temperatures averaging about 55°F. Some short periods of cold weather occur with temperature ranging from 0^o to 10^oF. The highest recorded temperature in Rogers was 114°F (July 1954), and the record low -16°F (February 1996). Relative humidity typically ranges from 41 percent (comfortable) to 91 percent (very humid) over the course of the year, and rarely drops below 24 percent and can reach 100 percent. Air is driest in spring and most humid during the summer.

On average, the area receives 45 inches of rain per year. Precipitation is weakly seasonal, with a bimodal pattern: wet seasons in the spring and fall, and relatively drier summers and winters, but some rain in all months. The spring wet season is more pronounced than fall with the highest rainfall typically occurring in May. Average snowfall for the Beaver area is about 12 inches per year. Snow packs are usually short lived and generally do not contribute to flooding in the spring.

3.6 Geologic Resources

Geological resources are defined as the topography, geology, mining, and soils of a given area. Topography describes the physical characteristics of the land such as slope, elevation, and general surface features. The geology of an area includes bedrock materials and mineral deposits. Mining refers to the extraction of resources (e.g. gravel).

*Topography**

Beaver Lake is situated in the Springfield Plateau that occupies primarily the western and southwestern flanks of the Ozark Plateau province. Land bordering Beaver Lake is typical of the Ozark Highlands, which is characterized by rugged terrain, containing narrow ridges and v-shaped valleys, steep, rocky slopes and bluffs. From a flood control pool elevation of 1130 feet National Geodetic Vertical Datum (NGVD), the Springfield Plateau in this region rises to an elevation of approximately 1400 feet where, in many areas, forms extensive plains.

*Geology**

Three rock formations are present in the Beaver Lake area. These are, in descending order: the Boone formations of Mississippian age and the Cotter and Jefferson City formations of Ordovician age. The Lower Mississippian Boone Formation comprises the surface rock over most of the area and forms the surface of the heavily dissected Springfield Plateau. The Boone Formation consists of gray, fine- to coarse-grained fossiliferous limestone interbedded with chert, and is well known for dissolutional features, such as sinkholes, caves, and enlarged fissures (McFarland 2004). The strata throughout the region are nearly horizontal. One predominant geological feature of the lake area is a low, persistent, limestone bluff, which occurs just above the Ordovician-Mississippian contact.

Karst features do not exhibit a surface expression in many areas of the Springfield Plateau because chert and clay tend to form a regolith cover that mantles the upper surface and masks the underlying karst features. Surface-karst features are generally only visible when carbonate rocks are within the zone of shallow groundwater circulation (i.e., less than 30 feet below land surface). Crinoids are the most common fossil found in the formation, but brachiopods, bryozoa, mollusks, corals, shark material, trilobites, conodonts, and others fossils are known.

Faulting in the Ozarks is generally normal with most faults displaying displacements down on the southern side. Lineaments and faults characteristic of the region are present around Beaver Lake. The Fayetteville Fault lies beneath the lake. This fault is the west side of a graben that has down-dropped the Boone Formation to lake level.

*M*ining

According to the Arkansas Geological Service website, Benton, Boone, Madison, and Washington counties have 134 sand and gravel pits, and crushed and dimension stone quarries that are either active, intermittent, abandoned or reclaimed (AGS 2017). Many of these sites are located in the Beaver Lake watershed, and all are monitored by the Arkansas Department of Environmental Quality to ensure there are no impacts to the surrounding environment.

Besides sand, gravel, and stone, there are several abandoned lead and zinc mines in the area, particularly in Boone County. Mining for lead and zinc occurred from the early 1800's to 1959, with peak outputs coinciding with the Civil War and World War I. None of these sites occur in the Beaver Lake watershed.

One abandoned tripoli mine is documented in Benton County, within the Beaver Lake watershed (AGS 2017). Tripoli mining in northwest Arkansas was continuous between 1929 and 1949. Most production was from horizontal drifts driven into hillsides. Tripoli is a microcrystalline form of quartz (SiO_2). Uses include as an abrasive in polishing, buffing, and burnishing compounds; in scouring soaps and powders; a filler or extender in plastics, rubber, and sealants like caulks and epoxy resins; and a pigment in paints.

There are no oil and gas fields located in northwestern Arkansas. Therefore, they do not present an issue.

*Soils**

In general, the soils of the Ozark Plateaus are residual and are formed on a broad, domed, upwarp consisting mostly of limestone and dolomite. The main difference in the soils is due to different rocks from which the soils were formed. The main geologic materials are cherty limestone; cherty, very siliceous dolomite; cherty, siliceous dolomite; and alluvium, which are weathered and water transported products of the first three materials.

The three rock formations are geologic deposits from past ages. They were continuous layers with the cherty limestone on top. Glade-rock soil occurs where the cherty, very siliceous dolomite is exposed to the soil formation. Dolomite is more resistant to weathering than limestone and siliceous dolomite is even more resistant, so very shallow soil results. In areas where the dolomite is less siliceous, more weathering has taken place; however, the soils produced are not as deep as soils formed by limestone.

The following eight soils associations are found in and around the Beaver project area: Captina-Nixa, Captina-Nixa-Pickwick, Clarksville-Nixa-Baxter, Corydon-Sogn, Enders-Allegheny-Mountainburg, Razort-Captina-Etowah, Linker-Apison-Hector, and Captina-Pembroke.

Prime Farmlands

No prime or unique farmlands as defined by the Council on Environmental Quality are in the area of proposed action.

3.7 Water Resources

Water resources include both surface water and groundwater resources; associated water quality; and floodplains. Surface water includes all lakes, ponds, rivers, streams, impoundments, and wetlands within a defined area or watershed. Subsurface water, commonly referred to as groundwater, is typically found in certain areas known as aquifers. Aquifers are areas with high porosity rock where water can be stored within pore spaces. Water quality describes the chemical and physical composition of water as affected by natural conditions and human activities. Floodplains are relatively flat areas adjacent to rivers, streams, watercourses, bays, or other bodies of water subject to inundations during flood events. A 100-year floodplain is an area that is subject to a one percent chance of flooding in any particular year, or, on average, once every 100 years.

Surface Water

Beaver Lake falls within the Upper White River Hydraulic Unit Code watershed (11010001), located in the western portion of the Upper White River basin. Major tributaries to Beaver Lake include the West Fork, Middle Fork, and Main Fork of the White River; Brush Creek; Richland Creek; and War Eagle Creek.

Wetlands

Wetlands are complex habitats that are transitional from dry land to open water, and they have soil, water, and plant components. Wetlands are defined as those areas inundated or saturated by surface or ground water at a frequency and duration to support a prevalence of vegetation typically adapted for life in saturated soil conditions.

The USACE has not completed a formal wetland inventory to determine the jurisdictional status of wetlands within the Beaver Lake Project area. Therefore, the National Wetland Inventory (NWI) website was utilized to identify potential wetland locations (NWI 2016). Wetlands identified on NWI maps may or may not be considered jurisdictional under Section 404 of the Clean Water Act. There are several classifications of NWI wetlands found within the Beaver Lake Project area. Lacustrine limnetic wetlands (deep water lake habitat) and lacustrine littoral wetlands (shoreline areas) comprise over 95% of the NWI wetland acreage in the project area. Other types of NWI wetlands found within the project area include palustrine forests, palustrine shrub-scrub, and palustrine emergent wetlands. The palustrine wetlands in the project area most often correlate with the upper reaches of tributaries or coves that feed into Beaver Lake such as the upper White River, Prairie Creek, Clifty Creek, and War Eagle Creek. Hydric soil units within the project area are also associated with valleys, floodplains, and other larger tributaries or waterways.

The diverse palustrine wetlands around Beaver Lake provide valuable functional values including water quality improvements such as sediment filtration and contaminant removal, flood storage, shoreline erosion control, and habitat for a variety of fish and wildlife species. Recreational users such as hunters, fishermen, bird watchers, and boaters, benefit directly and indirectly from the intrinsic wetland attributes at Beaver Lake.

Wild and Scenic Rivers

War Eagle Creek from Beaver Lake near Best, upstream to its headwaters near Boston, is listed on the National Rivers Inventory maintained by the National Park Service for potential Wild, Scenic, or Recreational River designations. No preliminary classification has been given to this river yet.

*Groundwater**

Beaver Lake sits over two groundwater aquifers in northwest Arkansas. The lower region of the lake sits over the Ozark aquifer, while the upper portion of the lake and much of the watershed sits over the

Springfield Plateau aquifer. The Springfield Plateau aquifer is widely used throughout northwestern Arkansas. Historically, the aquifer was used extensively for domestic, public-supply, commercial, and industrial purposes. Several towns were sited near areas of large springs, which were frequently used to power grain and lumber mills and to supply residents of the growing population. Because domestic and water-supply systems serving less than 50,000 gal/d are not required to report water use, total use of groundwater from the Springfield Plateau aquifer is unknown. The wider distribution of surface-water systems has largely supplanted use of the Springfield Plateau aquifer as a source of water supply (Kresse et al 2014).

The Ozark aquifer underlies and is generally unconfined below the Springfield Plateau aquifer in the Springfield Plateau and Boston Mountains regions of the Ozarks. Primary use of the Ozark aquifer is for public supply; however the high costs associated with drilling prevent smaller community-supply systems from using the more productive lower Ozark aquifer. While groundwater use from the lower Ozark aquifer is substantial, and some wells have been drilled into the lower Ozark aquifer in recent years, use of the aquifer has decreased.

Generally, groundwater use from the Ozark and Springfield Plateau aquifers is restricted to some small communities and remote, rural residents dependent on well water. Surface-water use has increased dramatically, and the vast majority of the population in northern Arkansas is served by surface water, especially in Benton and Washington Counties (Kresse et al 2014).

Water Quality

Section 305(b) of the Clean Water Act (CWA) requires states to assess the water quality of the waters of the state (both surface and groundwater) and prepare a comprehensive report documenting the water quality, which is to be submitted to the EPA every 2 years. In addition, Section 303(d) of the CWA requires states to prepare a list of impaired waters on which total maximum daily loads (TMDL) or other corrective actions must be implemented. Arkansas Department of Environmental Quality (ADEQ) is the agency in Arkansas responsible for enforcing the water quality standards and preparing the comprehensive report for submittal to EPA. ADEQ has conducted the required statewide water quality assessments for 2010, 2012, and 2014, however at the time this report was prepared, the 2008 303(d) list was the most recent state list of impaired water bodies that had been approved by EPA. Therefore, the results of the 2008 assessment are the only ones considered final; data from subsequent reports are provided for information only.

Surface Water

Water quality is generally good for the multiple uses of Beaver Lake, which include hydroelectric power generation, water supply; recreation, and flood risk management. Because the White River typically carries low amounts of sediment, water in the lake is clear except during heavy rainfall events. However, in recent years, growth in urban development and agricultural activities in the watershed has accelerated clearing of forestland resulting in more erosion and transport of sediment, nutrients and other non-point source containments to the lake. The origin of increased nutrients in the lake is uncertain; however, Arkansas' Non-point Source Pollution Management Program lists agricultural operations (both confined and pasture), rural roads, and mining as potential sources. Other potential

sources include erosion from construction sites, loss of riparian zones, on-site septic system failure, and ineffective or overburdened municipal wastewater treatment plants (Arkanaswater.org 2005).
Water quality varies in the lake since it is a long narrow water body with 449 miles of shoreline and much of the Beaver Lake watershed is upstream of the lake itself. Differences in water quality between the upstream northern portion and downstream southern portion near the dam include:

- Water clarity is typically greater in the downstream portions of the reservoir compared to the upstream portions.
- The trophic state of the lake changes from a eutrophic system in the upstream portions of the lake to a more oligotrophic type system in downstream portions.
- Coinciding with the trophic state of the reservoir, nutrient concentrations and algal populations tend to be highest in the upstream areas and lowest in downstream portions.

ADEQ (2008) classified the upper 1,500 acres of Beaver Lake as impaired on the 303(d) list because of turbidity. Turbidity measurements are used as a surrogate for sediment/siltation, for which there is no numeric water quality standard. According to the 2008 report, excessive turbidity can impact fisheries as well as primary contact uses; both of which are designated uses of Beaver Lake. The Draft 2010 Integrated Water Quality and Monitoring Report (ADEQ 2010) added pathogen indicator bacteria as a contaminant for the same area of Beaver Lake. Surface erosion activities are listed as the probable source for this contaminant as well. The 2012 draft report included the West Fork of the White River and the White River downstream of the West Fork as not supporting the Fisheries Designated Use, due to high turbidity and excessive silt loads (ADEQ 2012).

Groundwater

Groundwater quality resulting from rock/water interaction in the Springfield Plateau aquifer generally is good. The water can be used without treatment as an important source of water supply throughout the Ozarks, although low yields limit its use primarily to domestic supply. Analysis of pH and dissolved solids indicate that the aquifer is well buffered, which is typical of limestone aquifers. Iron concentrations are low throughout the Springfield Plateau aquifer (Kresse et al. 2014). Additionally, the Springfield plateau aquifer has naturally high water hardness, which can present problems related to scaling of plumbing fixtures.

Steep topography and poor soils result in agricultural operations (beef, swine, and poultry) as the dominant land use surrounding Beaver Lake. Nationally, Arkansas is ranked second in poultry production, with the top three counties for agricultural sales located in northwest Arkansas, and pollutants associated with agricultural activities are common contaminants found in the aquifer. A source of human derived contaminants is septic systems, which are the primary means of domestic waste disposal in rural and many suburban areas in the area. The Ozarks are characterized by thin, poorly developed soils that make installation of properly functioning septic systems difficult. Documented contaminants associated with septic systems and agricultural activities include nutrients (especially nitrate), fecal bacteria, and pesticides (Kresse, et al. 2014; Steele and McCalister 1985; Davis, Brahana and Johnston 2000; Knierem, Pennington and Steele 2009).

Sediment problems are frequently found in karst environments associated with urban land-use as a result of denuding the landscape. In addition to facilitating bacterial transport, increased sediment loads can have adverse impacts on karst habitats and processes. In northwest Arkansas, (Gillip 2007) observed large volumes of sediment move through caves near urban centers, where individual storm events deposited up to 3 feet of sediment, adversely impacting cave ecosystems. Fish kills at trout farms in Bella Vista, Rogers, and Springdale were attributed to increased sedimentation and resulting water quality degradation of springs (Kresse, et al. 2014).

3.8 BIOLOGICAL RESOURCES

Vegetation

The area surrounding Beaver Lake is typical Ozark Mountain terrain with steep slopes and hollows. Much of the area adjacent to the lake is forested, with south-facing, cherty slopes occupied by shortleaf pine and hardwood forests, while wetter, north-facing slopes dominated with white oak, northern red oak, chinquapin oak, and sugar maple. Rocky, open glades with exposed limestone or chert are extensive and common, with eastern red cedar dominating the sparse vegetative community (Keeland 1978). Sycamore, black willow, and green ash dominate the shoreline of the lake. One state-listed species of conservation concern, black maple *(Acer saccharum var. nigrum)*, has been documented in the Indian Creek arm of the lake (ANHC 2016).

Prairies on level plateau surfaces with thin soils were once extensive, but almost all have been converted to pasture, cities, and other developed areas. The most extensive prairies extended from Fayetteville to Rogers (Benton County), and also near Harrison (Boone County). These areas have experienced considerable urban growth.

Developed and disturbed areas around Beaver Lake include lawns, old fields, parking lots, roads, swimming beaches, eroded shorelines devoid of vegetation, and other areas. Developed and disturbed habitats are generally not good wildlife habitat, because they lack adequate food, cover, and seclusion from human activities.

Aquatic Resources

The Arkansas Department of Environmental Quality classifies Beaver Lake as a Type “A” water body (larger lakes of several thousand acres in size; watersheds dominated by upland forest; average depth 30 to 60 feet; low primary production/trophic status if in natural unpolluted condition). Low trophic status is mainly due to temperature stratification, which is natural and occurs in many deep reservoirs.

Beaver Lake supports a diverse fish community. Studies have documented about 50 fish species in the lake, including various sportfish species as well as forage, commercial, and rough fishes (Table below). Other species common in the White River and tributaries streams are occasionally found in Beaver Lake. According to the Arkansas Game and Fish Commission, the reservoir is managed as a two-tier sport fishery with both warm water and cool water species. Common warm water sportfish species include largemouth bass, spotted bass, smallmouth bass, white crappie, black crappie, channel catfish, and white bass. Cool water sportfish species include striped bass and smallmouth bass. Striped bass are stocked annually in the reservoir and provide a "put and take" fishery.

Table 3-1: Fish species known to occur in Beaver Lake, Arkansas

Species	Species
Threadfin Shad	Northern Studfish
Mooneye	Blackspotted Topminnow
Rainbow Trout (White R. Below Beaver Dam)	Mosquito Fish
Brown Trout (White River Below Beaver Dam)	Brook Silverside
Northern Pike	White Bass
Grass Carp	Striped Bass
Common Carp	Warmouth
Golden Shiner	Bluegill Sunfish
Striped Shiner	Longear Sunfish
Rosyface Shiner	Redear Sunfish
Steelcolor Shiner	Smallmouth Bass
Quillback	Spotted Bass
Highfin Carpsucker	Largemouth Bass
Northern Hog Sucker	White Crappie
River Redhorse	Black Crappie
Black Redhorse	Greenside Darter
Golden Redhorse	Rainbow Darter
Blue Catfish	Orange Throat Darter
Black Bullhead	Log Perch
Yellow Bullhead	Green Sunfish
Channel Catfish	
Slender Madtom	
Flathead Catfish	

Fish communities in Beaver Lake vary in terms of location and season. During the summers, water temperature and dissolved oxygen levels limit available habitat for striped bass (Johnson, et al 1996). Smallmouth bass are uncommon in the upstream portions of the reservoir, apparently due to the eutrophic conditions. Smallmouth bass are most common in mid-lake portions and downstream areas of the reservoir, and they also thrive in the upper reaches of each of the four main tributaries of Beaver Lake (Bowman 1993). Largemouth bass are present throughout Beaver Lake, but are more abundant in the upstream portions of the lake, as are spotted bass populations.

Aquatic habitats in Beaver Lake include littoral (shoreline), deep-water, and pelagic (open water) areas. Shoreline habitat consists of:

- Shallow sloping mud flats,
- Moderately sloping gravel and cobble banks,
- Sheer vertical limestone cliffs,
- Standing timber (permanently flooded); and
- Vegetated shorelines.

Standing timber is abundant in many coves and occurs to a lesser extent along shorelines and points. Shoreline vegetation is mostly black willows, which are abundant in some shallow coves and are tolerant of prolonged inundation. Shoreline habitat is important for many fish species throughout the year, particularly during spawning and post spawning periods. State fisheries biologists have said that the best spawns on Beaver Lake take place during high water years when terrestrial vegetation is flooded for an extended period. Flooded vegetation provides cover to help young fish avoid predators. In addition, flooded vegetation provides needed food sources for young fish.

Natural structures in deep water habitats of the lake is limited to submerged trees, brush, rock piles, as well as variations in topography. Since the impoundment of Beaver Lake in 1966, the few remaining submerged native forests have largely decomposed and provide little structure and forage habitat for fish. In response, the Arkansas Game and Fish Commission and the USACE, in cooperation with other state and federal agencies, and local businesses, enhance aquatic habitat by sinking cedar trees throughout the lake for fish cover.

As is the case in many reservoirs, water levels at Beaver Lake change due to flood risk management and hydropower generation, and in some years, lake levels are lower than desired for spawning conditions. To compensate for poor spawning years, the Arkansas Game and Fish Commission constructed the Beaver Lake Nursery Pond on Blackburn Creek. This nursery pond allows biologists to augment native and introduced sportfish populations by providing ideal spawning and rearing habitat. For example, in 2015, the state stocked the pond with more than 400 adult largemouth bass, and in September of 2015, they released over 20,000 5-inch fingerling bass into Beaver Lake.

Construction of the Beaver Lake dam changed the environment in tail-water areas of the White River downstream of the dam. Specifically, water releases from the dam are too cold to support native smallmouth bass and sunfish in tail-water areas. In response, the Arkansas Game and Fish began stocking rainbow trout in 1966 to create a recreational fishery in this new cold water habitat. In 1985, they added brown trout stockings to increase diversity of trout species available to anglers. Today, Beaver Lake tail-waters offer excellent trout fishing that supports a thriving tourism industry. Other fish in tail-water areas include paddlefish and walleye, which are also popular sport fish.

Wildlife

Wildlife watching is a popular activity around Beaver Lake. Black bears are the largest predators in the area; and other mammals abound such as white-tailed deer, raccoon, gray squirrel, opossum, and other mammals. Eastern wild turkeys are also common. Neotropical migrant songbirds are frequently seen during the summer near the lake, where they use a variety of habitats for nesting and brood-rearing. Common songbirds include the prothonotary warbler, painted bunting, Kentucky warbler, worm eating warbler, and Bell's vireo. Raptors such as barred owls, great horned owls, black vultures, turkey vultures, American kestrels, and red-tailed hawks also frequent the lake. Migratory waterfowl such as ring-neck and lesser scaup are common winter residents. Mallards and wood ducks also use the lake and its tributaries as habitats, as well as a growing population of resident Canada geese. Hunting is popular in the area. Important game species include deer, squirrels, turkey, doves, rabbits, and waterfowl.

3.9 THREATENED AND ENDANGERED SPECIES*

Pursuant to the Fish and Wildlife Coordination Act (16 U.S.C. 661-667e), the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d), and the Endangered Species Act (87 Stat. 884, as amended 16 U.S.C. 1531 et seq.), the District consulted the Arkansas Ecological Services Field Office of the U.S. Fish and Wildlife Service on June 30, 2015 and obtained a list of potential threatened and endangered species in the Beaver Lake Project area (Table below).

Table 3-2: Federally Listed Species for the Beaver Lake Project Area.

Common Name	Scientific Name	Status	County(s) of Occurrence
Ozark Cavefish	*Amblyopsis rosae*	Threatened	Benton
Gray bat	*Myotis grisescens*	Endangered	Benton, Carroll, Madison,
Northern long-eared	*Myotis septentrionalis*	Threatened	Benton, Carroll, Madison,
Indiana bat	*Myotis sodalist*	Endangered	Benton, Carroll, Madison,
Ozark Big-eared Bat	*Corynorhinus townsendii ingens*	Endangered	Benton, Carroll, Madison, Washington
Piping Plover	*Charadrius melodus*	Threatened	Benton, Carroll, Madison,
Bald Eagle	*Haliaeetus leucocephalus*	Protected	Benton, Carroll, Madison,
Missouri Bladderpod	*Physaria filiformis*	Threatened	Washington
Neosho Mucket	*Lampsilis rafinesqueana*	Endangered	Benton, Washington

Source: U.S. Fish and Wildlife Service IPAC website and Arkansas Ecological Service Office database

Ozark Cavefish

The Ozark Cavefish (*Amblyopsis rosae*) is a small (about 2 inches in length) pinkish-white fish. It is found in only 14 caves in the Springfield Plateau region of the Ozark Highlands in northwest Arkansas, southeast Missouri, and northeast Oklahoma. Habitat includes dark cave waters, primarily clear upwelling streams with chert or rubble bottom and occasionally pools over silt or sand bottom. This cavefish is known to inhabit a sinkhole in the AGFC nursery pond near Hobbs State Park.

Since it does not have eyes, the cavefish uses sensory organs on its head, body and tail to find food (primarily plankton, crustaceans, and salamanders) by sensing water movement. There is also some evidence that they feed directly on bat guano, but locations with bat guano also contain the highest concentration of other prey. Since the fish relies directly or indirectly on gray bat guano as an energy source, gray bat mortality and cave abandonment can threaten the survival of these small fish. Total numbers are unknown.

Gray Bat

The gray bat (*Myotis grisescens*) is 3 to 4 inches in length and weighs 7 to 16 grams (0.25 to 0.50 ounces). Its fur is gray, but may have a slight reddish cast in the summer. The gray bat is the only *Myotis* with the wing membrane attached to the ankle instead of the base of the toe, and the only bat in its range with dorsal (back) hair that is uniform in color from base to tip.

Gray bats roost almost exclusively in limestone karst caves throughout the year. Colonies occupy a home range that often contains several roosting caves scattered along as much as 43 miles of river or lake shoreline. Individuals forage up to 12 miles from their roosts. Winter roosts are in deep vertical caves with domed halls where temperatures range from 42 to 51 degrees. The species selects hibernation sites where there are multiple entrances and good air flow. Summer cave temperatures range from 57 to 75 degrees, trap warm air, provide restricted rooms or domed ceilings, and are nearly always located within a mile of a river or reservoir. Maternity caves often have a stream flowing through them. There are occasional reports of gray bats roosting in storm sewers, mines, and buildings. Forested areas along the banks of streams and lakes provide important protection for adults and young. Young often feed and take shelter in forest areas near the entrance to cave roosts. They do not feed in areas along rivers or reservoirs where the forest has been cleared (USFWS 2017).

The Pigeon Roost Cave on Beaver Lake is one of eight known caves in a five state area where gray bats are known to reside. It is classified as a bachelor cave and managed as a protected habitat by the Arkansas Game and Fish Commission and Arkansas State Parks. The natural entrance to the cave is located along the shore of the lake and is occasionally flooded when the elevation of the lake reaches into the flood control pool. During construction of Beaver Lake, the Corps excavated new entrance allowing bats to access the cave at all times and all lake water levels.

Northern Long-eared Bat

The northern long-eared bat (*Myotis septentrionalis*) is a medium-sized bat about 3 to 3.7 inches in length with a wingspan of 9 to 10 inches. As its name suggests, this bat is distinguished by its long ears, particularly as compared to other bats in its genus, *Myotis*, which are actually bats noted for their small ears (*Myotis* means mouse-eared). Northern long-eared bats arrive at the hibernacula in August or September, enter hibernation in October and November, and leave in March or April. During summer, bats typically roost individually or in colonies underneath bark or in cavities or crevices of both live trees and snags, or in caves and mines, switching roosts every 2 to 3 days. They are not partial to certain roost trees, but often select trees that retain bark and form suitable cavities, such as black oak, northern red oak, silver maple, black locust, American beech, sugar maple, sourwood, and shortleaf pine. Bats have also been observed roosting in buildings, barns, park pavilions, sheds, cabins, under eaves of buildings, behind window shutters, and in human made bat houses. Bats roost more often on upper and middle slopes, and migrate between 35 to 55 miles between summer roosts and winter hibernaculum. They commonly overwinter in caves and abandoned mines, which have large passages and entrances and relatively constant cool temperatures, high humidity, and little or no air currents. They have been found hibernating in abandoned railroad tunnels, storm sewer entrances, hydro-electric dam facilities, old aqueducts, and dry wells. Bats may use the same hibernaculum site for multiple years. The bat has a diverse diet of insects such as moths, flies, leafhoppers, caddisflies, and beetles (USFWS 2017).

The USFWS IPAC website lists the northern long-eared bat for the four counties surrounding Beaver Lake. They have not been documented in the Beaver Lake Project Area, however they have been captured in the broader area of northwest Arkansas. Additionally, several hibernacula are near, but not in the project area.

Indiana Bat
Indiana bats (*Myotis sodalis*) are small, weighing only one-quarter of an ounce, with a wingspan of 9 to 11 inches. Their fur is dark-brown to black.

Indiana bats live in forested wetlands and riparian habitats such as hardwood and mixed forest woodlands. In the summer and fall, colonies roost in dead or dying trees, or in tree cavities exposed to direct sunlight on wooded or semi-wooded areas near the hibernacula. Roost tree species include elm, oak, beech, hickory, maple, ash, sassafras, birch, sycamore, locust, cottonwood, and pine, especially when these trees have exfoliating bark. Indiana bats use the same roost sites in successive summers. Indiana bats hibernate in the coldest (40 to 46 degrees) parts of limestone caves with pools and shallow passageways.

The bats typically prey on flying insects, and forage along river and lake shorelines, in the crowns of trees in floodplains, and in upland forest. They forage in riparian areas, upland forests, and above ponds and fields. The foraging habitat for an Indiana bat includes an airspace 6-100 feet above a stream and a linear distance of 0.5 mile.

The USFWS IPAC website lists the Indiana bat for the four counties surrounding Beaver Lake. Similar to northern long-eared bats, Indiana bats have not been documented in the Beaver Lake Project area.

Ozark Big-eared Bat
The Ozark big-eared bat (*Corynorhinus townsendii ingens*) is a medium sized bat with a total body length of 98 mm and weighs between 7 and 12 grams. Their distinctive long ears give them their name. They also have mitten-shaped facial glands on either side of their snout. Fur color ranges from light to dark brown depending on age and subspecies.

Ozark big-eared bats are found primarily in the karst area of Arkansas. They inhabit caves year round, and often use the same cave during the summer and winter. These bats select caves that are surrounded by mature hardwood forest of hickory, beech, and maple, and forage along edge habitats of intermittent streams and mountain slopes. During the active season, Ozark big-eared bats emerge from caves about 45 minutes after sunset and do not return until sunrise. In winter, they usually hibernate near cave entrances just beyond the twilight zone.

The USFWS IPAC website lists the Ozark Big-eared bat for the four counties surrounding Beaver Lake. They have not been documented in the Beaver Lake Project Area.

Piping Plover
Piping plovers are migratory shorebirds that breed in North America in three geographic regions: the Atlantic Coast, Northern Great Plains, and Great Lakes. They are small and stocky, with a light brown upper-body, a white underside and orange legs. During the breeding season, adults have a black forehead and breast band and an orange and black bill.

Plovers from all three breeding populations winter along coastal beaches and barrier islands from North Carolina to Texas, the eastern coast of Mexico, and on Caribbean islands. They migrate to their nesting grounds in mid-April and depart mid-July to late August. During fall and spring, plovers use rest sites along the migration pathway including shorelines of reservoirs/man-made lakes, industrial ponds/fish farm ponds, rivers, marsh/wetlands, and natural lakes. These stopover sites are highly influenced by local water levels, and tend to consist of locations with muddy/sandy substrates. Plovers do not concentrate in large numbers at inland stopover sites; instead, they stay for just a few days and then move on. They do not use the same stopover sites between years.

The USFWS IPAC website lists the piping plover for the four counties surrounding Beaver Lake. They have not been documented in the Beaver Lake Project Area.

Bald Eagle
The bald eagle (*Haliaeetus leucocephalus*) is one of America's great conservation success stories. On June 28, 2007 the Department of Interior took the bald eagle off the Federal List of Endangered and Threatened Species because recovery goals had been achieved. Bald eagles frequent Beaver Lake, especially during winter months. As many as 229 bald eagles have been reported in lake surveys. While no longer listed as threatened or endangered, bald eagle protection continues under the federal Bald and Golden Eagle Protection Act and Migratory Bird Treaty Act.

Missouri Bladderpod
The Missouri bladderpod (*Physaria filiformis*) is a small annual plant between 4 to 8 inches tall, with many slender stems that grow from a cluster of leaves at the base. Tiny hairs cover the stems and leaves giving the plant a silvery color. Missouri bladderpod blooms from April to May with clusters of yellow flowers at the top of the stems. Seeds germinate in the fall and overwinter as tiny rosettes, which look like clusters of leaves on the ground.

Open limestone, dolomite, and shale glades (naturally dry, treeless areas with shallow, loose soil and large stretches of exposed rock) are the primary natural habitat of the Missouri bladderpod. Human development, overgrazing, and encroach of woody plants and non-native species are threatening these habitats. The plant cannot compete with other plants and relies on natural disturbances such as fire to keep the glades open of trees and shrubs. Aggressive control of wildfires in recent decades has resulted in many glades becoming overgrown.

Today, Missouri bladderpod grows in about 60 sites in Arkansas and Missouri. In 1987, when the species was listed endangered, only 9 sites where known-four in Missouri and three in Arkansas (NatureServe 2016). One Missouri bladderpod population grows in the Beaver Lake Project area. In addition to listed species, U.S. Fish and Wildlife Service reports that there are four designated karst recharge zones exist in the project area. Karst regions have unique surface and underground hydrologic features. Given that the true extent of the underground environment is difficult to clearly delineate, undiscovered karst features; such as cave openings, sinkholes, and underground passages may occur on or near the project site. U.S. Fish and Wildlife recommends that the Corps considers the effect of water reallocation on endangered species as well as on the hydrology of the karst recharge zones.

Neosho Mucket

The USFWS IPAC website lists the Neosho mucket for Benton and Washington counties. However, in Arkansas, it is only found within the Illinois River, thus not in the Beaver Lake Project Area.

Species of Special Concern

The Arkansas Natural Heritage Commission database lists 31 Species of Conservation Concern along the Beaver Lake shoreline (Table 3-4 below). The State of Arkansas works with what they term rare plants and animals or more specifically, species of conservation concern. These are native plants and animals that are at-risk due to declining population trends, threats to their habitats, restricted distribution, and or other factors. Listing as a species of concern is based on Arkansas's status ranking, and is not a statutory or regulatory designation under federal, state or local law.

Table 3-3: Species of Conservation Concern in the Beaver Lake Project Area

Scientific Name	Common Name	Federal Status	State Status	Global Rank	State Rank
Valerianella ozarkana	Ozark corn salad	-	INV	G3	S3
Arabis hirsuta var.	hairy rockcress	-	INV	G5T4Q	S1?
Festuca versuta	Texas fescue	-	INV	G3	S1
Physaria filiformis	Missouri bladderpod	LT	INV	G3	S1
Delphinium treleasei	Trelease's larkspur	-	INV	G3	S3
Elymus glaucus ssp.	Mackenzie's blue	-	INV	G5TNR	S1
Elymus riparius	river-bank wild rye	-	INV	G5	S1S2
Phlox amplifolia	broad-leaf phlox	-	INV	G3G5	S1
Phlox bifida	sand phlox	-	INV	G5?	S3
Perideridia Americana	American squaw-	-	INV	G4	S2
Argyrochosma	powdery cloak fern	-	INV	G4G5	S2
Veratrum woodii	Wood's false	-	INV	G5	S3
Acer saccharum var.	black maple	-	INV	G5T5	S1S2
Symphyotrichum	silvery aster	-	INV	G5	S2
Ulmus thomasii	rock elm	-	INV	G5	S2
Liatris punctata var.	dotted gayfeather	-	INV	G5T5	S2
Gastrocopta	a land snail	-	INV	G3G4	S2
Heterosternuta	Sulphur Springs	-	INV	G1?	S1?
Caecidotea steevesi	an isopod	-	INV	G3G4	S1
Caecidotea	an isopod	-	INV	G3G4	S3
Caecidotea	bat cave isopod	-	INV	G2G3	S2
Stygobromus	Ozark cave	-	INV	G4	S2
Plethodon	Ozark zigzag	-	INV	G4	S3
Eurycea spelaea	grotto salamander	-	INV	G4	S3
Lithobates sylvaticus	wood frog	-	INV	G5	S3
Pantherophis emoryi	Great Plains rat	-	INV	G5	S3
Etheostoma	autumn darter	-	INV	G4	S3
Amblyopsis rosae	Ozark cavefish	LT	SE	G3	S1

Haliaeetus	Bald Eagle	-	INV	G5	S3B,S4N
Colonial nesting site,		-	INV	GNR	SNR
Myotis grisescens	gray bat	LE	SE	G3	S2S3
Myotis septentrionalis	northern long-eared	LT	SE	G1G2	S1S2

FEDERAL STATUS CODES

LE = Listed Endangered; the U.S. Fish and Wildlife Service has listed this species as endangered under the Endangered Species Act.

STATE STATUS CODES

INV = Inventory Element; The Arkansas Natural Heritage Commission is currently conducting active inventory work on these elements. Available data suggests these elements are of conservation concern. These elements may include outstanding examples of Natural Communities, colonial bird nesting sites, outstanding scenic and geologic features as well as plants and animals, which, according to current information, may be rare, peripheral, or of an undetermined status in the state. The ANHC is gathering detailed location information on these elements.

GLOBAL RANKS

G3 = Vulnerable globally. At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.

G4 = Apparently secure globally. Uncommon but not rare; some cause for long-term concern due to declines or other factors.

G5 = Secure globally. Common, widespread and abundant.

T-RANKS= T subranks are given to global ranks when a subspecies, variety, or race is considered at the state level. The subrank is made up of a "T" plus a number or letter (1, 2, 3, 4, 5, H, U, X) with the same ranking rules as a full species.

3.10 Hazardous, Toxic, and Radioactive Wastes*

A review of the Arkansas Department of Environmental Quality (ADEQ) Hazardous Waste website and consultation with ADEQ staff indicates that there are no hazardous wastes or fuels, or any Arkansas Remedial Action Trust Fund Act (RAFTA) cleanup sites in the project area that would affect Beaver Lake.

3.11 Noise

Noise levels in and around the Beaver Lake Project are typical of those normally found in areas where water recreation takes places (i.e., noises from boats, jet skis and other recreational vehicles and equipment). Levels at Beaver Lake are not excessive.

3.12 Cultural Resources*

Over the past 70 years, archaeologists have carried out several phases of investigation in the Beaver Lake area. In 1922 and 1923, Mark R. Harrington of the Phillip Academy was the first archeologist to excavate sites in the area of what is now Beaver Lake. Mr. Harrington excavated 13 bluff shelters. Between 1928 and 1935, S.C. Dellinger of the University of Arkansas Museum continued the work of Harrington, and supervised the excavation of 21 rock shelters. In the early 1960s, several archeologists from the University of Arkansas conducted more surveys. Today, according to Arkansas Historic Preservation Program data, there are over 375 recorded cultural resources located within or along the shoreline of Beaver Lake including bluff shelters, prehistoric and historic archaeological sites, cemeteries and historic properties.

3.13 SOCIOECONOMIC AND ENVIRONMENTAL JUSTICE*

Socioeconomics is defined as the basic attributes and resources associated with the human environment, particularly population, demographics, and economic development. Demographics entail population characteristics and include data pertaining to race, gender, income, housing, poverty status, and educational attainment. Economic development or activity typically includes employment, wages, business patterns, an area's industrial base, and its economic growth.

The area of analysis includes counties adjacent to Beaver Lake where the water providers requesting allocations operate water systems (Benton, Boone, Carroll, Madison and Washington counties), and other counties that make up a at least a portion of the Upper White River Basin (both in Missouri and Arkansas). In addition, to the above counties, these include: Barry, Christian, Douglas, Greene, Madison, Marion, Taney and Webster.

<u>Population</u>

Data from the 2010 Census, the U.S. Bureau of Labor Statistics, and the 2014 American Community Survey for population, employment, were used to summarize socioeconomic conditions in the Project area. The table below shows 2014 population, 2010 population density, and net migration rates for each county in the area. With the exception of Benton, Greene, and Washington counties, the study area is largely rural. Near term growth in most counties is positive and more or less in line with state and national average rates; however, population in Douglas County, Missouri has declined slightly since the 2010 Census. With overall increases approaching 10 percent over the last four years, the fastest growing counties include Benton (Arkansas), Washington (Arkansas), and Christian. Benton and Washington counties host one of the three Project sponsors (Benton Washington County Water District). Population density ranges from 16 persons per square mile in Douglas County, Missouri to 356 in Greene County, Missouri.

Table 3-4: Existing Population Levels and Trends in Project Area

Region or county	2010 Population	2014 Population	Population percent change (2010-2013)	Population density (persons per square mile)
United States	308,745,53	318,857,05	3.3%	35
State of Arkansas	2,872,684	2,933,369	2.1%	51
State of Missouri	2,915,918	2,966,369	1.7%	87
Barry (Missouri)	35,597	35,662	0.2%	44
Benton (Arkansas)[a]	221,339	242,321	9.5%	181

Boone (Arkansas) [a]	36,903	37,196	0.8%	57
Carroll (Arkansas)[a]	27,446	27,744	1.1%	40
Christian (Missouri)	74,422	82,101	10.3%	96
Douglas (Missouri)	13,684	13,546	-1.0%	16
Greene (Missouri)	275,174	285,865	3.9%	356
Madison (Arkansas)[a]	15,717	15,740	0.1%	17
Marion (Missouri)	28,781	28,920	0.5%	65
Taney (Missouri)	51,675	52,412	1.4%	24
Washington	203,065	220,792	8.7%	83
Webster (Missouri)	36,202	36,888	1.9%	52
Total project area	1,020,005	1,079,187	5.8%	84

[a] Indicates that a county hosts water systems served by project sponsors.

Source: U.S. Census Bureau: 2013 American Community Survey. Accessed online: August, 2015.

Economy and Employment

Key income indicators (per capita income and median household income) for counties in the Project area vary with lower values characteristic of rural counties and higher values for urban counties (Table below). Average per capita income weighted by population for the entire basin is $23,750 and the median household income is $46,605, both of which are lower than national figures (16 and 12 percent respectively); however both figures are comparable to state level per capita and household income. Earnings in counties supplied by Project sponsors are generally close to state figures, and median household income in Boone and Benton counties is considerably higher than the state value. Douglass County, Missouri is the only county where income measures are significantly lower than statewide figures. The distribution of employment by occupation category in most counties tends to follow national and state allotments. In counties adjacent to Beaver Lake, tourism and recreation is also an important part of local economies.

Table 3-5: Existing Employment and Income in Project Area

County	Per capita income	Median household income	Total civilian workforce	Management, business, science, and arts	Natural resources, construction, and maintenance	Production and transportation	Sales and office workers	Service
United States	$28,155	$53,046	141,864,697	51,341,226	25,645,065	34,957,520	12,863,316	17,057,570
State of Arkansas	$23,045	$39,633	1,245,432	388,270	214,286	300,168	135,496	207,212
State of Missouri	$25,649	$59,527	2,770,617	956,605	498,458	696,630	247,212	371,712
Barry (Missouri)	$19,489	$38,710	14,297	3,923	1,764	3,708	2,931	1,971
Benton	$26,715	$61,706	103,176	35,624	8,887	16,879	27,044	14,742
Boone	$22,160	$47,585	88,035	40,794	5,235	6,626	20,867	14,513
Carroll	$20,637	$36,584	11,843	2,987	1,557	2,965	2,303	2,031
Christian	$25,134	$52,838	37,289	13,403	3,260	4,376	10,028	6,222
Douglas	$16,404	$32,130	4,924	1,062	951	1,018	1,240	653
Greene	$23,520	$40,337	132,328	44,998	9,714	15,500	36,225	25,891
Madison	$18,754	$43,737	6,474	1,622	1,056	1,608	1,304	884
Marion	$21,909	$42,046	12,881	3,910	1,067	2,562	2,789	2,553
Taney	$20,231	$38,461	22,601	5,299	1,861	1,736	7,093	6,612
Washington	$23,264	$41,248	99,115	34,172	17,131	24,353	9,012	14,447
Webster	$19,955	$50,033	14,347	3,555	2,171	2,631	3,525	2,465
Total project area	$23,570	$46,605	547,310	191,349	54,654	83,962	124,361	92,984

[a] Indicates that a county hosts water systems served by project sponsors.

Source: U.S. Census Bureau: 2013 American Community Survey. Accessed online: 18 August, 2015.

Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations*, addresses potential disproportionate human health and environmental impacts that a project may have on minority or low-income communities. The impetus behind environmental justice is to ensure that all communities, including minority, low-income or federally recognized tribes, live in a safe and healthful environment and that no group of people including racial, ethnic, or socioeconomic, should bear a disproportionate share of the negative consequences resulting from the execution of federal, state, local, and tribal programs and policies. The goal of fair treatment is not to shift risks among populations, but to identify potential disproportionately high and adverse effects and identify alternatives that may mitigate these effects. Thus, the environmental effects of the Project on minority and low-income communities or Native American populations must be disclosed, and agencies must evaluate projects to ensure that they do not disproportionally impact any such community. If such impacts are identified, appropriate mitigation measures must be implemented.

To determine whether a project has a disproportionate effect on potential environmental justice communities (i.e., minority or low income population), the demographics of an affected population within the vicinity of the Project must be considered in the context of the overall region. Guidance from the Council on Environmental Quality (CEQ) states that "minority populations should be identified where either: (1) the minority population of the affected areas exceeds 50 percent, or (b) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis (CEQ 1997)."

The Table below also displays the number of children adjacent to Project areas. The purpose of the data is to assess whether the project disproportionally affects the health or safety risks to children as specified by Executive Order (E.O.) 13045 - *Protection of Children from Environmental Health Risks and Safety Risks* (1997). Overall, it does not appear that the Project would disproportionally affect children.

Table 3-6: Racial Composition, Number of Children and Poverty Indictors in the Upper White River Basin

Region	White	Black or African American	Native American or Indian	Asian	Native Hawaiian or Pacific Islander	Hispanic or Latino	Other or two or more races	Percent Unemployed	Percent of population below poverty line	Percent of population under age 17
United States	56.10	12.6	0.9	4.8	0.2	16.3	9.1	6.2	15.4	23.7
State of Arkansas	70.60	15.40	0.80	1.20	0.20	6.40	5.40	5.1	15.8	24.2
State of Missouri	79.30	11.60	0.50	1.60	0.10	3.50	3.40	5.6	15.5	23.5
Barry (Missouri)	84.40	0.30	0.90	1.30	0.00	7.70	5.4	8.0	19.1	24.0
Benton (Arkansas)	63.70	1.30	0.90	2.70	0.10	18.70	12.60	3.6	12.2	18.0
Boone (Arkansas)	94.70	0.20	0.70	0.40	0.10	1.80	2.10	5.2	16.6	23.0
Carroll (Arkansas)	76.90	0.40	0.90	0.60	0.10	12.70	8.40	4.5	18.8	22.4
Christian (Missouri)	93.20	0.60	0.60	0.50	0.10	2.50	2.50	5.1	10.6	23.9
Douglas (Missouri)	96.30	0.20	0.60	0.20	0.00	0.80	1.90	5.4	22.6	22.0
Greene (Missouri)	88.20	2.90	0.70	1.60	0.10	3.00	3.50	5.4	18.7	21.2
Madison (Arkansas)	88.80	0.20	1.20	0.50	0.10	4.80	4.40	5.6	18.0	24.2
Marion (Missouri)	95.30	0.20	0.70	0.20	0.00	1.70	1.90	4.4	16.2	23.6
Taney (Missouri)	85.90	0.90	0.80	0.70	0.10	7.70	3.90	7.1	18.8	21.8
Washington (Arkansas)	64.80	3.00	2.00	2.20	2.00	15.10	10.90	5.0	20.7	25.2
Webster (Missouri)	94.60	0.90	0.70	0.20	0.00	1.70	1.90	4.7	18.9	30.8
Total Project Area	78.51	1.83	1.03	1.65	0.48	9.47	7.04	5.0	17.0	22.7

3.14 RECREATION*

Given the scenic and natural beauty of northwest Arkansas, Beaver Lake is a popular recreation venue for instate and out of state visitors. On average from 1999 through 2012, about 2.5 million people visited the lake for at least one day (Table below). Beaver Lake has a variety of recreational facilities (Table below). Paved access roads wind through 11 developed parks with 681 campsites. Other facilities include swimming beaches, hiking trails, boat launching ramps, sanitary dump stations, and picnic shelters. Seven parks contain year-around commercial marinas, which offer grocery items, fuel, boat rental and storage, fishing guides and other supplies and related services.

Table 3-7: Annual Number of Visitors Beaver Lake AR (1999 -2012)

Year	No. of visitors
1999	2,388,827
2000	2,826,853
2001	2,909,192
2002	2,998,615
2003	3,763,057
2004	5,168,720
2005	3,144,639
2006	2,724,809
2007	3,151,898
2008	2,470,292
2009	2,572,053
2010	2,749,764
2011	2,366,977
2012	2,457,662
Average (1999 through 2012)	2,978,097

Source: U.S. Army Corps of Engineers, Little Rock District

Table 3-8: Recreation Facilities at Beaver Lake, AR

Facilities	Number of sites
Recreation sites	28
Picnic sites	174
Camping sites	681
Playgrounds	19
Swimming areas	12
Trails	21
Trail miles	26
Fishing docks	1

Boat ramps	20
Marina slips	1,799

Source: U.S. Army Corps of Engineers, Little Rock District

Accounting for almost one half of reported activities, water sports (swimming, boating, skiing and fishing) are popular at Beaver (Figure below). There are 20 boat launches, and the lake is a popular destination for anglers seeking largemouth and smallmouth bass, crappie, bream, striped bass, and catfish.

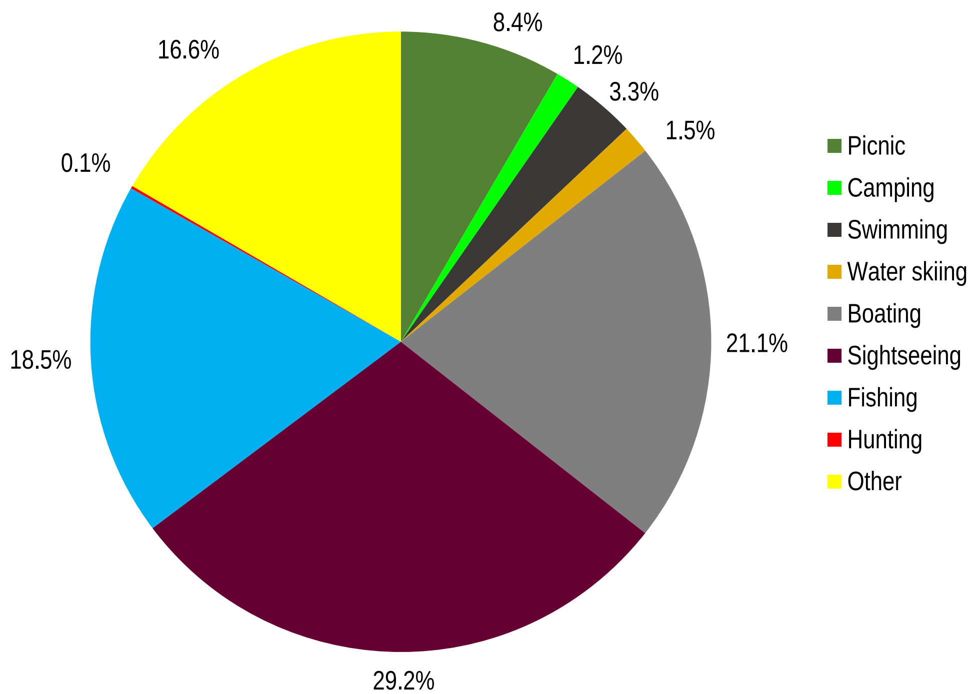


Figure 3-2: Distribution of Visitor Activities at Beaver Lake

Hunting is also a popular sport in the Beaver Lake vicinity. A mixture of hardwood and evergreen forest provides a good home to many different species of wildlife. Sportsmen and women can find many remote areas where they can hunt various types of upland game animals such as white-tailed deer, eastern wild turkey, rabbits and squirrels.

In addition to fishing and hunting, many other sports and activities abound. Boating, swimming, camping, picnicking, scuba diving, water skiing and sightseeing are just a few of the recreational opportunities available at or near Beaver Lake.

Recreation at the lake has substantial impact to local economies based on surveys of visitor spending and attendance at Corps projects. Based on 2012 data, roughly 2.45 million people visited Beaver Lake, and spent $84.7 million in local economies within 30 miles of the lake in 2012. This spending generated $65.6 million in business sales revenue, and supported about 955 full and part time jobs with $17.1 million in labor income.

3.15 TRANSPORTATION*

The primary transportation system at Beaver Lake serves visitors and workers driving to and from recreation and service areas. The road system, maintained by counties and the state, is primarily a low-standard paved road, although some roads are unpaved. Public access to the park requires a road system, although once visitors reach the park, designated parking areas are available from which miles of trails can be accessed. Nearby residents can access the park via foot or bike. Several state highways and county roads access the lake (Table below). The primary access roads to the shoreline are State Highways 187, 127 and 12.

Table 3-9: Access Roads to the Beaver Lake Shoreline

Gateway Towns	Lake Access Road
Lowell	SH 264
Pilgrims Rest and Blue Springs	SH 95, SH 502 and SH 507
Bethel Heights	SH 264
Rogers and Prairie Creek	SH 12
Avoca	CR 74 and CR 1751
Garfield	CR 99, SH, CR 1717, and CR 1720
Clantonville	CR 89
Busch and Holiday Springs	SH187

Source: U.S. Army Corps of Engineers Little Rock District

3.16 ECONOMIC CONSIDERATIONS

The region of economic impact consists of counties in the northwest portion of the State of Arkansas. Given population data, average per capita daily usage, and peaking factors, current and future water demand can be estimated for BWRPWA and CBWD. Estimated future water demands for MCRWD are outlined below. For this evaluation, the water demand (*See* Appendix A) for BWRPWA and CBWD is strictly based on population growth.

Population forecasts are presented in the tables below.

Table 3-10: BWRPWA Population Forecast

County	2013 Population	Annual Growth Rate			2043 Population		
		Low	Mid	High	Low	Mid	High
Benton	236,965	0.29%	1.90%	3.47%	255,716	371,741	487,765
Washington	214,867	-0.65%	1.28%	3.16%	171,203	297,155	423,107

Table 3-11: CBWD Population Forecast

County	2013 Population	Annual Growth Rate			2043 Population		
		Low	Mid	High	Low	Mid	High
Boone	37,513	-1.47%	0.30%	2.03%	20,599	40,928	61,256
Carroll	27,711	-1.83%	0.23%	2.22%	12,274	29,644	47,015

Table 3-12: MCRWD Population Forecast

	Current Population	Annual Growth Rate			2043 Population		
		Low	Mid	High	Low	Mid	High
Population Served	14,626	0.49%	0.97%	1.43%	16,947	19,540	22,386
Poultry Population	8,871,383	1.49%	2.98%	4.52%	15,108,746	25,554,929	43,568,215
Growth in Users	3,540	0.49%	0.97%	1.43%	4,102	4,730	5,418

Population data and associated projections were provided by the Institute for Economic Advancement (IEA) at the University of Arkansas, Little Rock (UALR). Weather data was provided by the National Oceanic and Atmospheric Administration (NOAA) - National Climatic Data Center (NCDC). Estimated impacts to Arkansas from global climate change were factored into the demand projections using the findings of the U.S. National Climate Assessment (2014). Utilizing all the data collected from the Designated Users and other open sources, coefficients were calculated for the variables affecting residential water demand using a multiple regression model. These coefficients were used to complete a demand model for future projections. Non-residential demands were projected through a unit use approach by calculating the rate of use per employee and using employment as the driver.

Wholesale demands were also projected through a unit-use approach by calculating the per person rate of use and using the retail population served by the wholesaler as the driver. Nonrevenue water demand was projected as a percent of the residential and non-residential demands, as reported by the Designated Users.

3.17 REAL ESTATE CONSIDERATIONS

The study team evaluated real estate consideration for this study. The Real Estate Plan outlines the real estate requirements for this study and any impacts. There are no known risks associated with this project due to the fact that there is no land to be acquired. See the Real Estate Plan at Appendix B.

3.18 DAM SAFETY CONSIDERATIONS

A Screening Portfolio Risk Analysis (SPRA) was performed on Beaver Dam in April of 2007 and approved in 2008 giving Beaver Dam a DSAC 4 Rating. The 2007 SPRA classified the dam according to relative risk in order to prioritize funding, investigations, and measures for risk-informed dam safety management. Potential failure modes (PFMs) were identified and engineering assessments were assigned to each PFM and assigned to each dam according to a Dam Safety Action Class (DSAC).

Pursuant to ER-1110-2-1156, DSAC Rating 4 is a Low Risk, Low Urgency rating. Transfers and assignments of existing agreements and new agreements for the reallocation of storage from the existing conservation pool are permitted, provided the reallocation report is approved, all other implementation requirements are completed and the district commander has informed the non-Federal entity in writing of the project's DSAC rating and current status of the dam and reservoir; that the dam will be subject to elevated monitoring and evaluation, that water supply storage may be reduced by Interim Risk Reduction Measures (IRRM) or other remediation, and upon execution of a water storage or water agreement, the non—Federal entity will be required to share in the costs of IRRM and other remediation consistent with current policy.

Recommendations for reallocation that require raising the conservation pool will be considered by HQ USACE on case-by-case basis. Reallocation reports that recommend pool raises must include a review of Potential Failure Mode Analysis (PFMA) for the dam and an analysis of the effect of higher pool elevation on the probability of failure and consequences associated with the changed pool elevation. Pursuant to ER 1110-2-1156, the Regional Dam Safety Center will perform a PFMA if the alternative of water reallocation from the flood pool is not screened out early.

A PFMA was performed in 2011 for the congressionally authorized Beaver Lake Trout Production Water Supply Storage Reallocation Study ("Beaver Trout"). Hydrologic studies indicated that pool changes resulting from the Beaver Trout reallocation would have no effect on pool elevation at extreme floods such as the Probable Maximum Flood and the Infrequent Flood Event (300 year return period). In fact, in the Beaver Trout study, the recommended plan is actually for the water to come from conservation storage – something that would marginally lessen the force on the dam as well as the water elevation.

The Beaver Trout Study was completed; however, due to lack of funding the project was not constructed and was de-authorized in August 2016.

Little Rock District Dam Safety performed a Periodic Assessment (PA) for Beaver Dam in August of 2016. The recommended results of this assessment are to change the DSAC rating for Beaver Dam. The PA team will develop an interim risk reduction plan after the PA is approved by the Dam Safety Oversight Group. One of the interim risk reduction measures (IRRM) under consideration is lowering the lake elevation (lowering flood pool storage). This would have an impact to current conservation pool users including hydropower and current water supply storage contract holders at Beaver Lake. There will not be a change to the DSAC or implemented IRRMs before this study is completed. The lower safety rating is driven by operational factors; and the dam safety team is not concerned about structural risk at this time.

Therefore, the PDT and SWL Dam Safety team have submitted a dam safety exception memorandum to be forwarded to HQ for approval to continue with the reallocation study. See the Dam Safety considerations at Appendix C.

3.19 H&H CONSIDERATIONS

This study investigated the feasibility of storage reallocations in Beaver Lake for water supply storage that would provide an additional firm yield (or dependable yield) of a total reallocation of 22 MGD. The firm yield was established utilizing the inflow created only by the inflow through the drought of record. For Beaver Lake the drought of record was from May 8, 1961 until February 8, 1965. Notably, the worst drought was during construction and accounts for the slow first filling. The design manual used 1952 to 1956 as the drought of record.

Storage volumes for reallocations of the proposed water supply yields were determined. Hydrologic and hydraulic studies were performed to determine, frequency and duration for pool elevation, lake-outflow, river stage, and river discharge for each of the respective reallocation alternatives. The reallocation of storage in Beaver Lake for water supply will provide firm yield (dependable yield) of 12 MGD for Benton-Washington Regional Public Water Authority, 6 MGD for Carroll-Boone Water District, and 4 MGD for Madison County Rural Water Authority. This reallocation will have minimal impact if reallocated from conservation or inactive pool; however, a reallocation from flood pool increases damaging releases and downstream lake elevations during extreme events and is NOT recommended. The full analysis and conclusion is located at Appendix D.

3.20 SUSTAINABILITY OF THE PROJECT – SEDIMENTATION CONSIDERATIONS

The White River above Beaver Lake has a relatively low sediment load, 0.0003 percent of average annual flow, and was estimated at the time of design to be about 350 AF per year. Sediment ranges have been obtained at nine (9) locations since the project was completed in 1966 (filling began in 1963). These ranges were obtained in 1965, 1977, and 1995. In those 30 years only three (3) ranges indicate any measurable deposition. Although the lake is now over 51 years old, there have been no reported sediment problems. Storage in Beaver for sediment is not quantified but listed as one of the project purposes of the inactive pool. The inactive pool contains 726,850 AF of storage below elevation 1,077 ft-NGVD. The maximum probable drawdown is estimated to be 1,075 ft-NVGD, also the lowest rated pool for turbine operation, sometimes referred to as dead pool, is 696,200 AF. Assuming that the sediment accruing in Beaver Lake at the estimated rate of 350 AF per year; then, approximately 5.0 percent of the storage below elevation 1,075 ft-NGVD, or less than 5 percent of the total inactive pool storage would be filled in a 100 year period.   The full H&H considerations for this report can be found at Appendix D.

4.0 FUTURE WITHOUT-PROJECT CONDITION.*

The Future Without-Project Condition (FWOP) is synonymous with the "No Action Alternative" as required under the National Environmental Policy Act (NEPA). The No Action Alternative is the most likely condition expected to occur in the future in the absence of the proposed action or any action alternatives.

The FWOP includes the following assumptions:

- No reallocation of water storage will occur from Beaver Lake, or any other Federally-controlled reservoir.
- Future water demands will require current project sponsors to construct a new water supply reservoir in northwest Arkansas to meet current and future demands.
- The new water supply reservoir would be approximately 5,000 to 10,000 acres in size, in order to provide similar amounts of water being evaluated in this study.

4.1 LAND USE

Construction of a new water supply reservoir would have significant impacts on land use. Depending on location of the reservoir, between 5,000 and 10,000 acres of rural property would have to be acquired, resulting in potential displacement of humans and loss of wildlife habitat (discussed further in subsequent sections below). Inundation of acres would likely impact prime and/or statewide important farmland in the northwest Arkansas area.

4.2 AIR QUALITY

Under the FWOP, air quality within the study area is not anticipated to change from the existing condition and is expected to remain good into the future. Operation of heavy equipment during construction, utilization of transportation vehicles, and other motorized machinery for construction of a new reservoir would generate fugitive dust and emissions of particulate matter (PM), as well as result in the emission of fossil fuel combustion exhausts and the release of nitrogen, oxides of Sulphur, ozone, carbon monoxide, and particulates. Construction emissions, including fugitive dust, would be short-term, lasting only as long as it takes to complete construction. There are no anticipated long-term impacts under the FWOP condition.

Overall, implementation of the FWOP is expected to have minor adverse impacts on air quality but is not expected to impact or contribute to any areas not meeting NAAQS. Construction would be relatively short in duration and limited to a small disturbance area.

4.3 CLIMATE AND CLIMATE CHANGE

Climate change has become a concern due to potential environmental effects, particularly related to water resources. Analysis of climate data from as long ago as 1880, show that the Earth's surface temperature has increased by more than 1.4°F over the past 100 years, with much of the increase taking place over the past 35 years (National Research Council 2012). Warming temperatures are often attributed to an increase in greenhouse gas (GHG) emissions, particularly carbon dioxide, which increased 80 percent between 1970 and 2004 (IPCC 2007).

To model future climate change, scientists utilize various general circulation models (GCM). Climate change analysis becomes more complex for the future than the past because there is not one time-series of climate, but rather many future projections from different GCMs run with a range of carbon dioxide emissions scenarios (IPPC 2007). It is important not to analyze only one GCM for any given emission scenario, but rather to use ensemble analysis to combine the analyses of multiple GCMs and quantify the range of possibilities for future climates under different emissions scenarios. Human population growth and related GHG emissions and changes in land cover have been modeled under various scenarios in order to project future trends for global temperature and precipitation.

Predicted GHG Emissions Changes

In May 2008, the Center for Climate Strategies (CCS) completed a GHG emissions inventory and reference case projection to assist in understanding past, current, and possible future GHG emissions in Arkansas (CCS 2008). The report found that GHG emissions are rising faster than those of the nation as a whole. As is common in many states, the electricity and transportation sectors have the largest emissions, and their emissions are expected to continue to grow faster than in other sectors. As well, the study found that from 2005 to 2025, emissions associated with electricity generation to meet both in-state and out-of-state demand are projected to be the largest contributor to future emissions growth, followed by emissions associated with the transportation sector. Other sources of emissions growth include the residential, commercial, and industrial fuel use sectors, the transmission and distribution of natural gas, and the increasing use of hydrofluorocarbons and perfluorocarbons as substitutes for ozone-depleting substances in refrigeration, air conditioning, and other applications.

In 2008, Arkansas completed a Climate Action Plan with assistance from the CCS. Arkansas' plan focuses exclusively on the reduction of GHG, including a comprehensive set of sector-based policies and measures. Its design is consistent with the national climate proposal passed in the U.S. House of Representatives and supported by the Obama Administration, but includes more specific listings and provisions for specific sector based policies and measures, and was less specific on the design of national market based mechanisms.

Predicted Temperature Changes

The U.S. Global Change Research Program summarized information regarding climate change and its potential effects in regional assessments (USGCRP 2009). Arkansas is part of the Southeast Region, which encompasses a range of natural systems, from the Appalachian Mountains to coastal plains and the Caribbean. The geographic distribution of impacts and vulnerabilities is uneven due to the different systems. Extreme events such as heat waves, droughts, and heavy rainfall events are projected to occur more frequently. Temperatures across the Southeast Region are expected to increase during this century, with shorter-term (year-to-year and decade-to-decade) fluctuations due to natural climate variability (Carter et.al. 2014). Consequences of warming may include significant increases in the number of hot days (95 degrees or more), and decreases in days with freezing temperatures. The U.S. Global Change Research Program predicts that average annual temperatures in the Southeast Region will rise 4 to 8 degrees depending upon the sub region. Increases in the interior states in the Southeast Region are more moderate ranging from 1 to 2 degrees.

Figure 4-1 plots average annual temperature from 1895 through 2016 for north Arkansas Climate Division 1 (NOAA 2016). Data appear to exhibit a cycle of change, where temperatures in the first half of the 20th century were warmer than the second half, but appear to be warming again in the early 21st century.

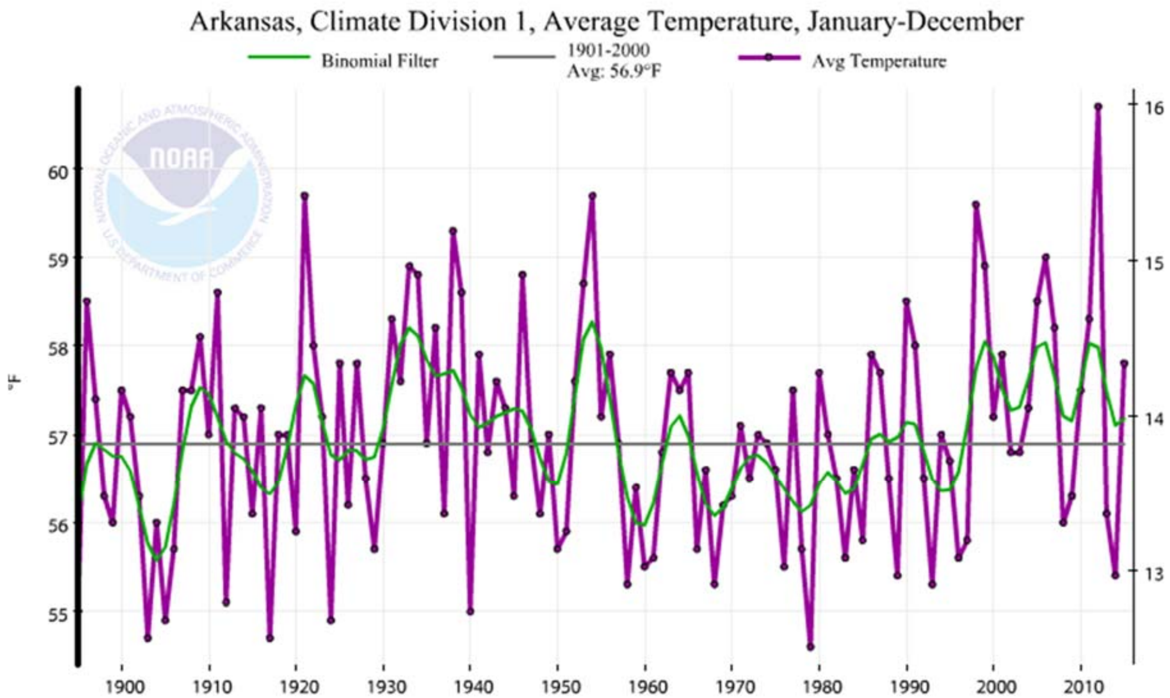


Figure 4-1: Long-term Temperature Variability in Arkansas (1895 through 2016)

Source: National Oceanic and Atmospheric Administration. "State of the Climate: Global Analysis for April 2016." May 2016.

Predicted Precipitation Changes

Global predictions for precipitation changes into the future point to an overall decrease. Projections of future precipitation are much less certain than projected temperature increases. Given that the Southeast is in a transition zone between projected wetter conditions to the north and drier conditions to the southwest, many projections show only small changes, if any, relative to natural variations. For Arkansas, there does not appear to be positive or negative trend in precipitation (Figure 4-2 below).

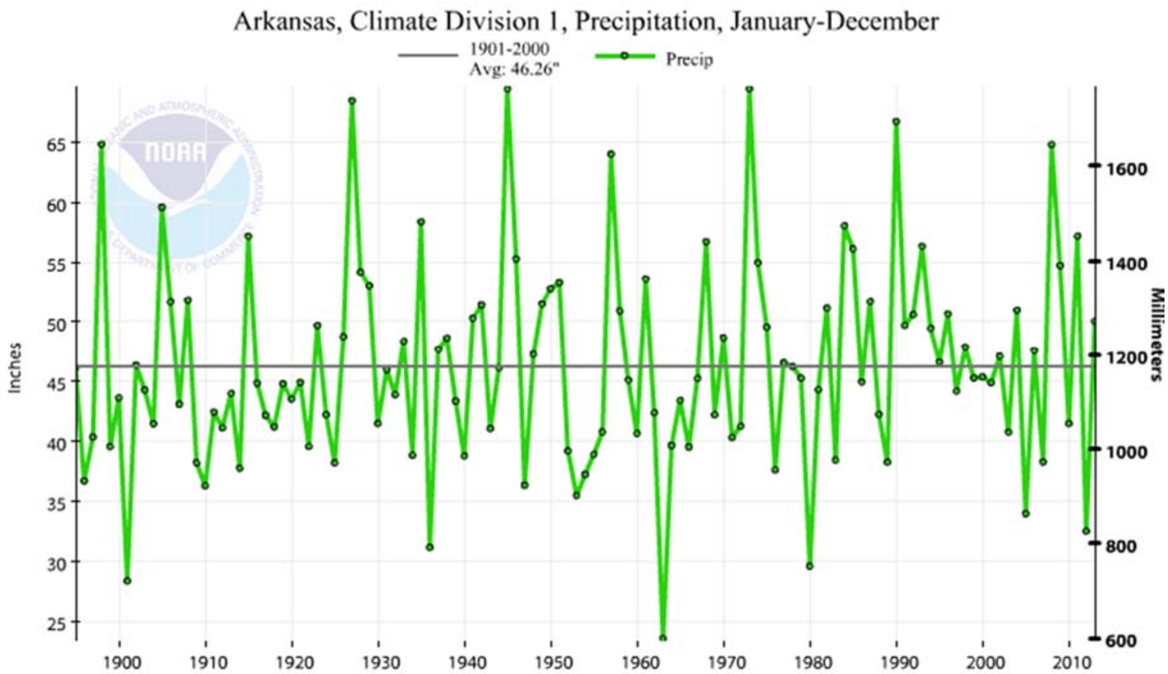


Figure 4-2: Long-term Precipitation Variability in Arkansas (1895 through 2016)

Source: National Oceanic and Atmospheric Administration. "State of the Climate: Global Analysis for April 2016." May 2016.

Extreme Weather Events

The changing climate is likely to increase inland flooding, particularly in communities along major rivers and in the study area. Since 1958, the amount of precipitation falling during heavy rainstorms has increased by 27 percent in the southeast, and the trend toward increasingly heavy rainstorms is likely to continue.

Droughts

Although climate change is likely to increase the risk of flooding, droughts are also likely to become more severe. Droughts are likely to be more severe, because periods without rain will be longer and very hot days will be more frequent. Droughts pose challenges for water management and river transportation. If the spring is unexpectedly dry, reservoirs may have too little water during the summer, resulting in reduced hydropower generation. If droughts become more severe, restrictions in withdrawals for water supply could occur.

Although precipitation in northwest Arkansas occurs year round, the region and the state as a whole is prone to occasional drought. Figure 4-3 below displays time series plots of the Palmer Drought Severity Index (PDSI). The PDSI is based on deviations of precipitation and temperature from normal conditions, and takes into account the time that drought conditions last. With a scale of positive and negative 4, values less than zero indicate drought conditions with a negative 2 indicating moderate drought, a negative 3 severe drought, and a negative 4 extreme drought. Figure 4-3 shows time series plots of PDSI values for northwest Arkansas. The highest negative drought indices occurred in 1902, 1954, 1963, 1981 and 2012. The drought of 1952 through 1956 was the most intense over a 5-year period. The most recent drought took place from 2010 through 2013.

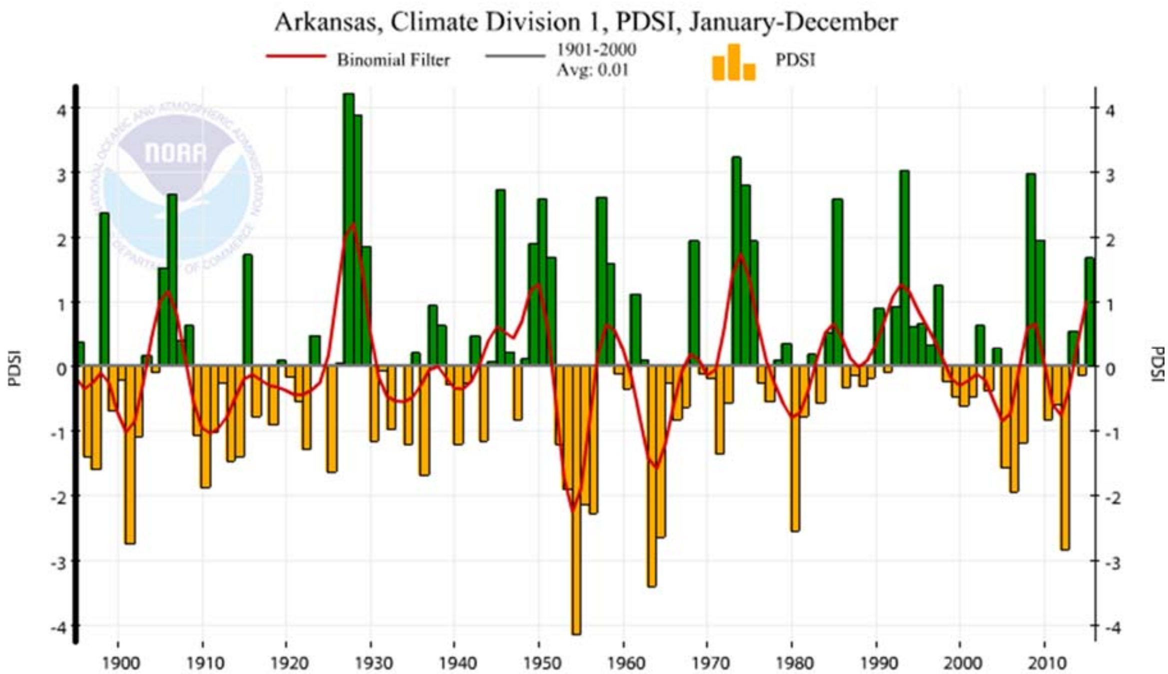


Figure 4-3: Long-term Variability in the Palmer Drought Severity Index, Arkansas (1895 through 2016)

Source: National Oceanic and Atmospheric Administration, National Data Climate Center

4.4 HABITAT CHANGE

Terrestrial Habitats

Higher temperatures and changes in rainfall are unlikely to substantially reduce forest cover in Arkansas, although the composition of those forests may change. Habitats that are drought-tolerant (e.g. glades and barrens, dry upland forests, and open woodlands/savannas) could fare better under future projected climate scenarios. These conditions are projected to cause an increase in the frequency and intensity of wildfires, thus potentially expanding these communities and improving habitat conditions for association of species of greatest conservation need (AGFC 2015).

Changing climate conditions may cause existing tree species to expand northward and be replaced by species from the south. Mesic forests would be more at risk to compositional changes due to drier conditions (AGFC 2015). Some of the species associated with these forests, such as sugar maple, would be expected to decrease (Brandt et al. 2014). The dominance in these communities would shift to more tolerant species, such as sweetgum, white oak, and red maple. Forests in general would experience a reduction in forest productivity, in basal area and canopy cover if trees are stressed by higher temperatures and more droughts. Climate change is also likely to increase the damage from insects and diseases. But longer growing seasons and increased carbon dioxide concentrations could more than offset the losses from those factors (EPA 2016a).

With overall warmer temperatures, conditions would be favorable for more non-native plant species from sub-tropical regions to invade communities (AGFC 2015). This would be especially true in areas where native species decline. Invasive non-native species would be an increased threat to all terrestrial habitats.

Aquatic Habitats
Aquatic systems could see substantial impacts from a changing climate. A reduction in available water, either due to decreased precipitation or increased evapotranspiration, would result in reduced stream flows and altered hydrology under the scenario in which there is a slight decrease in precipitation (AGFC 2015). Under the increase in precipitation scenarios, there would be at a minimum a temporary increase in aquatic habitat where conditions allow.

Warmer air temperatures would result in increased water temperatures and reduced dissolved oxygen. Warmer temperatures can also increase the frequency of algal blooms, which can be harmful and further reduce dissolved oxygen. Summer droughts may amplify these effects, while periods of extreme rainfall can increase the impacts of pollution on streams, such as increased sedimentation, turbidity, nutrient loading and agricultural run-off (EPA 2016a).

4.5 Geologic Resources

Potential exists for some impact to existing or future mining locations under the FWOP scenario, depending on the location of the new reservoir. Similarly, the FWOP would have minor to moderate impacts via inundation of land. Erosion of soils due to land disturbance and removal of vegetation would occur at the dam site, staging area, temporary roads and borrow areas. Soils, and possibly prime farmland soils, would be disturbed and/or inundated with a new reservoir. Construction and operation would also disrupt normal soil and sediment transport in the impounded watercourse, and sediment deposition would occur, mainly within the upper reaches of a new lake. Releases of water from a dam could scour and move existing soils in the channel and floodplain downstream of the dam.

Without knowing the specific area for construction of a new reservoir, it is impossible to estimate the magnitude of resource impacts. Duration of impacts would likely be permanent.

4.6 Water Resources

Surface and Groundwater
Construction of a new reservoir would result in changes to water resources (surface and groundwater) both upstream and downstream of the new dam. A new reservoir would provide more surface water for water supply use, as well as providing increased habitat for aquatic species. Downstream of a reservoir, river dynamics would likely change, particularly alterations in the distribution of runoff. This is caused by the water storage and the exploitation of the reservoir volume for irrigation, production of electricity, or other purposes.

As a general rule, groundwater levels decrease in areas with diverted rivers and increase in the areas close to, and downstream of, reservoirs, but impacts to groundwater are very site specific, and cannot be adequately addressed without knowing the location of a new reservoir.

Wetlands

Under the FWOP scenario, potential exists for impacts to wetlands, depending on the location of a new reservoir. Any impacts to wetlands would be permanent.

4.7 Water Quality

Surface Water

As previously discussed under Geologic Resources, construction of a new reservoir would result in soil disturbance, could impact water quality downstream of the construction site. These impacts would likely be moderate, and of short duration (during construction). Some increase in siltation could occur downstream of the new reservoir, dependent on water releases. These releases could create erosion of downstream streambanks.

Recreational uses in a new lake can add sources of microbial, physical, and chemical contaminants to the drinking water produced from the reservoirs. Since the new lake would be for water supply, water utility decisions regarding permitting recreational uses of water supply reservoirs would likely consider how recreational uses could impact water quality, particularly contact uses such swimming.

Groundwater

Due to the karst nature of the topography in northwest Arkansas, potential exists for some impacts to groundwater quality from the FWOP scenario. Duration and severity of impacts is contingent on the location of the new reservoir, thus cannot be fully evaluated here.

4.8 Biological Resources

While there would be no FWOP impacts to the biological resources surrounding and in Beaver Lake, there could be moderate to major effects on biological resources at the location of the new reservoir. Overall, the most significant of adverse effects would be the inundation of thousands of acres of potential wildlife habitat after the watercourse in question were impounded. It is likely that both timber and agricultural land would be lost. Conversely, beneficial effects would also occur with the creation of new aquatic habitat in the region.

During construction activities, it is anticipated that there would be a temporary decrease in aquatic habitat quality due to increased sedimentation from construction activities. Fish and mussels that do not or cannot avoid the area are susceptible to mortality caused by heavy equipment using the area. Additionally, assuming the new reservoir is constructed on a perineal stream, the entire area upstream of the dam will be converted from a lotic (flowing) system to a lentic (standing water) system. This drastic change in aquatic habitat would almost entirely change the aquatic species utilizing the area. Species dependent on flowing water would have to move to suitable habitat, or perish.

Aquatic habitat downstream of a new dam will likely change as well, contingent on the water temperature and quality that is discharged downstream. Drastic changes, as seen below many Corps reservoirs, has drastically altered native species compositions. Changes in temperature, siltation, etc. would have deleterious impacts to sessile species, such as native mussels. Native warm water fish species may have to relocate, depending on the water temperature below the new dam. These native species may be replaced by cold water species such as trout – as is the case below many Corps lakes.

Construction of the new dam would prevent fish migration upstream and downstream that was accessible under the existing condition.

Construction-related activities are anticipated to impact listed, special status, and non-listed species, if they occur as a resident, migrant or incidental, within or near the project area. Impacts include habitat removal and/or fragmentation from construction, as well as inundation of terrestrial habitat. Other impacts include habitat avoidance because of increased noise, dust generation, and vibrations. Losses of slow moving species (mammals and herptofauna) are anticipated within the new lake basin. Faster moving species are expected to be able to avoid injury or death by relocating to suitable habitat. In general, most wildlife species would become habituated to the on-going work including adapting to the habitat changes; however, species with a low tolerance to activities are anticipated to be displaced. The level and duration of the impacts is dependent on the final design and location of the new reservoir, type of equipment used, duration of construction activities, and plans for restoration activities, if required. However, it is anticipated that once construction is complete, construction-impacts to terrestrial wildlife would cease.

As with any ground-disturbance activity, the probability of introducing, spreading, and/or establishing new populations of invasive, terrestrial non-native species, particularly plant species, exists. Contractors would be required to clean all equipment prior to entering the construction area to avoid the spread of invasive species into the project area. The spread of aquatic non-native species is also a possibility.

4.9 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

While there would be no impacts from hazardous, toxic or radioactive wastes to Beaver Lake by implementation of the FWOP scenario, there could be impacts at the location of the new reservoir. Without knowing the location of the new reservoir, impacts cannot be evaluated. Sponsors of the new reservoir would be required to follow all applicable state and federal laws regarding hazardous, toxic, or radioactive wastes before, during, and after construction. Compliance with all laws and regulations should be sufficient to prevent wastes from entering the environment.

4.10 NOISE

Construction activities associated with the FWOP (new reservoir) would create minor to moderate increases in noise levels, depending on the location of the new reservoir, and its proximity to populated areas. These would be short-term impacts that would end once construction is complete. Recreational activities associated with a new reservoir would increase ambient noise levels, however without knowing the location, and what activities would be allowed, it is impossible to assess potential noise impacts.

4.11 Cultural Resources

While the FWOP condition would not impact cultural resources in and around Beaver Lake, construction of a new reservoir could have major and permanent impacts to cultural resources, due to construction of a new reservoir and associated pump stations and pipelines necessary for water distribution. However, without knowing the specific construction site, it is impossible to assess potential impacts to historic properties or archeological sites.

4.12 H&H CONSIDERATIONS

The FWOP condition would not impact the H&H considerations in and around Beaver Lake. The in-flows and out flows would remain the same. All potential sites analyzed by the study team were outside the White River basin system. The full H&H analysis and conclusion is located at Appendix D.

4.13 SUSTAINABILITY OF THE PROJECT – SEDIMENTATION CONSIDERATIONS

The FWOP condition would not impact the sedimentation considerations in and around Beaver Lake or the White River system. The White River above Beaver Lake has a relatively low sediment load, 0.0003 percent of average annual flow, and was estimated at the time of design to be about 350 AF per year. The full H&H considerations for this report can be found at Appendix D.

4.14 Socioeconomics and Environmental Justice

Socioeconomics

Construction operation of a new water supply reservoir would have positive and negative impacts in terms of socioeconomics. Any property in the reservoir footprint would be lost including any residences, agricultural land or timber tracts, and project sponsors would have to compensate affected land owners and relocate any residences. Market prices based on assessed value of land and structures would determine compensation amounts. Property taxes would no longer be paid on properties covered by the reservoir.

In terms of benefits, expenditures for constructing and operating a new reservoir would generate new economic activity for local communities in the affected region assuming the money came from outside the local economies. Expenditures have multiplier affects and support jobs, income and taxes in local communities. Expenditures can be either short term or long term. Short-term (probably about 3 to 4 years) expenditures end after initial construction outlays for the dam and other facilities. Long-term expenditures associated with dam and facility operation and maintenance would recur over time and would persist over the life of the dam. Another potential benefit of a new lake are new recreation opportunities such as fishing, boating, swimming, hiking and wildlife viewing. Spending associated with recreation would also benefit local communities near the lake assuming people recreating came from outside the local area, or if local residents spent money that they would have otherwise saved or spent outside of the area.

Commercial and residential development along a new lake's shoreline or in areas near the lake would also be a possibility, but as is the case with recreation, water districts owning the land may restrict or prohibit certain development to protect water quality in the lake. If new development did occur, the local economies would likely benefit from new construction activity, and new commercial businesses such as restaurants or marinas would create new jobs, income and tax revenues. Although, new residents and visitors to the local area would place greater demands for public services and infrastructure, more new residents and business activity combined with operations and maintenance expenditures for the lake would grow the local tax base.

Environmental Justice

Environmental justice impacts are assessed in terms of directs effects on overburdened populations (i.e., minorities, Indian tribes, low-income residents, and children) within or adjacent to the study area. Environmental justice impacts would be considered significant if impacts related to the various resource sections analyzed would result in disproportionate impact to the identified populations.

Table 4-1 also displays the number of children adjacent to Project areas. The purpose of the data is to assess whether the project disproportionally affects the health or safety risks to children as specified by Executive Order (E.O.) 13045 - *Protection of Children from Environmental Health Risks and Safety Risks* (1997). Overall, it does not appear that the FWOP would disproportionally affect children.

Table 4-1: Racial Composition, Number of Children and Poverty Indictors in the Upper White River Basin

Region	White	Black or African American	Native American or Indian	Asian	Native Hawaiian or Pacific Islander	Hispanic or Latino	Other or two or more races	Percent Un-employed	Percent of population below poverty line	Percent of population under age 17
United States	56.10	12.6	0.9	4.8	0.2	16.3	9.1	6.2	15.4	23.7
State of Arkansas (AR)	70.60	15.40	0.80	1.20	0.20	6.40	5.40	5.1	15.8	24.2
State of Missouri (MO)	79.30	11.60	0.50	1.60	0.10	3.50	3.40	5.6	15.5	23.5
Barry MO	84.40	0.30	0.90	1.30	0.00	7.70	5.4	8.0	19.1	24.0
Benton AR	63.70	1.30	0.90	2.70	0.10	18.70	12.60	3.6	12.2	18.0
Boone AR	94.70	0.20	0.70	0.40	0.10	1.80	2.10	5.2	16.6	23.0
Carroll AR	76.90	0.40	0.90	0.60	0.10	12.70	8.40	4.5	18.8	22.4
Christian MO	93.20	0.60	0.60	0.50	0.10	2.50	2.50	5.1	10.6	23.9
Douglas MO	96.30	0.20	0.60	0.20	0.00	0.80	1.90	5.4	22.6	22.0
Greene MO	88.20	2.90	0.70	1.60	0.10	3.00	3.50	5.4	18.7	21.2
Madison AR	88.80	0.20	1.20	0.50	0.10	4.80	4.40	5.6	18.0	24.2
Marion MO	95.30	0.20	0.70	0.20	0.00	1.70	1.90	4.4	16.2	23.6
Taney MO	85.90	0.90	0.80	0.70	0.10	7.70	3.90	7.1	18.8	21.8
Washington AR	64.80	3.00	2.00	2.20	2.00	15.10	10.90	5.0	20.7	25.2
Webster MO	94.60	0.90	0.70	0.20	0.00	1.70	1.90	4.7	18.9	30.8
Total Project Area	78.51	1.83	1.03	1.65	0.48	9.47	7.04	5.0	17.0	22.7

Source: U.S. Census Bureau: 2013 American Community Survey. Accessed online: 14 August, 2015.

5.0 PLAN FORMULATION AND EVALUATION OF ALTERNATIVES.

The plan formulation and evaluation of alternatives used for this study and detailed in this section was conducted in accordance with the Planning Guidance Notebook (Engineer Regulation 1105-2-100) and the Corps' Water Supply Handbook. This guidance is based on the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Planning Act (P.L. 89-80) and Executive Order 11747, which was approved by the U.S. Water Resources Council in 1982, and by the President in 1983. A defined six-step process is used to identify and respond to problems and opportunities associated with the Federal objective, and specific state and local concerns. The six step process is as follows:

Step 1: Identify Problems and Opportunities

Step 2: Inventory and Forecast Conditions

Step 3: Formulate Alternative Plans

Step 4: Evaluate Alternative Plans

Step 5: Compare Alternative Plans

Step 6: Select Recommended plan

5.1 PROBLEMS AND OPPORTUNITIES

The existing problem in this study is that there are three (3) water users that have an "immediate need" for water supply storage due to current population growth and growth projected over the course of the next fifty (50) years. A feasible opportunity exists with our water resource, Beaver Lake, to meet the immediate water needs of the three water users: Benton Washington Regional Public Water Authority (BWRPWA or Benton Washington), Carroll Boone Water District (CBWD or Carroll Boone), and Madison County Rural Water Authority (MCRWA or Madison County).

5.2 OBJECTIVE

As outlined in the 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, the Federal objective in water resources planning is to contribute to national economic development (NED) consistent with protecting the Nation's environment.

<u>Objectives</u>

The objective is to determine if there is an economically viable alternative to meet the current and future water supply storage deficiencies utilizing the Beaver Lake's current or increased storage capacity. Objectives must be met in manner consistent with protecting the environment, while adhering to applicable statutes, executive orders and other Federal planning requirements.

5.3 Constraints

The planning process is subject to the limitations imposed by the following general constraints:

- Conformance to USACE policies for the project purpose.
- All applicable Federal laws, regulations, and Executive Orders.
- Public Law 106-53 restricts lowering the conservation pool elevation. Public Law 106-53 (August 17, 1999), states ". . . except that at no time shall the bottom of the conservation pool be at an elevation that is less than 1,076 feet, NGVD."

No other specific planning constraints have been identified for this study that would further limit the planning process. Although there are many factors that may ultimately affect the implementability of a particular alternative and be used throughout the screening process, these do not necessarily qualify as planning constraints.

5.4 Formulation and Evaluation Criteria

An alternative plan consists of a system of structural and/or nonstructural measures, strategies, or programs formulated to meet, fully or partially, the identified study planning objectives subject to the planning constraints. A management measure is a feature or an activity that can be implemented at a specific geographic site to address one or more planning objectives. Management measures are the building blocks of alternative plans and are categorized as structural and nonstructural.

An alternative plan is a set of one or more management measures functioning together to address one or more objectives. In this study, the team will look at combining measures or using stand-alone measures as alternative plans in the formulation process.

5.5 Inventory of Current and Future Conditions

The inventory of current and future conditions is located in different sections of the report and appendices. Current water resources are discussed in Section 3.5 above.

The water currently provided to BWRPWA, CBWD, and MCRWD comes exclusively from Beaver Lake. Residents living in rural areas outside these districts rely on wells for their water. There is a potential for the districts to acquire users from the rural areas; however, there are not any current additions in progress. Conversions from rural to municipal water supply are not included in the demand analysis.

BWRPWA, CBWD, and MCRWD currently have agreements with the government to provide storage with a dependable yield of 4.0, 6.0, and 2.5 mgd through the drought of record. All three designated users' average daily usage is more than the current yield under their agreements. (Table 5.1)

Table 5-1: Average Daily Usage versus Dependable Yield under Agreement by Designated User

Water District	FY 2015 Average Daily Usage (mgd)	Dependable Yield under Agreement
Benton-Washington	8.1	4.0
Carroll-Boone	7.8	6.0
Madison County	3.4	2.5

According to "Estimated Water Use of Water in the United States in 2005," USGS states that the average per capita use for Arkansas is 89 gallons per day for self-supplied water and 99 gallons per day for public-supplied water.

Benton Washington Regional Public Water Authority

Benton Washington is a wholesale water provider serving customers in Benton and Washington counties. They operate a treatment plant with a capacity of 24 mgd with four water storage locations: 12.5 million gallons in Decatur, 5 million gallons in Lincoln, just under 0.9 million in Garfield, and an additional 3.5 million in Centerton. Their distribution system includes about 120 miles of pipeline. Benton Washington also runs a booster pump station in Lincoln, which produces the pressure required to fill Lincoln water storage tanks.

Since 2002, Benton Washington's withdrawals from Beaver Lake have grown at annual compound growth rate of 3.6 percent per year (Figure 1). In 2002, water production totaled 5.5 mgd; and by 2014, production was 8.6 mgd. They currently sell water to 14 communities with a collective population about 93,000 people. Most individual systems served are relatively small and resell water to communities with 25,000 customers or less (average of 6,800 customers). Average per capita use for is 104 gallons per capita day (gpcd) with a range of 60 for the Lost Bridge Water and Sewer District (residential use only) to 512 gpcd for Decatur Waterworks, which provides water to several poultry processing plants.

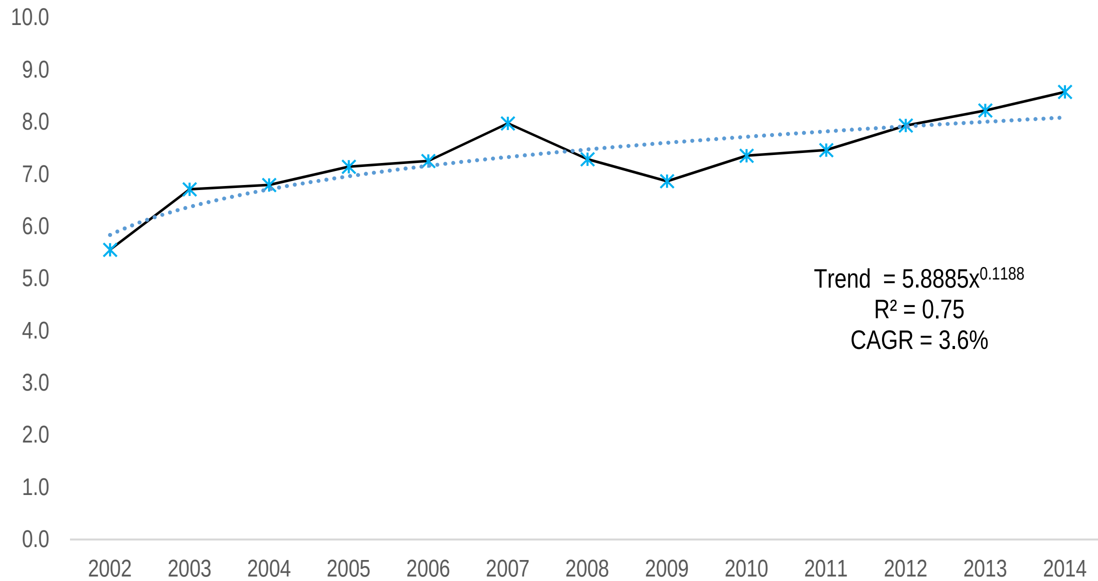


Figure 5-1: Historical Water Production for BWRWA (mgd)

Table 5-2: Benton Washington Regional Public Water Authority Customers (2014)

BWRWA customer	County	Population served	Average daily water use (mgd)	Per capita water use (gpcd)[b]
Benton Co. Water District 1[a]	Benton	5,217	0.54	104
Bella Vista P.O.A	Benton	26,641	2.16	81
Centerton Waterworks	Benton	11,424	0.81	71
Decatur Waterworks	Benton	2,851	1.46	512
Garfield Waterworks	Benton	610	0.04	66
Gateway Public Water Authority	Benton	1,890	0.17	90
Gentry Waterworks	Benton	5,153	0.63	121
Gravette Works	Benton	3,445	0.31	91
Highfill Water Dept.	Benton	1,586	0.17	109
Lost Bridge Village Water and Sewer Districts	Benton	995	0.06	60
Pea Ridge Waterworks	Benton	5,595	0.41	73
Lincoln Waterworks	Washington	6,209	0.45	73
Prairie Grove Waterworks	Washington	5,414	0.46	85
Washington County Water Authority	Washington	15,734	0.43	102 [c]
Total		92,764	8.10	104

a) Resells water purchased from BWRWA to the towns of Avoca, Little Flock and rural residents. b) gpcd = gallons per capita per day. c) GPCD for the Washington County Water Authority is based on total annual water use for the system, which is 1.6 mgd.

Source: Data from the Arkansas Department of Health

Carroll Boone Water District

Carroll Boone operates a water treatment system with a maximum capacity of 18 mgd. Since its inception in 1987, water withdrawals have increased at annual rate of 4.3 percent. In 1987, the district pumped an average of 2.7 mgd from Beaver Lake; and by 2014, this increased to 8.4 mgd (Figure 2). As is the case with Benton Washington, most of Carroll Boone's customers are small in terms of population. The largest is the City of Harrison with 16,905 residential customers, and the smallest is Alpena Waterworks serving 550 residential customers (Table 7). Per capita use also varies considerably from a high of 400 (Berryville) to a low of 67 in Alpena Springs. Again, larger values indicate the presence of water intensive manufacturing customers. The Southwest Boone Water Association is a reseller that provides water to the towns of Olney, Everton and to rural residents in unincorporated communities.

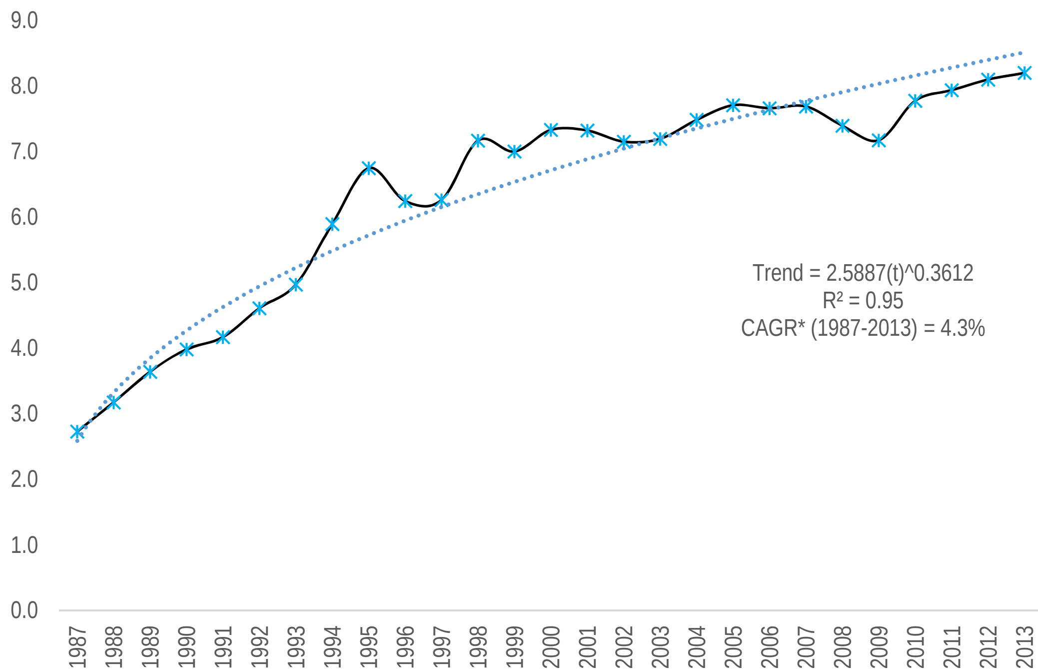


Figure 5-2: Historical Water Production for the Carroll Boone Water District (1987–2013, mgd)

Table 5-3: Carroll Boone Water District Customers

CBWD Customer	County	Population served	Average daily water use (mgd)	Per capita water use (gpcd)[a]
Harrison	Boone	16,905	3.05	180
Southwest Boone Water Association [b]	Boone	3,953	0.34	86
Alpena Waterworks	Boone and Carroll	550	0.04	67
Eureka Springs Waterworks	Carroll	3,158	0.60	190
Berryville Waterworks	Carroll	5,632	2.25	400
Green Forest Waterworks	Carroll	5,473	2.13	389
Total	-	35,671	8.41	236 180

[a] gpcd = gallons per capita per day

[b] Resells water purchased from CBWD to the towns of Olney, Everton and rural residents.

Source: Data from the Arkansas Department of Health and the Carroll Boone Water District

Madison County Rural Water Authority

Madison County has two main direct customers—the Madison County Water Facilities Board (MCWFB), and the City of Huntsville (Table 9). MCWFB is also a reseller and provides water to the Mount Olive Water Association, and to the Benton County Water Authority No. 5. As shown in Figure 3, water withdrawals from Beaver Lake by MCRWD have increased at a rate of 2.8 percent per annum. In 1997, the district pumped an average of nearly 2.2 mgd from the lake; and by 2014, they withdrew 3.5 mgd.

With about 8,000 customers, the MCWFB is the largest customer of the MCRWD in terms of population; however, in terms of water demand, the City of Huntsville is the largest with an average daily volume of 1.4 mgd. Population served in Huntsville is only 2,402; and as a result, the city has a very high per capita rate (583 gpcd). Huntsville's unusually high per capita rate is due to the presence of a Butterball poultry processing facility. Benton County Water Authority No. 5 also has high gpcd (392). Again, this is a result of water consumption by poultry producers in the county. Poultry farmers often rely on groundwater for water supply, but most of the groundwater in Madison County is very high in total dissolved solids, which is unsuitable for poultry consumption. In fact, high dissolved solids can be toxic poultry; thus, some broiler houses in the county are connected to public water supplies. A typical modern boiler house uses about 15,000 gallons per day for feeding, cooling and waste management. University of Alabama Cooperative Extension Service, "*Alabama Poultry Engineering and Economics Bulleting.*" No. 7, September, 2005.

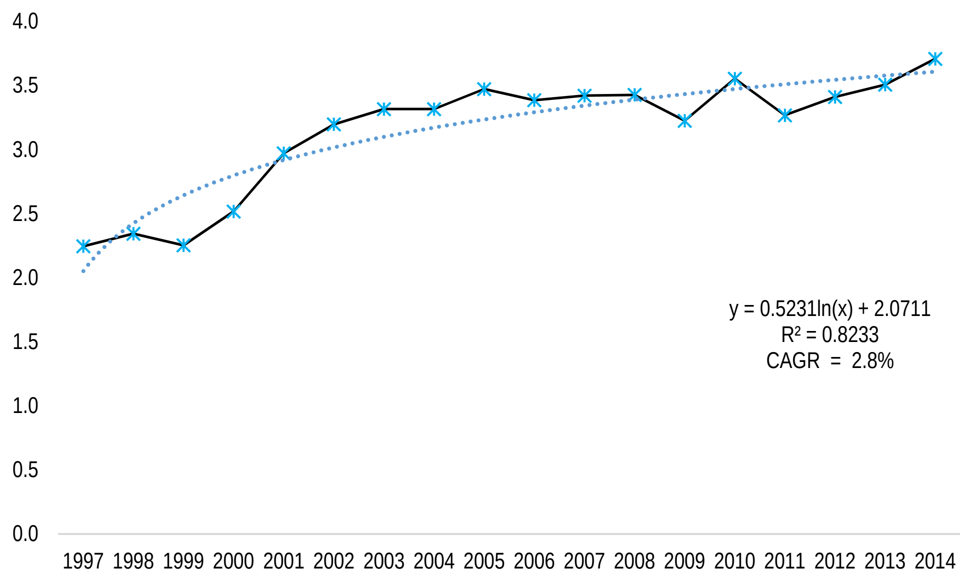


Figure 5-3: Historical Water Production for MCRWD (mgd)

Table 5-4: Madison County Rural Water Authority Customers

MCRWD Customer	County	Population served	Average daily water use (mgd)	Per capita use (gpcd)
Huntsville Waterworks	Madison	2402	1.40	583
Mount Olive Water Association	Madison	5,400	0.47	87
Madison County Water Facilities Control Board	Madison	8,059	1.40	174
Benton Co. Water Authority No. 5	Madison	1,530	0.07	44
Total	-	17,391	3.34	192

*Resells water purchased from CBWD to the towns of Olney, Everton and rural residents

Source: Data from the Arkansas Department of Health and the Carroll Boone Water District

Future water availability and demand are discussed in *Section 5.6* below. Current and future environmental conditions under the No-Action and future condition are discussed in *Section 3* (CURRENT AND FUTURE WITHOUT CONDITIONS); and *Section 7* (ENVRIONMENTAL CONSEQUENCES) respectively in this report. Discussion on current and future hydrologic conditions is in the Hydrology and Hydraulics Appendix. Discussion on current and future economic conditions is in Sections 4, 5, and 6 of this report, and in the Economics Appendix A.

5.6 Water Supply Needs Analysis

In accordance with Corps Guidance, the purpose of this study is to analyze potential ways to meet the water needs of the designated users and their partners. The Corps' policy for "immediate need" is a water demand study showing the needs for the water and the sponsor's ability and willingness to pay for the storage of the water. Long-term planning needs mean water needs over a 50-year planning horizon.

Three regional water suppliers have requested reallocation of storage space:

1) The Benton Washington Regional Public Water Authority (Benton Washington),
2) The Carroll-Boone Water District (Carroll-Boone); and
3) The Madison County Rural Water Authority (Madison County).

Water supply needs for these three requesters was forecasted for a 50 year period (2015 through 2065) using a spreadsheet-based water needs model developed by the team Economist. The water needs model was reviewed and revised by USACE Fort Worth to ensure reasonableness, accuracy and adequate documentation. The demand model was subjected to review by the USACE Water Management and Reallocation Studies Planning Center of Expertise (WMRS-PCX), beginning in July 2016. Following contingent approval by the WMRS-PCX, the model was forwarded to the Headquarters Model Review Panel for a one-time use approval. The Panel approved the water needs model for use at the review panel meeting on August 9, 2016.

The full water needs model and evaluation can be found in Appendix A. The water supply forecast was based on input from the Designated Users, including the use of groundwater, current allocations from surface water sources, and purchased water agreements. Development of the water demand forecast was based on historic and current weather data, socio-economic and demographic data, and water consumption and usage data. Data was obtained from the Designated Users.

These water users operate water systems in northwestern Arkansas (the "Ozarks" region of the state). Washington, Benton and Madison counties make up the Fayetteville-Springdale-Rogers Metropolitan Statistical Area (Fayetteville MSA). Fayetteville, Springdale, Rogers, and Bentonville, are the third, fourth, eighth and tenth largest cities in Arkansas. According to projections by HIS Global Insight, Northwest Arkansas is the third fastest-growing economy among large metropolitan areas in the nation through 2020. IHS Global Insight, "U.S. Metro Economies GDP and Employment 2013-2015 Including 2020 Economic Forecast." June 2014. IHS expects the Fayetteville MSA economy (measured in regional gross domestic product) to grow at a rate of 4.2 percent annually through 2020. Current real annual gross domestic product in the region is about $26 billion. The supplier base includes many Fortune 500 companies that numbers over 1,350 who have located here to be close to their customers and because of the region's great business climate.

Benton Washington has one previous allocation of 7,643 af or 4.0 mgd from the Flood Pool at Beaver Lake in 1996 and are now requesting an additional 22,887.11 af or 12.0 mgd. The 50 year period of analysis assumes drought conditions with water demands for Benton Washington project to grow from 10.5 mgd to 28.4 mgd. See Table below. Project demands for Benton Washington reach 16.0 mgd in about 2045.

Carroll-Boone has one previous allocation of 9,000 af or 4.74 mgd from the Conservation Pool at Beaver Lake in 1977 and a congressionally authorized allocation of 2,396 af or 1.26 mgd in 2006. Therefore, Carroll-Boone currently has approximately 6.0 mgd in reallocated water storage and is requesting an additional 6.0 mgd from Beaver Lake. Water demands for Carroll Boone and Madison County, are expected to grow at slower rate largely due to smaller increases in projected populations. See Table below. Total average annual demands for Carroll Boone rise from 8.9 in 2015 to 14.2 mgd in 2065.

Madison County Rural Water Authority (MCRWA or Madison County) has one previous reallocation of 3,882 af or 2.5 mgd. In August of 2015, USACE requested Madison County revise their original request from October 2006 for 8.0 mgd, because the water demand could only support 4.0 mgd or 7,629.04 af. Total average annual demands for Madison County rise from 4.1 mgd in 2015 to 6.1 mgd in 2065. See Table 5-5 below.

Table 5-5: Projected Drought Demands and Yield Allocations for the Beaver Lake Reallocation Study (drought conditions)

	Current and request	Projected demands	2016	2025	2035	2045	2055	2065
Benton Washington Regional Public Water Authority								
Current allocation from Beaver Lake	4.0	Residential	6.9	8.3	10.3	12.6	15.5	19.1
Request Beaver Lake	12.0	Commercial	1.6	2.0	2.4	3.0	3.7	4.5
Total current and requested allocation	16.0	Manufacturing and poultry	2.0	2.3	2.8	3.3	4.0	4.7
		Total BWRA	10.5	12.6	15.5	18.9	23.2	28.4
Carroll Boone Water District								
Current allocation from Beaver Lake	6.0	Residential	3.6	3.8	3.9	4.1	4.2	4.4
Request from Beaver Lake	6.0	Commercial	1.6	1.6	1.7	1.8	1.8	1.9
Total current and requested allocation	12.0	Manufacturing and poultry	3.7	4.2	4.9	5.8	6.8	7.9
		Total CBWD	8.9	9.6	10.6	11.6	12.8	14.2
Madison County Rural Water Authority								
Current allocation from Beaver Lake	2.5	Residential	2.1	2.1	2.2	2.3	2.3	2.4
Request from Beaver Lake	4.0	Commercial	0.5	0.5	0.5	0.5	0.5	0.5
Total current and requested allocation	6.5	Poultry	1.5	1.7	2.0	2.4	2.8	3.3
		Total MCRWD	4.1	4.4	4.7	5.1	5.6	6.1
Total								
Current allocation from Beaver Lake	12.5	Residential	12.7	14.2	16.4	18.9	22.1	25.9
Request from Beaver Lake	22.0	Commercial	3.7	4.1	4.6	5.2	6.0	7.0
Total current and requested allocation	34.5	Manufacturing and poultry	7.2	8.3	9.8	11.5	13.5	15.9
		Total demands	23.5	26.6	30.7	35.7	41.6	48.8

5.7 IDENTIFICATION OF MEASURES

Many different potential measures were initially considered for addressing the stated problem in regards to immediate and future water needs in the Northwestern service area of Arkansas. Generally, measures were screened out at this stage if they would not be effective in adequately addressing the problem if they did not provide the quantity of water needed or if another measure could provide equivalent benefits at a significantly lower cost. The potential measures can be found in Table 5-6: Potential Measures below.

Table 5-6: Potential Measures

#	Measure	Structural or Non-Structural or Both	Screened or Carried Forward
1	Construct New Single-Purpose Reservoir	Structural	Carried Forward
2	Development of Groundwater	Structural	Carried Forward
3	Water Supply Storage from another existing reservoir	Structural	Carried Forward
4	Buy Wholesale	Structural	Carried Forward
5	Beaver Lake reallocation within conservation pool	Structural	Carried Forward
6	Beaver Lake reallocation within flood pool	Structural	Carried Forward
7	Beaver Lake reallocation within inactive pool	Structural	Carried Forward
8	Obtain water supply from local/river stream	Structural	Screened (Insufficient quantity of water available)
9	Conservation measures	Non-Structural	Screened (Team considered as a reduction in demand rather than a source of supply)
10	Combination of measures	Both	Carried Forward

5.8 Evaluation Criteria and preliminary screening of measures to alternatives

Alternative plans are evaluated by applying numerous, rigorous criteria. Four general criteria are considered during alternative plan screening: completeness, effectiveness, efficiency, and acceptability. It should be noted that these criteria may not be fully evaluated at the initial stages of plan formulation in regards to evaluation of measures and preliminary alternatives, but are fully evaluated for the final array of alternatives.

- *Completeness*: Completeness is the extent that an alternative provides and accounts for all investments and actions required to ensure the planned output is achieved. These criteria may require that an alternative consider the relationship of the plan to other public and private plans if those plans affect the outcome of the project. Completeness also includes consideration of real estate issues, O&M, monitoring, and sponsorship factors. Adaptive management plans formulated to address project uncertainties also have to be considered.
- *Effectiveness:* Effectiveness is defined as the degree to which the plan will achieve the planning objective. The plan must make a significant contribution to the problem or opportunity being addressed.
- *Efficiency*: The project must be a cost-effective means of addressing the problem or opportunity. The plan outputs cannot be produced more cost-effectively by another institution or agency.
- *Acceptability*: A plan must be acceptable to Federal, state, and local government in terms of applicable laws, regulation, and public policy. The project should have evidence of broad-based public support and be acceptable to the non-Federal cost sharing partner.

Screening is an ongoing process of eliminating, based on planning criteria, alternatives that will no longer be considered. Criteria are derived from the specific planning study, based on the planning objectives, constraints, and the problems and opportunities of the study/project area.

The team gathered information from the sponsors, project office and other relevant agencies. The team then had a meeting with the gathered information and used professional judgment as a group to perform initial screening using the following criteria:

- Environmental impacts;
- Dam safety impacts;
- Recreational impacts;
- Flood risk management impacts;
- Hydropower impacts;
- Probability of insufficient quantity of water; and
- Order of Magnitude estimated costs.

There are also specific technical criteria related to engineering, economics, environment and the impacts to other authorized purposes, which also will be considered in evaluating alternatives. These criteria are as follows:

Engineering Criteria:

- The design of a safe, efficient, and reliable project that incorporates best engineering principles/practices in support of an NED plan.

Economic Criteria:

- The plan must contribute benefits to National Economic Development.

Environmental Criteria:

- The plan should fully comply with all relevant environmental laws, regulations, policies, and Executive Orders.
- The plan should represent an appropriate balance between economic benefits and environmental sustainability.
- The plan should be developed in a manner that is consistent with the USACE's Environmental Operating Principles (EOPs).
- Adverse impacts to the environment should be avoided. In cases where adverse effects cannot be avoided, then mitigation must be provided to minimize impacts to at least a level of insignificance.

Discussed below is the preliminary screening for this stage of the planning process. Measures that were included in the final array of alternatives were forwarded on for further consideration, underwent additional analysis as it related to technical viability, environmental impacts, costs, and benefits. These will be discussed in a later section of this report. In addition, a "No Action" measure is always carried forward. "No Action" consists of the lack of actions to address the stated problems and is the basis for comparison for all alternatives.

1. **Construct a new single purpose Reservoir:** This measure consists of the construction of a new dam and reservoir that provides a yield of 60 mgd to meet long-term needs. This measure will be evaluated for potential costs, technical considerations, its "completeness" in regard to its contribution to water supply over the fifty-year period of water supply need, and its potential effects, both environmental and societal.

2. **Development of Groundwater Supplies using Multiple Local Wells:** This measure consists of the development of groundwater using multiple well fields as a source of additional water supply.

3. **Obtain Additional Water Supply from another lake (Existing Reservoir):** This measure consists of creating additional water storage, and thus, water supply, from another corps or non-corps lake.

4. **Buy Wholesale from another water entity:** This measure consists of buying water wholesale from another water entity in the area.

5. **Beaver Lake - Reallocation of Storage within the Conservation Storage from hydropower to Water Supply:** This measure consists of the reallocation of storage from hydropower storage to water supply storage in Beaver Lake. This measure is a reallocation of storage within the same elevation range in the reservoir currently allocated to hydropower and water supply. This measure will be evaluated for a range of reallocation volumes to determine the required volume necessary to satisfy the water needs.

6. **Beaver Lake - Raising of Normal Pool (reallocate storage from flood storage):** Permanently raising the normal pool by reallocation of flood control (flood risk management) storage. This measure will be evaluated to determine the required volume necessary to satisfy the water needs.

7. **Beaver Lake - Reallocation of Storage in Inactive Storage to Water Supply Storage:** This measure consists of the reallocation of storage from existing inactive/sediment storage to supplement water supply storage. This measure has a constraint, as Public Law 106-53 restricts lowering the conservation pool elevation. Public Law 106-53 (August 17, 1999), states ". . . except that at no time shall the bottom of the conservation pool be at an elevation that is less than 1,076 feet, NGVD."

8. **Combination of measures.** The team evaluated optimization by analyzing combined measures.

The study team evaluated the measures and determined that only some measures could be combined to form a complete and efficient alternative. These preliminary alternatives are presented in the next section. These preliminary alternatives were evaluated and screened in an initial screening process. Feasible alternatives will then be more fully developed, discussed, evaluated, compared and contrasted, and screened to a single recommended action in a final screening process.

5.8 PRELIMINARY ALTERNATIVES –EVALUATION AND SCREENING OF ALTERNATIVES TO THE FINAL ARRAY.

This section assesses each of the preliminary alternatives for their ability to provide adequate water supply to the requesting water entities for a projected period of fifty years (2015 through 2065). Those alternatives that have the capacity to meet the projected demand will also be **assessed** for their cost-effectiveness, technically viability, environmentally acceptability, and impacts on other project purposes to determine if they should be carried forward for further review.

1. ***No Action Plan.*** The No Action Plan is the absences of any measures undertaken to solve the water supply problem facing these three water entities. The No Action plan is a requirement of National Environmental Policy Act (NEPA) and the plan is evaluated against all other alternatives. The No- Action Plan is the basis to which each measure and alternative are

compared. The No-Action Plan assumes that no means are possible to provide storage of water supply necessary to alleviate water supply shortfalls forecast over the fifty year period of analysis (2015 to 2065). Population growth for the fifty-year period (as demonstrated in the Water Needs Analysis - Appendix A) is projected to result in an approximate 48.8 mgd shortfall under 2065 basin conditions and demands, even with implementation of additional water conservation measures.

2. Water Users' construct a New Single Purpose Reservoir. In the absence of federal action in developing water supplies, the alternatives analysis assumes that the project sponsors would build a new reservoir that could provide a yield of 60 mgd to meet long-term demands. Project sponsors in conjunction with the Beaver Water District first considered a new reservoir in the region in the 1980s, and in 2002 the Mid-Arkansas Regional Water Discussion Group also proposed a new reservoir, but shelved the idea due to high costs and severe environmental impact. Although this alternative has high costs (capital costs alone for a new regional reservoir would likely be in the range of $500 to $700 million dollars), requirements for multiple permits, and significant environmental and socioeconomic impacts; this alternatives appears to be the least cost, most likely condition without a federal project. Therefore, the team will carry this alternative forward as the future without condition.

3. *Groundwater for both aquifers and wells.* In the study area (Benton, Washington, Carroll, Boone, and Madison counties), use of groundwater as a primary source of public supplies is limited. As shown in Table 4, In terms of volume, Benton County uses the most groundwater (4.6 mgd). In terms of relative share of total supplies, Boone County is highest at 78 percent; but overall groundwater makes up only about 7 percent of public water supplies for the five-county area. See U.S. Geologic Survey and Arkansas Water Science Center's Water-Use Data Base System. The primary reason is that in most of the region aquifer yields are small.

Three formations underlie the five-county area: 1) the Ozark Plateau, 2) the Western Interior Plains, and 3) the Springfield Plateau. The Ozark formation is in the far northeastern portion of Benton County and the north halves of Benton and Carroll counties. Arkansas Natural Resources Commission, "Arkansas Groundwater Protection and Management Report for 2013: A Supplement to the Arkansas Water Plan." January, 2014; and 2) Renken, R.A., and U.S. Geological Survey, "Groundwater Atlas of the United States: Arkansas, Louisiana, and Mississippi: HA 730-F." 1998.

Well yields in the Ozark generally range from 100 to 300 gallons per minute, which equates to about 0.14 to 0.43 mgd at full capacity. This is adequate to supply water for small public supply wells, livestock, irrigation, and other uses. The Springfield Plateau aquifer underlies about 80 percent of Benton County including the high growth area in and around Fayetteville, about the northern halves of Washington and Madison counties.

Data regarding Springfield Plateau are sparse, in part, because the aquifer is exposed in a limited area and, because it dips steeply beneath the thick shale, siltstone, and sandstone sequence of the Western Interior Plains confining system. Where the aquifer dips beneath this confining system, it is buried at great depths, which makes water-well drilling costs prohibitive. Yield of wells completed in the Springfield Plateau aquifer are reported to range from less than 1 to more than 75 gallons per minute;

reports indicate that average yield from the aquifer is 5 gallons per minute, which is not adequate for public supply.

In the Western Interior Plains aquifer, dissolved-solids concentrations are typically greater than 1,000 milligrams per liter. In thick, deeply buried parts of the aquifer system, dissolved-solids of more than 200,000 milligrams per liter have been reported. Saline water occurs at depths of 500 to 2,000 feet. These large concentrations are due, in part, to the slow movement of ground water in system. Little water is withdrawn from the Western Interior Plains system due to the poor quality and the fact that the system is deeply buried, which makes well drilling costs prohibitive.

Thus, the only portion of the study area that could accommodate wells is a small slice of Benton County, and northern segments of Carroll and Boone counties (i.e., the Ozarks Plateau aquifer). However, generating the amount of water requested (22 mgd) with groundwater alone would require 51 new wells assuming yields of 300 gallons per minute. Capital costs alone for 51 new wells would run $20 million, and adding in booster pumps, conveyances to treatment facilities, land and easements, legal, permitting etc. could easily double construction costs. Given the high costs, and inefficiency of installing and operating at least 51 new wells, the study team screened this alternative from further consideration.

Table 5-7: Groundwater Use as a Percentage of Total Public Water Supplies for Benton, Boone, Carroll, Madison and Washington Counties, Arkansas (2012 data, millions of gallons per day)

County	Groundwater Use	Total Water Use	Percent Groundwater
Benton County	4.62	66.01	7%
Boone County	0.90	1.16	78%
Carroll County	0.80	8.58	9%
Madison County	0.00	3.55	0%
Washington County	0.00	32.47	0%
Total	6.32	111.77	7%

Source: U.S. Geologic Survey and Arkansas Water Science Center's Water-Use Data Base System

4. ***Purchase Storage from another Corps' Project.*** Table Rock Lake, a Corps project 50 miles downstream of Beaver Lake, would be the only viable option to buy storage. There are two problems with this alternative: 1) reallocating storage in Table Rock Lake would have significant negative impacts to flood risk management; and 2) project sponsors would have to get the water to their treatment plants, and capital costs (excluding land and easements, operations, legal and permitting) for a 50-mile pipeline would likely run $120 to $150 million. Given the high financial costs, and impacts to Table Rock; the study team eliminated this alternative from further consideration.

5. ***Purchase Wholesale from another Water Provider.*** Beaver Water District is the only other wholesale water supplier in the region. In coordination correspondence with the Little Rock District dated July 2015, Beaver Water stated that in principle they support the reallocation for the three project sponsors; however, they unequivocally stated "no consideration should be given to reallocating any of BWD's existing contracted rights to storage in the Lake." In addition, Beaver Water District indicated that it would not consider selling any water permanently. BWD would sell to them on a temporary basis in the interim but not permanently. Since Beaver Water has made it clear that it will not wholesale water permanently to any of the water entities and there are no other water entities in the area outside of the requesters, this alternative was screened from the analysis.

6. ***Beaver Lake – Reallocation of Storage within the conservation pool from hydropower to water supply.*** Beaver Lake conservation storage serves two of the authorized purposes of for the project; it supplies storage for water supply and hydropower purposes. When the Corps reallocates storage from a conservation pool, the overall yield of conservation pool does not change. Water storage in this case, and thus yield, transfers from hydropower to water supply causing a reduction in hydropower yield and increase in water supply yield. In other words, there is not net change. This measure consists of the reallocation of storage from the hydropower purpose.

Beaver Lake is the only water source currently used by all three of the current requesting water entities. Analysis of water demand conducted during this phase of study (Appendix A), indicated an immediate need and projected shortfall for the requested 22 mgd, which modeling indicates can be met by an additional 41,960 acre-feet of water supply storage in Beaver Lake. This alternative could provide all of that storage shortfall.

This appears to be the least costly alternative with the least environmental impact of the water supply expansion measures available. However, due to the fact this alternative affects the hydropower project purpose, the team evaluated effects to hydropower in accordance with the requirements of the Water Supply Act of 1958. The team also evaluated the remaining not screened the no action alternative and the combined reallocation in conservation and inactive pool for hydropower effects. The results of this evaluation are discussed below in this report.

In July of 2015, the District sent coordination letters to the Southwest Power Administration (SWPA) that operates the hydroelectric generating station at Beaver Lake. In response, SWPA voiced concern of a conservation storage reallocation due to loss of dependable capacity for the hydroelectric plant. SWPA also stated that they believed that it is imperative that the Corps properly evaluate impacts of reallocating from hydropower including: 1) determining the actual loss of hydropower capacity and energy, 2) estimating the value of lost capacity and energy; and 3) ensure proper procedures for determining hydropower credits. SWPA also stated that they believe the proposed reallocation: 1) must satisfy an immediate need for water supply, 2) the reallocated must be the least cost alternative, and 3) Federal hydropower must be properly compensated for revenue losses due to a reallocation. SWPA is also concerned with the environmental impacts and potential for high costs of replacement energy and capacity relating to greenhouse gas emissions.

In addition to evaluating reallocation from the flood pool, SWPA recommends as an available option, the use of storage for hydropower yield protection operation (HYPO). Use of HYPO as part of a storage reallocation would maintain the current yield of the hydropower storage and, therefore, minimize the hydropower losses, especially capacity and on-peak energy losses. However, current Corps policy does not support using HYPO as a storage reallocation.

During preliminary screening, the study team discussed reallocating storage from the conservation pool, and concluded that while this alternative would involve forgone benefits of hydropower production, it would likely be one of the lower cost options based on a review of previous reallocation studies; and the study team carried it forward to the final array for further evaluation.

7. Beaver Lake – Reallocation of Storage within the flood pool/flood risk management to Water Supply Storage. This measure consists of seasonal or permanent raising of the normal (operational) elevation of the conservation storage to create additional storage space for water supply. If the Corps reallocates storage from the flood pool, storage in the conservation pool increases due to changes in the yield to storage relationship. District Hydraulics and Hydrology staff analyzed the yield storage curve for Beaver Lake and determined that reallocating from the flood pool would raise lake elevations by more than one foot.

When storage is taken from a flood pool, the amount of storage allocated to each existing water supply user must increase to maintain their expected yield. This additional storage is called “dependable yield mitigation storage” (DYMS). As stated in EC 1105-2-216, Reallocation of Flood Control Storage to Municipal and Industrial Water Supply–Compensation Considerations: "It is Corps policy not to provide DYMS for hydropower as is done for existing water supply users." Thus, if the Corps reallocates storage from a flood pool, hydropower yield will decline. When storage comes from a flood pool, the Corps calculates the requested safe yield, and the DYMS for existing users. Cost of the DYMS is the responsibility of the water supply requestor, as stated in EC 1105-2-216, "All costs associated with DYMS will be paid for by the new user of the new water supply storage space (i.e., the water supply requestor)."

The District’s Dam Safety Officer and Hydrology & Hydraulic Division indicated that they do not support the raising of the conservation pool at Beaver Lake for several reasons. The top of conservation pool is at an elevation of 1120.43 feet during the wetter time of year (October through April); and 1121.43 feet, during the drier part of the year (May through September). Raising the conservation pool to hold additional water supply would raise the conservation pool by 0.63 feet in the wet season and 0.66 feet during the dry season. Resulting pools would be 1,121.06 feet and 1,122.09 feet, respectively. Increased pool elevation would have the following impacts:

a) Surcharge operations would become more frequent and larger in magnitude with the rise in pool elevation.
b) Raising the conservation pool would decrease the ability of the lake to safely retain water during heavy rain events. Currently, Beaver Lake’s wet season flood pool can retain 4.93 inches of basin wide runoff. Raising the conservation pool, would reduce retention capacity by 0.66 inches to 4.27 inches. Currently, a 72-hour duration rain event of about 6 inches will fill the flood pool.

Coincidentally, a 0.20 Annual Chance of Exceedance (ACE) 72-hour point rainfall in the basin is 5.9 inches). If the conservation pool rises, the 72-hoourr rainfall event that would fill the pool is likely to be about 5 inches (the 0.50 ACE 72-hour point rainfall in the basin is 4.8 inches).

c) Increased frequency and volume of releases would translate into higher flood damages.
d) More spillway releases would increase the likelihood of spillway releases for downstream dams, particularly Table Rock and Bull Shoals Dams, which are both DSAC 3 dams. Even a small increase in risk at a DSAC 3 dam is unacceptable.
e) Environmental Agencies have stated that a higher conservation pool would negatively affect critical habitat and endangered species within the project.
f) Increased hydraulic head loading on Beaver Dam structures would likely increase risks of dam breach or failure.

For these reasons, the study team opted to screen this alternative from further evaluation.

8. Beaver Lake – Reallocation of Storage in Inactive Pool to water supply storage.

This measure consists of the reallocation of storage from existing sediment storage to supplement the water supply storage. Sedimentation is a naturally occurring process in any reservoir and results in the loss of reservoir storage over time. Without dedicated sedimentation storage, sedimentation would diminish the conservation and flood storage over the life of the project, impacting the ability of the project to meet its authorized purposes. Based on sedimentation surveys done to date, the current sediment storage volume of 25,073 acre-feet appears to be more than adequate for the purposes of sediment storage for Falls Lake.

Temporary reallocation of sediment storage to water supply was considered for Falls Lake during the drought of 2007-08. While permanent reallocation from existing sediment storage to water supply storage is not prohibited, it is generally not considered to be a practical long- term storage option. While previous surveys indicate perhaps a surplus of sediment storage, an updated, detailed lake survey to verify/update available storage and sedimentation rates would also be necessary.

With additional survey and technical analysis, this measure is technically and environmentally feasible, and could be a cost-effective means of providing additional water supply in the longer term future. However, given that the sediment storage volume will diminish over time and need to be replaced with another measure, this alternative will not be carried forward for further evaluation within this study. This alternative may prove to be a cost-effective, environmentally-sound, and technically viable alternative in the future, should augmentation of local water supply prove necessary.

Reallocating storage from the inactive pool would increase storage in the conservation pool by lowering the elevation of the conservation pool into the inactive (i.e., sediment) pool thereby changing the yield storage relationship. Analysis of the yield storage curve for the lake indicated that taking storage from the inactive pool would not raise water levels of the lake thereby reducing potential environmental and social impacts.

During the evaluation of the alternatives, a public law was found that restricts lowering the conservation pool elevation. Public Law 106-53 (August 17, 1999), states ". . . except that at no time shall the bottom of the conservation pool be at an elevation that is less than 1,076 feet, NGVD."

For the reasons above, the reallocation of the inactive pool at Beaver Lake as a sole source was screened from further analysis.

9. Beaver Lake – Combined reallocation in conservation and flood pools. The combined alternative for reallocation of the conservation and flood pools would increase storage in the conservation pool by increasing the elevation of the conservation pool into the flood pool thereby changing the yield storage relationship. Reallocation of combined flood and conservation pools at Beaver Lake was screened from further consideration for the same impacts listed in the flood pool sole source alternative above. There was no combination of the flood pool that would not trigger these impacts.

10. Beaver Lake - Combined reallocation in conservation and inactive pools. The combined alternative for reallocation of the conservation and inactive pools would still increase storage in the conservation pool by lowering the elevation of the conservation pool into the inactive (i.e., sediment) pool thereby changing the yield storage relationship. A combined reallocation from both the conservation and inactive pools at Beaver Lake was carried forward as a final alternative to be evaluated and analyzed in the study.

The alternatives to be carried forward are as follows:

4. No Action.
5. *Beaver Lake – Reallocation of Storage within the conservation pool from hydropower to water supply.*
6. *Beaver Lake – Combined reallocation in conservation and inactive pools.*

5.9 Evaluation and Comparison of Final Array of Alternatives

The team then evaluated and compared the final array of alternatives, concurrently with the serious effects analysis and cumulative discretionary water supply storage effects on other authorized purposes at Beaver Lake associated with the final array of alternatives.

1. No Action – Future without Federal Project

In the absence of federal action in developing water supplies, the alternatives analysis assumes that the designated water users (requesters) would build a new reservoir that could provide a yield of 60 mgd to meet long-term needs.

2. Reallocation of Conservation Pool at Beaver Lake

Reallocating storage from the conservation pool does not change the overall yield of the pool. Water storage in this case, transfers from hydropower to water supply causing a reduction in hydropower yield and increases water supply yield.

The reallocation from the conservation pool as a sole source is approximately 41,960 acre-feet of storage.

3. <u>Reallocation combined of conservation and inactive pool at Beaver Lake</u>

Reallocating storage from the combined conservation and inactive pools would increase storage in the conservation pool by lowering the elevation of the conservation pool into the inactive (i.e., sediment) pool thereby changing the yield storage relationship.

Although the inactive pool was screened as sole source, there is still water supply storage within the elevation of 1076 as required by PL 106-53. Lowering the bottom of the conservation pool from 1077 to 1076, increases the conservation storage by about 15,337 acre-feet. The combination reallocation of storage is approximately 43,108 acre-feet, approximately 1,148 acre-feet greater than the reallocation from conservation pool alone (approximately 41,960 acre-feet). The DYMS required is approximately 980 acre-feet depending upon the order in which I apply the reallocations for each sponsor.
Of the 1,148 acre-feet of increase, 980 acre-feet is used for DYMS leaving about 169 acre-feet of storage to produce yield for the 3 sponsors. The total yield of the entire conservation pool at Beaver Lake will increase from 491.479 MGD to 496.713 MGD (an increase of approximately 1.1%), however the yield/storage ratio decreases by about 0.6%.

5.11 EVALUATION OF SERIOUS EFFECTS ON OTHER AUTHORIZED PURPOSES AT BEAVER LAKE

The study team concurrently evaluated whether there were serious effects to other authorized project purposes due to both potential water supply storage reallocations discussed in this study and previous cumulative discretionary water supply storage reallocations at Beaver Lake. This evaluation was necessary in order to comply with the Water Supply Act of 1958 which requires Congressional approval if the reallocation will seriously affect other authorized project purposes.

<u>Policy and Procedures</u>

The August 30, 2007 Memorandum for Water Supply Reallocation Policy by Thomas Waters, Chief, Policy and Policy Compliance Division, Directorate of Civil Works, states that ***Congressional approval is required ONLY when authorized project purposes are severely impacted***. This means that recommended reallocations of less than the 15% of total storage capacity or 50,000 acre feet could result in the need for congressional authorization. Any recommendation for reallocations above 15% of total storage capacity or 50,000 acre-feet may be approved by the Assistant Secretary of the Army (Civil Works) as long as authorized project purposes are not severely impacted. The determination of ***severely impacted*** is **based on project specific criteria.**

In 2009, USACE Chief Counsel prepared a legal opinion regarding authority to reallocate storage for Municipal & Industrial Water Supply under the Water Supply Act of 1958, 43 U.S.C. § 390b. Memorandum for the Chief of Engineers, *Subject: Authority to Reallocate Storage for Municipal & Industrial Water Supply under the Water Supply Act of 1958, 43 U.S.C. § 390b*, Earl H. Stockdale, Chief Counsel, 9 January 2009.

An excerpt from that Chief Counsel's legal opinion reads as follows:

> *In modifying a project to include water supply, the Corps must respect the intent of Congress as expressed in the project authorization and associated project documents referred to in law, as well as in the WSA [Water Supply Act]. This requires establishing*

whether and to what extent Congress intended, at the time of project authorization, for the project to provide for water supply needs. Where a project as originally authorized provided in some way for water supply needs, the Corps must construct and operate the project in accordance with Congressional intent, and the WSA provides a separate authority to make modifications for additional levels of waters supply that were not envisioned in the project authorization. A narrow reading of § 301(d) that would interpret the phrases "seriously affect [project] purposes" or "major structural or operational change" to preclude any accommodation of water supply needs beyond what Congress envisioned under the project authorization is not tenable given the structure, language, and purpose of the WSA (Chief Counsel's Memorandum p. 12).

The Chief Counsel also wrote a memorandum on the same subject matter in 2012, (Memorandum for the Chief of Engineers, *Subject: Authority to Provide for Municipal and Industrial Water Supply from the Buford Dam/Lake Lanier Project, Georgia*, Earl H. Stockdale, Chief Counsel, 25 June 2012.) where on page 37 he states as follows:

Regardless of how the amount of storage is calculated, the amount or percent of storage contracted for under the Water Supply Act is not determinative of whether a proposed action will result in major structural or operational change or seriously affect authorized purposes.

In the footnote following this statement, the Chief Counsel explains:

In section 301(d) of the Water Supply Act, the provision in which Congress set forth limitations on the Corps' authority under the Water Supply Act, Congress chose not to specify any number in connection with those limits. Percentages of costs and benefits associated with Corps reservoir projects are relevant under certain statutory and regulatory provisions, but these provisions are different from, and may not be correlated with, the percent of storage needed to accommodate a particular water supply request.

It is evident from the excerpts above that the Chief Counsel repeatedly emphasizes the importance of using Congressional intent at the time of project authorization as the baseline in determining whether a particular water reallocation is permitted by the Water Supply Act of 1958. The Chief Counsel also emphasizes the importance of not creating any number and percentage-based thresholds in making such determinations due to the fact that Congress itself chose not to do so in the 1958 Water Supply Act. With regard to the current reallocations, it is once again important to note that the Chief of Engineers put Congress on notice of water supply being an actual and potential purpose for Beaver reservoir, that Congress specifically authorized subsequent water reallocations, and that Congress did not set any numeric limitations on water reallocations for the reservoir.

Summary and Conclusion

The team evaluated serious effects by analyzing the energy loss, capacity loss and value for both this reallocation and cumulative discretionary water supply storage reallocations at Beaver Lake. The team evaluated the final array of alternatives which were to be carried forward from the section above:

1. No Action;
2. *Beaver Lake – Reallocation of Storage within the conservation pool from hydropower to water supply.*
3. *Beaver Lake – Combined reallocation in conservation and inactive pools.*

Since there was no change in the elevation of the water level at Beaver Lake for this reallocation study, the team concluded that there were no serious effects to flood risk management, recreation, dam safety or environmental impacts. Therefore, the only remaining authorized purpose for which further evaluation of potential serious effects was needed was the hydropower purpose. The study team brought in the Hydropower Analysis Center (HAC) to assist with this analysis of serious effects to hydropower.

Impacts to Hydropower Project Purpose

The Corps Hydropower Analysis Center (HAC) estimated impacts to the hydropower project purpose for this report. Monetary figures are expressed at an estimated October 2015 (FY2016) price level. Some prices, such as annual wholesale generation prices in the Energy Information Agency Annual Energy Outlook forecasts, are based on a calendar year price level rather than fiscal year. Because the fiscal year overlaps three-quarters of the calendar year, these prices are used as if they were fiscal year prices, without adjustment. Costs and benefits occurring at different points in time are converted to an average annual equivalent basis over a 50-year period of analysis using the federal discount rate prescribed for water resources projects (currently 3.125 percent). See Appendix E which contains the full analysis from HAC.

The selected plan for reallocation of storage within the conservation pool of an additional 41,960 acre-feet does not have serious effects to hydropower. There is approximately 2 days per year in lost energy (generation) that Southwestern Power Administration (SWPA) would have to determine how to make up for the lost generation. The cumulative non-congressional change with this reallocation is negligible for capacity and is a 4.4% decrease in energy. There would be approximately $361,000 in credits to SWPA if the reallocation of Beaver Lake is made from the conservation pool.

Taking into account the cumulative discretionary reallocations along with this current reallocation, the result would be an estimated 4.4 percent decrease in energy generating capacity; and although, SWPA revenues would decline slightly, SWPA would receive $357,000 in credits to the U.S. Treasury to offset lost revenues if the reallocation comes from the conservation pool. The full analysis on the serious effects to the hydropower purpose can be found in the HAC Report attached as Appendix E.

5.12 NED Analysis.

National Economic Development (NED) Account

The NED cost includes the costs to implement, maintain, and operate each alternative. The NED account compares the alternatives based on NED cost at FY 2017 price levels and interest rates. NED costs include first costs and Operations, Maintenance, Repair, Rehabilitations and Replacement (OMRR&R) costs. Hydropower benefits foregone and revenues lost were calculated by the Hydropower Analysis Center from Riverware model outputs from the study team's engineers and are included in the analysis.

Table 5-8: Final Array of Alternatives Analysis

Criteria	**Construction of a New Dam and Reservoir** (Future Without Federal Project)	**Reallocation of Beaver Lake** Reallocate Storage in Conservation Storage to Water Supply Storage	**Reallocation of Beaver Lake** Reallocate Storage from combined conservation and inactive pools to water supply storage
Corps Criteria			
Acceptability	Alternative is acceptable in regards to Federal laws, regulations, and guidelines	Alternative is acceptable in regards to Federal laws, regulations, and guidelines	Alternative is acceptable in regards to Federal laws, regulations, and guidelines
Completeness	This alternative provides an incomplete solution to the identified problem	This alternative provides a complete solution to the identified problem	This alternative provides an incomplete solution to the identified problem
Effectiveness	This alternative provides a less certain solution to the identified problem	This alternative provides an effective solution to the identified problem	This alternative provides a less certain solution to the identified problem

Criteria	**Construction of a New Dam and Reservoir** (Future Without Federal Project)	**Reallocation of Beaver Lake** Reallocate Storage in Conservation Storage to Water Supply Storage	**Reallocation of Beaver Lake** Reallocate Storage from combined conservation and inactive pools to water supply storage
Corps Criteria			
Efficiency	This alternative provides a less efficient use of non-Federal resources, while also providing a less cost-effective solution to the identified problem	This alternative provides an efficient use of Federal and non-Federal resources, while providing a cost-effective solution to the identified problem	This alternative provides a less efficient use of non-Federal resources, while also providing a less cost-effective solution to the identified problem

NOTE: The NED cost includes costs required to implement the alternatives, and includes only costs of reallocated storage and includes operation and maintenance costs annually.

5.13 DERIVATION OF USER COST.

This section presents the information used to derive the costs that the user will incur over the repayment period to implement the reallocation of storage at Falls Lake only. The user cost does not include costs to extract, transport, treat, or deliver water to end users. User cost also does not include potential repair, or rehabilitation costs, should those costs become necessary.

5.14 HYDROPOWER BENEFITS FOREGONE.

Hydropower benefits are based on the cost of the most likely alternative source of power. When conservation storage is reallocated for water supply, the usual assumption is that the lost hydropower will be replaced with power generated from thermal sources. The power benefits foregone can be divided into two components, energy benefits foregone and capacity benefits foregone. Energy benefits foregone are based on the loss in generation (both at-site and downstream) as a result of water being diverted from the reservoir for water supply rather than passing through the hydropower plant. In addition, there could be a loss of capacity benefits as a result of a loss in dependable capacity at the project.

Energy benefits foregone are computed by multiplying expected annual losses in megawatt-hours (MWh) of super-peak, peak and off-peak generation by the average annual prices of super-peak, peak and off-peak energy in dollars per megawatt-hour ($ per MWh) over the period of analysis. Energy prices are based on the marginal cost of energy from a combination of thermal generating plants that would replace the energy lost from hydropower generation.

For each month of the year, the present value of forecast energy prices (values) over the 50-year period of analysis is amortized to produce annualized monthly prices.[1] Energy benefits foregone are computed by condition: for each condition annualized monthly energy price and the energy loss due to water withdrawal are multiplied together.

Capacity benefits foregone are the product of the composite fixed cost of the most likely mix of replacement thermal power plants and the loss of dependable capacity. Capacity benefits foregone are computed by determining a composite cost per MW representing the annualized fixed cost of the combination of thermal power plants most likely to replace the power lost to the White River system as a result of the reallocation conditions. Next, the loss of dependable capacity for each condition is calculated using the average availability method. Loss of dependable capacity can be a result of: 1) loss in head due to lower post-withdrawal reservoir elevations, or 2) Inadequate water to support full capacity during low-flow periods (i.e., low-flow periods that reduce the amount of water that can be passed through the generators).

HAC computed foregone Energy benefits foregone are computed for two conditions; 1) reallocation from the conservation pool at Beaver Lake; and 2) reallocation from the inactive pool (See Tables below) by calculating how generation would change when compared to the current conditions at Beaver Lake. Average monthly electricity prices during each peaking period (i.e., super peak, peak, weekday off-peak and weekend off-peak) were multiplied by these differences for these two conditions to obtain foregone energy benefits. Losses are expressed as negative numbers and increases in generation are presented as positive numbers.

Table 5-9: Conservation Pool Reallocation - Energy Benefits Foregone

Project	Time	Energy Benefits Forgone	Total Forgone Benefits
Beaver	Super Peak	-$55,224.83	**-$130,142.79**
	Peak	-$52,835.06	
	Weekday Off-peak	-$6,394.30	
	Weekend Off-peak	-$15,688.60	
Bull Shoals	Super Peak	-$18,764.75	**-$117,546.32**
	Peak	-$71,103.12	
	Weekday Off-peak	-$1,522.29	
	Weekend Off-peak	-$26,156.16	
Greers Ferry	Super Peak	$2,754.94	**$1,046.56**

[1] The “Period of Analysis” as defined in *Planning Guidance Notebook*, Section 2-4j, for a multiple-purpose reservoir project, is not to exceed 100 years. Section E-63 “Benefits Foregone”, defines the period of analysis for storage reallocations as the greater of (a) the remaining economic life of the project, or (b) 50 years.

	Peak	-$1,070.89	
	Weekday Off-peak	-$504.74	
	Weekend Off-peak	-$132.76	
Norfork	Super Peak	$1,441.45	**-$1,173.20**
	Peak	-$5,536.06	
	Weekday Off-peak	$681.94	
	Weekend Off-peak	$2,239.47	
Table Rock	Super Peak	-$11,217.62	**-$114,649.36**
	Peak	-$75,263.92	
	Weekday Off-peak	-$10,736.90	
	Weekend Off-peak	-$17,430.92	
Total	Super Peak	-$81,010.81	**-$418,559.23**
	Peak	-$203,245.01	
	Weekday Off-peak	-$19,034.38	
	Weekend Off-peak	-$115,269.03	

Table 5-10: Inactive Pool Reallocation - Energy Benefits Foregone

Project	Time	Energy Benefits Forgone	Total Forgone Benefits
Beaver	Super Peak	-$55,224.83	**-$130,142.79**
	Peak	-$52,835.06	
	Weekday Off-peak	-$6,394.30	
	Weekend Off-peak	-$15,688.60	
Bull Shoals	Super Peak	-$18,764.75	**-$117,546.32**
	Peak	-$71,103.12	
	Weekday Off-peak	-$1,522.29	
	Weekend Off-peak	-$26,156.16	
Greers Ferry	Super Peak	$2,754.94	**$1,046.56**
	Peak	-$1,070.89	
	Weekday Off-peak	-$504.74	
	Weekend Off-peak	-$132.76	
Norfork	Super Peak	$1,441.45	**-$1,173.20**
	Peak	-$5,536.06	
	Weekday Off-peak	$681.94	
	Weekend Off-peak	$2,239.47	
Table Rock	Super Peak	-$11,217.62	**-$114,649.36**
	Peak	-$75,263.92	
	Weekday Off-peak	-$10,736.90	
	Weekend Off-peak	-$17,430.92	
Total	Super Peak	-$81,010.81	**-$418,559.23**
	Peak	-$203,245.01	
	Weekday Off-peak	-$19,034.38	

	Weekend Off-peak	-$115,269.03	

Table 5-11: Summary of Alternatives for Reallocation

Alternative for Beaver Lake	Total Hydropower Benefits Foregone for White River Projects
Conservation (CON) Pool	($ 418,559)
Combined CON/INA Pool	($ 418,559)

The cumulative effects for reallocation from the Conservation Pool, Inactive Pool or combined Conservation Pool and Inactive Pool on the White River System for hydropower benefits foregone is $418,559.

5.15 Hydroelectric Power Revenues Foregone

Hydropower revenues foregone are on current SWPA contract rates for the White River projects and include the firm energy, supplemental energy, and excess energy rate of $9.40 per MWh and the power purchase adder of $5.90 MWh for a total energy rate of $15.30 per MWh. In addition, the following are included:

- Monthly capacity charge of $4,500 per MW,
- Monthly regulation and frequency response of $70 per MW,
- Monthly spinning operating reserve: $14.6 per MW,
- Monthly supplemental operating reserve of $14.6 per MW; and,
- Annual capacity rate total: $55,190.4 per MW per year.

To compute energy revenues foregone, the contract peaking energy rate is applied to the average annual on-peak contract energy losses, and the supplemental peaking energy rate is applied to on-peak non-contract energy losses and off-peak energy losses. Supportable capacity in the critical year of 1954, which is used in the revenue foregone calculation, was unaffected by any of the reallocation conditions, so there is no capacity revenue foregone. Tables 10 and 11 show estimated foregone revenues for hydropower under the proposed reallocation from the conservation and inactive pools.

Table 5-12: Conservation Pool Reallocation - Power Revenue Foregone

Project	Energy Loss (MWh)	SWPA Current Rates ($/MWh)	Critical Year Capacity Loss (MW)*	Capacity Rate	Total Revenue Foregone
Beaver	-3,714	$15.30	0	$55,190.40	($56,824)
Bull Shoals	-3,871	$15.30	0	$55,190.40	($59,226)
Greers Ferry	-18	$15.30	0	$55,190.40	($275)

Norfork	-42	$15.30	0	$55,190.40	($643)
Table Rock	-3,812	$15.30	-0.06	$55,190.40	($61,635)
White River	-11,457	$15.30	-0.06	$55,190.40	($178,604)

*Capacity values are based on SWPA defined critical water year (1954).
Source: USACE & HAC

Table 5-12: Inactive Pool Reallocation - Power Revenue Foregone

Project	Energy Loss (MWh)	SWPA Current Rates ($/MWh)	Critical Year Capacity Loss (MW)*	Capacity Rate	Total Revenue Foregone
Beaver	-3,714	$15.30	0	$55,190.40	($56,824)
Bull Shoals	-3,871	$15.30	0	$55,190.40	($59,226)
Greers Ferry	-18	$15.30	0	$55,190.40	($275)
Norfork	-42	$15.30	0	$55,190.40	($643)
Table Rock	-3,812	$15.30	-0.06	$55,190.40	($61,635)
White River	-11,457	$15.30	-0.06	$55,190.40	($178,604)

*Capacity values are based on SWPA defined critical water year (1954).
Source: USACE & HAC

Table 5-13: Hydropower Power Revenue Foregone

Project	Total Revenue Foregone
Conservation Pool Reallocation Total	($178,604)
Combined Pool Reallocation Total	**($178,604)**

Source: USACE & HAC

The cumulative effects for this reallocation on the White River System for hydropower revenues foregone is the same no matter which alternative, $178,604.

5.16 Hydroelectric Power Replacement Cost

In the case of hydroelectric power, power benefits foregone are, by definition, identical to the NED cost of replacement power, based on costs of the most likely alternative source of replacement power. Thus, the replacement cost of power is the value of power benefits in the previous section of this report.

5.17 Recreation Benefits

Since surface water elevations would not change due to a reallocation from the conservation or inactive pools, there would be no impacts to recreation.

5.18 SELECTED PLAN

After the analysis above, the study team selects reallocation of 41,960 acre-feet of storage from the Conservation Pool at Beaver Lake. See the final alternatives NED Analysis in Table 5-13 below and costs allocated to storage in Table 5-14 below.

Table 5-13: NED Analysis for final alternatives

Alternative	Hydropower Benefits Foregone **	Hydropower Revenues Foregone	Replacement Cost	Updated Cost of Storage *
Alternative 5, Conservation (CON) Pool	$ 457,402	$ 178,604	$ 418,559	$ 490,349
Alternative 9, Combined CON/INA Pool	$ 457,402	$ 178,604	$ 418,559	$ 496,555

Note: * - 2.875% at 50 years is the federal interest rate for calculating impacts. 2.5% at 30 years is the water supply federal interest rate for payment. Therefore, updated cost of storage for impacts in this section will be slightly different than updated cost of storage for users cost in the next section. (Economic Guidance Memo, EGM 17-01 Federal Interest rate)

Note: ** - This number includes both hydropower benefits foregone and energy benefit foregone (Appendix E - HAC Report pgs. 35-36)

Table 13-11: Costs allocated to Storage

Item	Amount ($)
Hydropower Benefits Foregone	$ 457,402
Hydropower Revenues Foregone	$ 178,604
Replacement Cost	$ 457,402
Updated Cost of Storage *	$ 490,349

Note: * - 2.875% at 50 years is the federal interest rate for calculating impacts. 2.5% at 30 years is the water supply federal interest rate for payment. Therefore, updated cost of storage for impacts in this section will be slightly different than updated cost of storage for users cost in the next section. (Economic Guidance Memo, EGM 17-01 Federal Interest rate)

Costs allocated to storage is set to the highest of benefits, foregone, revenues foregone, replacement costs, or updated cost of storage. Therefore, the users will be charged the updated cost of storage. The calculations for the updated cost of storage can be found in the next section.

5.19 UPDATED COST OF STORAGE.

The District updated original costs of reservoir construction as presented in the: “Beaver Project Final Cost Allocation Report” published in November of 1973 after projection construction. Original cost at construction midpoint in 1962 were converted to present FY1967 using the Engineering News Record (ENR) construction cost indices, and from F71967 to current FY2017 price levels using the Corps of Engineers Civil Works Construction Cost Index System (CWCCIS). Given that the CWCCIS does not have an index for land value, the District applied an average of indices for other project features through FY2000. For values from 2000 to 2017, land price indices for the State of Arkansas as published by the Lincoln Institute for Land Policy which are available by quarter starting in year 2000 through 2017. Davis, M.A., and Heathcote, "The Price and Quantity of Residential Land in the United States," Journal of Monetary Economics, vol. 54 (8), p. 2595-2620, 2007. The Table below shows updated costs of storage.

Table 5-14: Updated Cost of Storage for Beaver Lake

Item	Project purpose	Original cost (1960)	Construction mid-point	ENR Index 1962 [b]	CWCCIS Index 1967 [c]	CWCCIS Index 2017	FY1967 Project costs	FY2017 Project costs
Land and								
Recreation	Recreation	$140,600	1962	1078	100	-	$173,815	$1,397,724
Other	Joint	$5,413,400	1962	1078	100	-	$6,692,254	$53,798,978
Relocation								
Replacement in	Flood	$167,800	1962	1078	100	851.79	$207,441	$1,776,960
Other	Joint	$3,322,500	1962	1078	100	851.79	$4,107,403	$34,986,444
Reservoir								
Recreation	Recreation	$1,196,400	1962	1078	100	954.52	$1,479,036	$14,117,692
Water supply	Water	$196,400	1962	1078	100	954.52	$242,797	$2,317,548
Other	Joint	$819,000	1962	1078	100	954.52	$1,012,479	$9,664,318
Dam and spillway								
Main dam	Joint	$19,183,300	1962	1078	100	834.37	$23,715,135	$197,871,969
Power intake	Power	$1,152,400	1962	1078	100	834.37	$1,424,641	$11,886,779
Auxiliary dams	Joint	$430,100	1962	1078	100	834.37	$531,706	$4,436,397
Fish and wildlife	Flood	$11,800	1962	1078	100	817.93	$14,588	$119,316
Power plant	Power	$9,893,400	1962	1078	100	761.52	$12,230,602	$93,138,483
Roads	Joint	$441,900	1962	1078	100	851.79	$546,294	$4,653,276
Recreational	Recreation	$2,227,000	1962	1078	100	802.86	$2,753,103	$22,103,564
Buildings								
Recreation	Recreation	$156,700	1962	1078	100	802.86	$193,719	$1,555,289
Other	Joint	$82,500	1962	1078	100	802.86	$101,990	$818,834
Equipment								
Recreation	Recreation	$129,600	1962	1078	100	802.86	$160,217	$1,286,314
Other	Joint	$100,200	1962	1078	100	802.86	$123,871	$994,512
Total project	-	$45,065,000	1962	-	-	-	$277,446,396	$456,914,398

[a] FY 2017 land values use an average of CWSSIS indices for other project features through year 2000. From 2000 to 2017, the value is inflated using land prices indices for Arkansas from: Davis, Morris A. and Jonathan Heathcote, 2007, "The Price and Quantity of Residential Land in the United States," Journal of Monetary Economics, vol. 54 (8), p. 2595-2620; data located at Land and Property Values in the U.S., Lincoln Institute of Land Policy. Figures from the 2007 are continually updated by the Lincoln Institute.

[b] Engineering News Record price indices maintained by the Corps Little Rock District.

5.20 User's Cost.

The total cost to the users for the recommended reallocation would be $10,678,727 or $579,467 annually over the 30-year repayment period, excluding Operations and Maintenance costs of $82,846 annually. This is based on the updated cost of storage for the entire project ($307,224,727), multiplied by the percentage of storage reallocated from water quality to water supply (3.40%) as a percent of total usable storage for the project (1,240,200 total acre-feet of usable storage). It must be noted that the cost of reallocated storage to the customer is estimated to be a total of $10,678,727 unadjusted for inflation in future out-years, including annual O&M costs.

Table 5-15: Total Annualized Payment for Updated Storage

Item	Amount (monetary figures shown in $FY2017)
Total storage required (acre-feet)	41,960
Water supply yield (mgd)	22
Interest rate	2.5%*
Repayment period	30
Top of flood control pool	1,951,500
Top of conservation pool	1,664,200
Top of inactive pool	711,300
Flood control storage	287,300
Conservation Storage	952,900
Inactive storage	711,300
Usable Storage	1,240,200
Storage required as percent of useable storage	3.4%
Joint use project cost	$307,224,727
Annual O&M	$2,448,660
Total cost of storage (capital)	$10,394,412
Total cost of storage (OM)	$82,846
Annual cost of storage (capital)	$496,620
Annual cost of storage (OM)	$82,846
Total annual repayment	$579,467

Note: * - 2.5% at 30 years is the water supply federal interest rate for payment; 2.875% at 50 years is the federal interest rate for calculating impacts. (Economic Guidance Memo, EGM 17-01 Federal Interest rate)

Table 5-16: Annualized Payment for the Benton Washington Regional Public Water Authority (BWRPWA or Benton Washington)

Item	Amount (monetary figures shown in $FY2017)
Storage required and economic parameters	
Total storage requested by sponsor (acre-feet)	22,887
Water supply yield requested by sponsor (mgd)	12.0
Interest rate	2.5%*
Repayment period (years)	30
Storage in Beaver Lake	
Flood control storage	287,300
Conservation Storage	952,900
Inactive storage	711,300
Total usable Storage	1,240,200
Total repayment costs	
Total joint use project cost (initial construction indexed to (FY2017)	$307,224,727
Total annual O&M (annual average)	$2,448,660
Storage required as percent of useable storage	3.4%
Capital costs of total proposed reallocation	$10,394,412
Annualized capital costs of total proposed reallocation	$496,620
Annual O&M costs of total proposed reallocation	$82,846
Total annual repayment of proposed reallocation	$579,467
Sponsor share of total repayment costs	
Storage required as percent of useable storage	1.9%
Cost of storage (capital)	$5,716,926.60
Annual repayment for storage (capital)	$270,881
Annual O&M payment	$45,188
Total annual repayment	$316,069

Note: * - 2.5% at 30 years is the water supply federal interest rate for payment; 2.875% at 50 years is the federal interest rate for calculating impacts. (Economic Guidance Memo, EGM 17-01 Federal Interest rate)

Table 5-17: Annualized Payment for the Carroll Boone Water District

Item	Amount (monetary figures shown in $FY2017)
Storage required and economic parameters	
Total storage requested by sponsor (acre-feet)	11,444
Water supply yield requested by sponsor (mgd)	6.0
Interest rate	2.5% *
Repayment period (years)	30
Storage in Beaver Lake	
Flood control storage	287,300
Conservation Storage	952,900
Inactive storage	711,300
Total usable Storage	1,240,200
Total repayment costs	
Total joint use project cost (initial construction indexed to (FY2016)	$307,224,727
Total annual O&M (annual average)	$2,448,660
Storage required as percent of useable storage	3.4%
Capital costs of total proposed reallocation	$10,394,412
Annualized capital costs of total proposed reallocation	$496,620
Annual O&M costs of total proposed reallocation	$82,846
Total annual repayment of proposed reallocation	$579,467
Sponsor share of total repayment costs	
Storage required as percent of useable storage	0.9%
Cost of storage (capital)	$2,806,491.24
Annual repayment for storage (capital)	$135,446
Annual O&M payment	$22,595
Total annual repayment	$ 158,041

Note: * - 2.5% at 30 years is the water supply federal interest rate for payment; 2.875% at 50 years is the federal interest rate for calculating impacts. (Economic Guidance Memo, EGM 17-01 Federal Interest rate)

Table 5-18: Annualized Payment for the Madison County Rural Water Authority (MCRWA or Madison County)

Item	Amount (monetary figures shown in $FY2017)
Storage required and economic parameters	
Total storage requested by sponsor (acre-feet)	7,629
Water supply yield requested by sponsor (mgd)	4.0
Interest rate	2.5% *
Repayment period (years)	30
Storage in Beaver Lake	
Flood control storage	287,300
Conservation Storage	952,900
Inactive storage	711,300
Total usable Storage	1,240,200
Total repayment costs	
Total joint use project cost (initial construction indexed to (FY2016)	$307,224,727
Total annual O&M (annual average)	$2,448,660
Storage required as percent of useable storage	3.4%
Capital costs of total proposed reallocation	$10,394,412
Annualized capital costs of total proposed reallocation	$496,620
Annual O&M costs of total proposed reallocation	$82,846
Total annual repayment of proposed reallocation	$579,467
Sponsor share of total repayment costs	
Storage required as percent of useable storage	0.6%
Cost of storage (capital)	$1,870,994.16
Annual repayment for storage (capital)	$90,294
Annual O&M payment	$15,063
Total annual repayment	$105,356

Note: * - 2.5% at 30 years is the water supply federal interest rate for payment; 2.875% at 50 years is the federal interest rate for calculating impacts. (Economic Guidance Memo, EGM 17-01 Federal Interest rate)

6.0 TEST OF FINANCIAL FEASIBILITY.

As a test of financial feasibility, the annual cost of storage should be compared to the cost of the most-likely, least-costly alternative that the applicant would undertake in the absence of utilizing the Federal project. This should be an alternative that would provide water of equivalent quality and quantity.

The estimated cost of the designated water users building a single-purpose reservoir (Future without Federal Project) is approximately $14.3M annually for 50 years at 2.875%. See the Test of Financial Feasibility table below.

The reallocation of storage has a significant cost advantage over the alternative construction of a reservoir, providing a significant cost savings over a new reservoir, and would result in fewer environmental impacts than that of any other alternative.

Table 6-1: Test of Financial Feasibility

	Future Without Federal Project	Reallocation from Conservation Pool
Joint use project cost 2016 $	$337,568,250	
Annual OMRR&R (average for first 50 years)	$1,500,000	
Interest Rate	2.875%	2.875%
Annual cost of storage (capital)	$12,810,100	$ 405,237
Annual cost of storage (OMRR&R)	$1,500,000	$ 85,112
Total annual repayment	**$14,310,100**	**$ 490,349**

Note: * - 2.5% at 30 years is the water supply federal interest rate for payment; 2.875% at 50 years is the federal interest rate for calculating impacts. (Economic Guidance Memo, EGM 17-01 Federal Interest rate)

7.0 ENVIRONMENTAL CONSEQUENCES.

This section discusses the resources in the project area and the probable effects or impacts of the proposed project on environmental resources. The Recommended Plan is to reallocate storage in Beaver Lake's conservation pool from the hydropower purpose to water supply storage. The effects were considered over a 50-year period of analysis (2015-2065).

In addition to the Recommended Plan, the impacts of the No Action alternative are addressed in this section. The No Action alternative involves the existing condition of the resources in the project area as well as the future without-project condition of these resources also over a 50- year period of analysis. A future without-project condition expects that the water users would construct their own reservoir. In addition, impacts of the No Action plan are compared to the Recommended Plan in more detail in the sections following.

7.1 STATUS OF ENVIRONMENTAL COMPLIANCE

The Status of Environmental Compliance are listed in the Table below.

Table 7-1: Environmental Compliance

Policies	Compliance of Plan
Public Laws	
Archeological and Historic Preservation Act, 1974, as amended	Compliant
Archeological Resources Protection Act, 1979, as amended	Compliant
Clean Air Act, 1977, as amended	Compliant
Clean Water Act, 1972, as amended	Compliant
Endangered Species Act, 1973, as amended	Compliant
Farmland Protection Policy Act	Compliant
Fish and Wildlife Coordination Act, 1958, as amended*	Compliant
Migratory Bird Treaty Act, 1918, as amended	Compliant
National Environmental Policy Act, 1969, as amended	Compliant
National Historic Preservation Act, 1966, as amended	Compliant
Native American Graves Protection and Repatriation Act, 1990	Not Applicable
Rivers and Harbors Act, 1899	Compliant
Wild and Scenic Rivers Act, as amended	Compliant

Executive Orders	
Environmental Justice (E.O. 12898)	Compliant
Flood Plain Management (E.O. 11988)	Compliant
Protection of Wetlands (E.O. 11990)	Compliant
Protection of Children from Environmental Health Risks (E.O. 13045)	Compliant
Invasive Species (E.O. 13112)	Compliant
Migratory Birds (E.O. 13186)	Compliant

Initial Alternatives

In Section 5.7 of this report, a description of all initial alternatives originally considered was provided for this reallocation, and the screening analysis for those alternatives. These initial alternatives include:

- No Action
- Future without Project (includes new reservoir construction)
- Groundwater (new wells)
- Buy water or storage from another reservoir
- Purchase water from one or more wholesale water providers
- Reallocation of conservation pool at Beaver Lake
- Reallocation of flood pool at Beaver Lake
- Reallocation of inactive pool at Beaver Lake
- Reallocation of combined conservation and flood pools at Beaver Lake
- Reallocation of combined conservation and inactive pools at Beaver Lake

Based on an analysis of available groundwater in the region surrounding Beaver Lake, it was determined that only a small portion of the study area over the Ozarks Plateau aquifer could accommodate wells (a small portion of Benton County, and northern segments of Carroll and Boone counties). Supplying the amount water requested (22 mgd) with groundwater alone would require 51 new wells, assuming yields of 300 gallons per minute. Given the high costs, and inefficiencies associated with installing and operating at least 51 new wells, the study team screened groundwater from further consideration.

Storage from another reservoir alternative was screened from further consideration due to high costs and likely significant environmental impacts associated with construction of 50+ miles of pipeline from Table Rock Lake to northwest Arkansas.

Purchasing water from wholesale water suppliers was screened from consideration due to lack of suppliers. Beaver Water District is the only wholesale water supplier in the region, and they have made it clear that they will not wholesale water to any of the project sponsors.

The District's Dam Safety Officer and Hydrology & Hydraulic Division indicated that they do not support the raising of the conservation pool, i.e., flood reallocation at Beaver Lake for several reasons:

- Surcharge operations would become more frequent and larger in magnitude with the rise in pool elevation.
- Raising the conservation pool would decrease the ability of the lake to safely retain water during heavy rain events.
- Increased frequency and volume of releases would translate into higher flood damages.
- More spillway releases would increase the likelihood of spillway releases for downstream dams, particularly Table Rock and Bull Shoals Dams, which are both DSAC 3 dams. Even a small increase in risk at a DSAC 3 dam is unacceptable.
- Environmental Agencies have stated that a higher conservation pool would negatively impact endangered species in the area.
- Increased hydraulic head loading on Beaver Dam structures would likely increase risks of dam breach or failure.

Reallocation from the inactive pool at Beaver Lake alternative was screened from further consideration as a sole source alternative due to a conflict with public law. During the evaluation of the alternatives, a public law was found that restricts lowering the conservation pool elevation. Public Law 106-53 (August 17, 1999), states ". . . except that at no time shall the bottom of the conservation pool be at an elevation that is less than 1,076 feet, NGVD." Reallocating solely from the inactive pool would require the conservation pool to drop below this restricted elevation.

Reallocation from Beaver Lake with combined flood and conservation pools was screened from further consideration because of the flood pool sole source component of the reallocation. All impacts from a sole source flood pool reallocation from Beaver Lake are the same with any combination of flood and conservation pool reallocation due to raising the water level of the lake.

Final Alternatives

There were three alternatives which were carried forward for further evaluation and analysis. This section presents an analysis of each resource topic that was identified as having a potential to be affected by implementation of these three alternatives. The section is organized by resource category, and presents the effects of each of the alternatives on that resource. Impacts are quantified whenever possible. Qualitative descriptions of impacts are explained by accompanying text where used. Table 7-2 below provides a summary of possible impacts to resources by alternative.

“Significance” has been analyzed in this document in terms of both context (sensitivity) and intensity (magnitude and duration):

- Magnitude
  - Minor – noticeable impacts to the resource in the project area, but the resource is still mostly functional;
  - Moderate – the resource is impaired, so that it cannot function normally;
  - Major – the resource is severely impaired so that it is no longer functional in the project area;

- Duration
  - Short term – temporary effects caused by the construction and/or implementation of a selected alternative;
  - Long term – caused by an alternative after the action has been completed and/or after the action is in full and complete operation;

Table 7-2: Summary of Potential Effects by Alternative

Resource	No Action/ Future Without Project	Beaver Lake reallocation of conservation pool	Beaver Lake reallocation from combined conservation and inactive pools
Land Use	Potential major impacts, dependent on new reservoir location.	Impacts to hydropower purpose. Although analysis determined not serious effects.	No impacts
Air Quality	Minor, short term impacts associated with new reservoir construction.	Possible minor (insignificant) increases in pollutants if lost energy production from hydropower is replaced by coal or gas fired plants.	Possible minor (insignificant) increases in pollutants if lost energy production from hydropower is replaced by coal or gas fired plants.
Climate and Climate Change	Possible minor impacts	Possible minor impacts	Possible minor impacts
Geologic Resources	Possible impacts. Potential exists for erosion or inundation of Prime Farmlands. Magnitude impossible	No impacts	No impacts

Resource	No Action/ Future Without Project	Beaver Lake reallocation of conservation pool	Beaver Lake reallocation from combined conservation and inactive pools
	to evaluate without specific area identified for new reservoir.		
Water Resources	Additional surface water available for water supply. No or insignificant impacts to groundwater.	No impacts	No impacts
Biological Resources	Potential exists for significant impacts to biological resources (wildlife, threatened and endangered species, and vegetation) from new reservoir construction. Without knowing the specific area specific impacts cannot be identified.	No impacts	No impacts
Hazardous, Toxic, and Radioactive Waste	Potential exists for constructed related impacts. Existing waste cannot be evaluated without knowing new reservoir location.	No impacts	No impacts
Noise	Moderate increase in noise from heavy equipment associated with new reservoir construction.	No impacts	No impacts
Cultural Resource	Potential major impacts, dependent on new reservoir location.	No impacts	No impacts

Resource	No Action/ Future Without Project	Beaver Lake reallocation of conservation pool	Beaver Lake reallocation from combined conservation and inactive pools
Socioeconomic Resources	Negative impacts to landowners at new reservoir site; loss of property taxes; new job creation; new recreational opportunities;	Lost hydropower revenue	Lost hydropower revenue
Environmental Justice	No impacts anticipated	No impacts	No impacts
Cumulative Impacts	Potential exists, but without knowing location of new reservoir, cannot determine other past, present or future impacts.	None identified	None identified

7.2 Resources Eliminated From Further Consideration

The following resources have been considered and found not to be affected by the proposed alternatives. Where there were no potential effects identified, the resource itself has been eliminated from further evaluation and analysis. A summary of eliminated resources follows:

Geologic Resources (Topography, Geology, Mining)

None of the alternatives evaluated for water reallocation would have any impact to the topography or geology in the study area. Gravel mining, likewise, would not be impacted by conservation pool reallocation; and combined conservation & inactive pool alternatives. Potential exists for some impact to existing or future mining locations with implementation of FWOP, depending on the location of the new reservoir. Without knowing the specific area for construction of a new reservoir, it is impossible to estimate the magnitude of resource impacts. Duration of impacts would likely be permanent.

Noise

Conservation pool reallocation; and combined conservation & inactive pool alternatives would not affect noise levels around Beaver Lake. Construction activities associated with FWOP (new reservoir) would create minor to moderate increases in noise levels, depending on the location of the new reservoir, and its proximity to populated areas. These would be short-term impacts that would end once construction is complete. Recreational activities associated with a new reservoir would increase ambient noise levels, however without knowing the location, and what activities would be allowed, it is impossible to assess potential noise impacts.

Cultural Resources

There would be no impacts to cultural resources from conservation pool reallocation; and combined conservation & inactive pool alternatives, as there would be no change in the surface water elevation, nor any construction activities around the lake associated with the reallocation. FWOP could have major and permanent impacts to cultural resources due to construction of a new reservoir and associated pump stations and pipelines necessary for water distribution. However, without knowing the specific construction site, it is impossible to assess potential impacts to historic properties or archeological sites.

7.3 Resources Evaluated

7.4 Land Use

Since neither alternatives, conservation pool reallocation nor combined conservation & inactive pool alternatives would raise (or lower) the operating surface water elevations on Beaver Lake, land use surrounding the lake would not change. In contrast, FWOP would have significant impacts on land use if a new water supply reservoir were constructed. Construction of a new reservoir capable of providing similar amounts of water evaluated in this study would inundate anywhere from 5,000 to 10,000 acres of rural land, resulting in potential displacement of humans and loss of wildlife habitat (discussed further in subsequent sections below).

7.5 Air Quality

FWOP has the potential for minor, short-term impacts to air quality should the water districts elect to construct a new reservoir for supply needs. Impacts to air quality would be construction related, and would be relatively short-term and minor in intensity.

Conservation pool reallocation; and combined conservation & inactive pool alternatives would decrease both dependable capacity and energy available from the Beaver Lake hydropower plant; and presumably, alternate sources of power such as gas, coal or nuclear fired plants would make up for the lost generation. If coal or gas fired plants compensate for the reduction, a minor increase in emissions would occur in the combustion area (which would be outside the project area). Assuming that minor increase of pollutants emitted by a fossil fuel generation plant is proportional to power production, the increase in emissions would likely be insignificant.

Based on data provided by Southwestern Power Administration (SWPA), reallocation of 42,000 acre-feet from the conservation pool would result in a dependable capacity loss of about 3.4 megawatts (3,400 kilowatts), and an annual peaking energy loss of about 8,300 megawatt-hours (8.3 million kilowatt-hours). Assuming the same mix of generation types for the Energy Information Administration's Midwestern region, which includes Arkansas (Table 7-3), reallocating storage from the conservation pool would increase releases of Sulfur Dioxide by 19 tons per year, Nitrous Oxide by 12 tons annually, and Carbon Dioxide by 4,016 tons. When compared to total annual emissions in Arkansas from power generation on percent basis, the increase would be inconsequential (0.02 percent, 0.03 percent, and 0.01 percent, respectively) (Table 7-4).

Table 7-3: Estimated Average Power Generation Emissions by U.S. Region (pounds per kilowatt hour)

Region	Sulfur Dioxide	Nitrous Oxide	Carbon Dioxide
New England	0.007	0.002	0.691
New York and New	0.005	0.002	1.014
Midwest	0.008	0.005	1.731
South Atlantic	0.007	0.004	1.429
West	0.001	0.000	1.002
Northwest	0.000	0.001	0.244
U.S.	**0.006**	**0.004**	**1.276**

Source: Energy Information Agency, "2015 Annual Outlook for U.S. Electric Power"

Table 7-4: Increase in emissions from combustion power generation

	Sulfur Dioxide	Nitrous Oxide	Carbon Dioxide
Annual emissions in Arkansas (tons per year)*	84,823	44,434	28,283,302
Increased Emissions due to Reallocation from Conservation Pool	19	12	4,016
Increased Emissions due to Reallocation from Conservation Pool	0.02%	0.03%	0.01%

* Data from the U.S. Environmental Protection Agency Emissions & Generation Resource Integrated Database (E-GRID)

7.6 Climate and Climate Change

FWOP could theoretically affect or contribute to climate change given that anaerobic bacteria would decompose vegetation that remained in the reservoir footprint after inundation. Unless all vegetation was removed, bacteria would release greenhouse gases such as methane and carbon dioxide (Lindström 2012). This release would be extremely minor when mixed with existing atmospheric gases. The converted acres for a new reservoir may result in a decrease in vegetated acres that traps atmospheric carbon dioxide. Without knowing the location of a new reservoir, it is impossible to estimate the amount of vegetation loss. Emissions from construction vehicles would also contribute minor pollutants into the air for a short period of time. All of these potential impacts to climate change are considered minor.

Conservation pool reallocation; and combined conservation & inactive pool alternatives could both have minor impacts to climate, since hydroelectric generating capacity would decline, and thus presumably would need to be offset by another source of energy. Offsetting lost hydropower with coal fired generation would result in minor increases in emissions of greenhouse gas and other emissions (see Cumulative Impacts section).

Any changes in the climate by implementation of any alternative would be insignificant, and fall within the range of natural variation discussed by the USGCRP for the Southeast Region (http://nca2014.globalchange.gov/report/regions/southeast).

7.7 Topography, Physiography, and Soils

FWOP, with the construction of a new reservoir, would have minor to moderate impacts via inundation of land. Erosion of soils due to land disturbance and removal of vegetation would occur at the dam site, staging area, temporary roads and borrow areas. Soils, and possibly prime farmland soils, would be disturbed and/or inundated with a new reservoir. Construction and operation would also disrupt normal soil and sediment transport in the impounded watercourse, and sediment deposition would occur, mainly within the upper reaches of a new lake. Releases of water from a dam could scour and move existing soils in the channel and floodplain downstream of the dam. Without knowing the location of a new reservoir, site-specific impacts cannot be identified.

Conservation pool reallocation; and combined conservation & inactive pool alternatives would both have no effect to the topography, physiography or soils.

7.8 Water Resources

FWOP would have the greatest impacts to water resources. Construction of a new reservoir would result in changes to water resources (surface and groundwater) both upstream and downstream. River diversion may occur upstream to bring more water into the reservoir and increase its capacity, which could partially dehydrate landscapes. As a general rule, groundwater levels decrease in areas with diverted rivers and increase in the areas close to, and downstream of, reservoirs, but impacts to groundwater are very site specific. Downstream of a reservoir, river dynamics would likely change, particularly alterations in the distribution of runoff. This is caused by the water storage and the exploitation of the reservoir volume for irrigation, production of electricity, or other purposes. As with all other resources, it is impossible to fully evaluate impacts from alternative 1 without knowing the specific site of a new reservoir.

Conservation pool reallocation; and combined conservation & inactive pool alternatives would both reduce the amount of water available in the lake for other purposes, such as hydropower generation. Impacts from the loss of available water for hydropower are largely financial, and discussed elsewhere.

7.9 Biological Resources

FWOP could have moderate to major effects on biological resources, both during construction and operation, depending on the location of reservoir construction. Overall, the most significant of adverse effects would be the inundation of thousands of acres of potential wildlife habitat after the watercourse in question were impounded. It is likely that both timber and agricultural land would be lost. Conversely, beneficial effects would also occur with the creation of new aquatic habitat in the region.

Implementation of the conservation pool reallocation; and combined conservation & inactive pool alternatives would not affect biological resources in the area since pool elevations would not change, nor would the hydrology upstream and downstream of Beaver Dam.

7.10 Threatened and Endangered Species

FWOP has potential to adversely impact threatened or endangered species; however, without knowing the exact location of reservoir construction, species and impacts cannot be determined.

Conservation pool reallocation; and combined conservation & inactive pool alternatives would not impact any threatened or endangered species, since the lake pool elevation would remain unchanged.

7.11 Hazardous, Toxic, and Radioactive Waste

Construction of a new reservoir under FWOP would require project sponsors to identify and remove any hazardous, toxic or radioactive wastes prior to constructing a dam; however, without knowing the exact location of reservoir construction, species and impacts cannot be determined. Possible hazardous waste could be generated during construction activities by heavy equipment. Existing state and federal laws requiring best management practices should be sufficient to prevent these wastes from entering the environment.

Hazardous, toxic or radioactive wastes are not potential concerns with respect to the Conservation pool reallocation; and combined conservation & inactive pool alternatives, since neither action would affect land use.

7.12 Socioeconomic Resources

Any alternative that provides additional water for the three water districts would benefit the regional economy by providing sufficient water for additional growth and economic development. FWOP and reallocating from the conservation pool would have additional economic impacts.

Reallocation from Beaver Lake from Conservation Pool

As discussed in Section 5.0 of this report, reallocating storage from the conservation pool would affect hydropower generation in terms of forgone power benefits and forgone revenues.

Forgone hydropower benefits are based on the cost of the most likely alternate source of power. When the Corps reallocates storage from hydropower to water supply, forgone benefits are equal to costs of replacing hydropower with the most likely alternate source and can have two components: 1) lost energy benefits and 2) lost capacity benefits. In the case of water supply reallocations, there is typically a loss of energy benefits because water diverts from hydro-plant turbines to water supply intakes. These forgone benefits are based on results of analysis by the Power Branch Management Division of the Corps Northwestern Division form the basis for determining the amounts of energy and generating capacity lost due to reallocation storage from hydropower to water supply. The Power Branch's report has tables showing the marginal amounts of lost energy and capacity for a 1 million gallons per day yield reduction, which simplifies determining impacts by providing a straight forward method of converting the amount of yield reallocated to a pre-calculated amount of energy and capacity.

Forgone hydropower power revenues are based on the lost energy sales using rates charged by the Southwest Power Administration to energy customers. Hydroelectric rates (and most energy and water rates) have two components: 1) an annual variable charge used to price each kilowatt hour of electricity consumed, and 2) an annual base charge that is independent of the amount of electricity consumed. The variable rate is applied to estimated average annual energy losses due to reallocating water from the conservation pool, and the base rates charges are applied to estimated losses in marketable capacity.

To compensate for reduced hydropower revenues, the federal government would credit the Southwest Power Marketing Agency for the amount of forgone revenues forgone assuming a uniform annual repayment. The power marketing agency can also obtain a credit as stated in the Policy and Planning Guidance For Conducting Civil Works Planning Studies, ER 1105-2-100, 22 April 2000 on page E217: *"In cases where the power marketing agency has existing customer contracts, the replacement cost of power may be estimated as the agency's cost of obtaining power form the lowest cost alternative source for the duration of the contracts."* But to obtain this credit, the power marketing agency would need to provide *"documentation of the contracts and estimated of replacement costs of power to fulfill them"* and they *"should be included in the reallocation report."*

No-Action (Without Federal Project Condition)

Construction operation of a new water supply reservoir would have positive and negative impacts in terms of socioeconomics. Any property in the reservoir footprint would be lost including any residences, agricultural land or timber tracts, and project sponsors would have to compensate affected land owners and relocate any residences. Market prices based on assessed value of land and structures would determine compensation amounts. Property taxes would no longer be paid on properties covered by the reservoir.

In terms of benefits, expenditures for constructing and operating a new reservoir would generate mew economic activity for local communities in the affected region assuming the money came from outside the local economies. Expenditures have multiplier affects and support jobs, income and taxes in local communities. Expenditures can be either short term or long term. Short-term (probably about 3 to 4 years) expenditures end after initial construction outlays for the dam and other facilities. Long-term expenditures associated with dam and facility operation and maintenance would recur over time and would persist over the life of the dam. Another potential benefit of a new lake are new recreation opportunities such as fishing, boating, swimming, hiking and wildlife viewing. Spending associated with recreation would also benefit local communities near the lake assuming people recreating came from outside the local area, or if local residents spent money that they would have otherwise saved or spent outside of the area.

Commercial and residential development along a new lake's shoreline or in areas near the lake would also be a possibility, but as is the case with recreation, water districts owning the land may restrict or prohibit certain development to protect water quality in the lake. If new development did occur, the local economies would likely benefit from new construction activity, and new commercial businesses such as restaurants or marinas would create new jobs, income and tax revenues. Although, new residents and visitors to the local area would place greater demands for public services and infrastructure, more new residents and business activity combined with operations and maintenance expenditures for the lake would grow the local tax base.

7.13 H&H Considerations

H&H analysis showed that the inflows of water and sediment are not changed by any of the alternatives. This reallocation will have minimal impact if reallocated from conservation or inactive pool; however, a reallocation from flood pool increases damaging releases and downstream lake elevations during extreme events and is NOT recommended. The full analysis and conclusion is located at Appendix D.

7.14 Sedimentation Considerations

H&H analysis showed sediment levels or predictions are not changed by any of the alternatives. The full analysis is located at Appendix D.

7.15 Environmental Justice

Executive Order 12898, entitled “Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations,” addresses potential disproportionate human health and environmental impacts that a project may have on minority or low-income communities. Thus, the environmental effects of the Project on minority and low-income communities or Native American populations must be disclosed, and agencies must evaluate projects to ensure that they do not disproportionally impact any such community. If such impacts are identified, appropriate mitigation measures must be implemented.

To determine whether a project has a disproportionate effect on potential environmental justice communities (i.e., minority or low income population), the demographics of an affected population within the vicinity of the Project must be considered in the context of the overall region. Guidance from the Council on Environmental Quality (CEQ) states that “minority populations should be identified where either: (1) the minority population of the affected areas exceeds 50 percent, or (b) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis (CEQ 1997).”

Census data summarizing racial, ethnic and poverty characteristics of areas adjacent to construction sites (loops and compressor stations). The purpose is to analyze whether the demographics of the affected area differ (i.e., Census Tract) in the context of the broader region (the county as a whole); and if so, do differences meet CEQ criteria for an Environmental Justice community. Based on the analysis, it does not appear that minority or low income populations in the Project area are disproportionately affected.

Table 7-5 also displays the number of children adjacent to Project areas. The purpose of the data is to assess whether the project disproportionally affects the health or safety risks to children as specified by Executive Order (E.O.) 13045 - *Protection of Children from Environmental Health Risks and Safety Risks* (1997). Overall, it does not appear that the Project would disproportionally affect children.

Table 7-5: Racial Composition, Number of Children and Poverty Indictors in the Upper White River Basin

Region	White	Black or African American	Native America n or Indian	Asian	Native Hawaiian or Pacific Islander	Hispanic or Latino	Other or two or more races	Percent Un-employed	Percent of population below poverty line	Percent of population under age 17
United States	56.10	12.6	0.9	4.8	0.2	16.3	9.1	6.2	15.4	23.7
State of Arkansas	70.60	15.40	0.80	1.20	0.20	6.40	5.40	5.1	15.8	24.2
State of Missouri	79.30	11.60	0.50	1.60	0.10	3.50	3.40	5.6	15.5	23.5
Barry (Missouri)	84.40	0.30	0.90	1.30	0.00	7.70	5.4	8.0	19.1	24.0
Benton (Arkansas)	63.70	1.30	0.90	2.70	0.10	18.70	12.60	3.6	12.2	18.0
Boone (Arkansas)	94.70	0.20	0.70	0.40	0.10	1.80	2.10	5.2	16.6	23.0
Carroll (Arkansas)	76.90	0.40	0.90	0.60	0.10	12.70	8.40	4.5	18.8	22.4
Christian (Missouri)	93.20	0.60	0.60	0.50	0.10	2.50	2.50	5.1	10.6	23.9
Douglas (Missouri)	96.30	0.20	0.60	0.20	0.00	0.80	1.90	5.4	22.6	22.0
Greene (Missouri)	88.20	2.90	0.70	1.60	0.10	3.00	3.50	5.4	18.7	21.2
Madison (Arkansas)	88.80	0.20	1.20	0.50	0.10	4.80	4.40	5.6	18.0	24.2
Marion (Missouri)	95.30	0.20	0.70	0.20	0.00	1.70	1.90	4.4	16.2	23.6
Taney (Missouri)	85.90	0.90	0.80	0.70	0.10	7.70	3.90	7.1	18.8	21.8

Washington (Arkansas)	64.80	3.00	2.00	2.20	2.00	15.10	10.90	5.0	20.7	25.2
Webster (Missouri)	94.60	0.90	0.70	0.20	0.00	1.70	1.90	4.7	18.9	30.8
Total Project Area	78.51	1.83	1.03	1.65	0.48	9.47	7.04	5.0	17.0	22.7

Source: U.S. Census Bureau: 2013 American Community Survey. Accessed online: 14 August, 2015.

7.16 CUMULATIVE IMPACTS

No additional projects or activities have been identified in the Beaver Lake project area that would impact the resources considered. Normal maintenance and operations activities would continue to occur, but would not increase the intensity or duration of impacts discussed.

There could be cumulative impacts associated with FWOP (construction of a new reservoir), however, without knowing the location of the new reservoir, it is impossible to determine any other past, present, or future activities that could have impacts.

7.17 SUMMARY OF RECOMMENDED PLAN

Reallocation from the conservation pool has no effects on geological resources, water resources, biological resources, HTRW, noise, cultural resources, socioeconomic resources, environmental justice, or cumulative effects. While there is an effect to hydropower generation, the team analyzed this impact and determined that it would not result in a serious effect to the hydropower purpose. Although the environmental impacts are similar between the conservation pool alternative and the combined conservation pool and inactive pool alternative, the combined pool alternative requires additional storage and costs for DYMS. Use of the inactive pool storage reduces the emergency drought-contingency pool for the Corps and also reduces hydropower's operating head. Due the additional costs and other effects associated with the use of combined conservation pool and inactive pool alternative, using the conservation pool at Beaver Lake to reallocate from the hydropower purpose to the water supply purpose is the most suitable plan.

7.18 CONCLUSION OF ENVIRONMENTAL ASSESSMENT

No alternatives identified in this report/EA would have significant impacts on the human environment. The proposed action, reallocation of water supply from the conservation pool, would have the least effect on the environmental and socioeconomic resources in the area. Hydropower generation would be affected by this reallocation, but the impact to the hydropower purpose would not be significant, and it would be compensated through appropriate methods as listed.

8.0 Public Involvement, Review, and Consultation

8.1 Public Involvement Program

On June 30, 2015, USACE sent out a Scoping Letter to interested parties, including state and federal agencies, local communities and conservation districts, water municipalities, and area marinas, to help identify concerns and issues that might be addressed, and bring them to USACE attention. On July 19, 2015, a similar Scoping letter was sent to potentially interested Tribes, requesting information and comments. These letters also inquired whether the Tribe would like to participate as a consulting party under Section 106 of the National Historic Preservation Act of 1966, as amended. A copy of these Scoping letters and a complete list of agencies and Tribes contacted, can be found in Appendix F.

8.2 Institutional Involvement

Study Team

The following individuals were primarily responsible for the preparation of this report:

Glenn Proffitt – Project Manager

Tacy Jensen – Study Manager

Stuart Norvell – Economist

Nathaniel Keen – Civil Engineering and Engineering Lead

Craig Hilburn – Biologist and NEPA lead

Seth Sampson – Cultural Resources

Martin Regner – Cost Engineering

Jeremy Johnson – Real Estate

Agency Coordination

Coordination was completed with tribes, local, state, federal agencies and other interested parties for this study. Responses were received from the U.S. Fish & Wildlife Service, Arkansas Natural Resources Commission, Arkansas Geological Survey, Arkansas Department of Parks and Tourism, Arkansas Highway and Transportation Department, Southwestern Power Administration, and the Arkansas Natural Heritage Commission. Most environmental agency comments and concerns focused on impacts to the karst region and endangered species with a water level raise. Southwestern Power Administration voiced concerns over the reallocation. All other comments were supportive. A copy of the coordination list, all scoping letters, and responses are located in Appendix F.

9.0 CONCLUSIONS.

The analysis conducted during the course of study to-date indicate that Reallocation of Storage in Beaver Lake's Conservation Pool from the Hydropower Purpose to Water Supply Storage, is the most technically feasible, cost-effective, and environmentally sound alternative of those evaluated. The detailed evaluation, comparison and screening analysis conducted indicates that this alternative should be adopted as the Recommended Plan. This plan consists of reallocation of 41,960 acre-feet of storage from existing hydropower purpose to supplement three existing water entities water supply storage, and would benefit the three water utilities and its partner water agencies, as well as all residents within the service area benefitting from this action.

Supplemental Water Supply Agreements will be prepared for these three water entities to include the obligations related to the reallocation.

10.0 RECOMMENDATIONS.

It is recommended that the USACE allow the reallocation of 41,960 acre-feet of storage in Beaver Lake, from existing hydropower storage, to water supply storage, for the long-term benefit of Benton Washington, Carroll Boone and Madison County Water Districts and service areas. I have determined that it is within the discretionary authority of the Chief of Engineers to approve this proposed action, as the Recommended Plan does not include any mitigation or modifications which would affect the purposes for which the project was authorized, surveyed, planned, or constructed, nor would it involve major structural or operational changes. A draft Finding of No Significant Impact (FONSI) is provided as an attachment to this report.

Robert G. Dixon
Colonel, US Army
District Engineer

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