Stockton Lake Reallocation Study

Draft Integrated Water Supply Storage Reallocation Report and Environmental Assessment

June 2020

US Army Corps of Engineers ®
Kansas City District

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FINDING OF NO SIGNIFICANT IMPACT

STOCKTON LAKE WATER SUPPLY STORAGE REALLOCATION STUDY FEASIBILITY STUDY WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

CEDAR, POLK, AND DADE COUNTIES, MISSOURI

The U.S. Army Corps of Engineers, Kansas City District (Corps) has conducted an environmental analysis in accordance with the National Environmental Policy Act of 1969, as amended. The draft final Integrated Feasibility Report and Environmental Assessment (IFR/EA) dated 10 June 2020, for the Stockton Lake Water Supply Storage Reallocation Report addresses water supply storage opportunities and feasibility in the Stockton Lake project area of Cedar, Polk, and Dade Counties, Missouri. The final recommendation will be contained in the Director's Report, anticipated in January 2021.

The Draft Final IFR/EA, incorporated herein by reference, evaluated various alternatives that would provide additional water supply storage to meet the needs of communities in Southwest Missouri. The recommended plan is Alternative 7, and includes:

- Reallocation of 45,750 acre-feet (AF) from the multipurpose pool and 49,000 AF from the flood control pool, with a 1.8-foot increase to the normal pool elevation (i.e., a pool raise). The value of the 94,750 AF of storage in fiscal year 2020 dollars (FY20) is estimated to cost $35,800,000 based on the updated cost of storage.
- The plan includes a new water intake structure within existing water supply user easements at Stockton Lake.
- A water transmission pipeline from the intake structure to the water supply user's water treatment facilities will be assessed in the future through the USACE regulatory process.
- As a test of financial feasibility, the cost of the reallocated storage was compared to the cost of the most likely, least costly alternative for a reliable source in the absence of reallocating storage at Stockton Lake. The most likely, least costly alternative was determined to be construction of a new reservoir and associated transmission and treatment lines. The results of the comparison indicate reallocating water supply storage from Stockton Lake is the least costly alternative to meet water supply gaps.

In addition to a "no action" plan, eleven alternatives were evaluated. The alternatives included increased water conservation measures, new reservoir construction, additional groundwater withdrawals, and multiple water importation and reallocation projects. Alternative 5: Water supply storage reallocation from the Stockton Multipurpose Pool (90,200 acre-feet) and Alternative 7: Water supply storage reallocation from a combination of the Stockton Multipurpose and Flood Control Pools (45,750 acre-feet from the multipurpose pool/49,000 acre-feet from the flood control pool) were carried forward for detailed analysis in the EA. Section 3 of the EA describes the plan formulation, and Section 5 of the EA evaluates the final array of alternatives.

For all alternatives, the potential effects were evaluated, as appropriate. A summary assessment of the potential effects of the recommended plan are listed in Table 1:

Table 1. Summary of Potential Effects of the Recommended Plan

Resources	Insignificant effects	Insignificant effects as a result of mitigation*	Resource unaffected by action
Aesthetics	☒	☐	☐
Air quality	☒	☐	☐
Aquatic resources/wetlands	☒	☐	☐
Invasive species	☒	☐	☐
Fish and wildlife habitat	☒	☐	☐
Threatened/Endangered species/critical habitat	☒	☐	☐
Wildlife Management Refuge Areas	☒	☐	☐
Wild and Scenic Rivers	☐	☐	☒
Historic properties	☐	☒	☐
Other cultural resources	☐	☒	☐
Floodplains	☐	☐	☒
Hazardous, toxic & radioactive waste	☐	☐	☒
Hydrology (lake elevation, downstream releases)	☒	☐	☐
Land use	☒	☐	☐
Noise levels	☒	☐	☐
Public infrastructure and Recreational Amenities	☐	☒	☐
Socioeconomics	☒	☐	☐
Environmental justice	☒	☐	☐
Soils	☒	☐	☐
Tribal trust resources	☐	☐	☒
Water quality	☒	☐	☐
Climate change	☒	☐	☐
Lake Operations	☒	☐	☐
Hydropower	☒	☐	☐
Real Estate	☐	☐	☒

All practicable and appropriate means to avoid or minimize adverse environmental effects were analyzed and incorporated into the recommended plan. Best management practices (BMPs) as detailed in the IFR/EA will be implemented, if appropriate, to minimize impacts. Based on the 1950 to 2012 period of record, Alternative 7 would have little difference in the average annual number of days for above normal, normal and below normal surface water elevations (National Geodetic Vertical Datum of 1929) as compared to baseline conditions. Above normal surface water elevations greater than or equal to 870.0 feet would be approximately 1 additional day per year. At normal water surface elevations (869.9 to 865.0 feet), 7 additional days would be expected. At below normal surface water elevations (864.9 to 845.1 feet), approximately eight fewer days would be expected on an average year.

The recommended plan may result in unavoidable adverse impacts to cultural sites located around the shoreline of Stockton Lake. Water surface elevation fluctuations associated with normal lake operations and minor changes associated with implementation of Alternative 7 may increase the potential for erosion and other processes leading to cultural resource site damage. Approximately 549 cultural resource sites have been formally recorded within the study area. Twenty-four of these sites are located within the 1.8-feet pool raise water surface elevations of 867.0 to 868.8 feet for Alternative 7. However, as large portions of the study area have not been surveyed, additional sites are likely present within all lake elevations. To mitigate for potential unavoidable adverse impacts, USACE will require the water supply

user to provide funds to conduct further survey work, further testing, and potential mitigation for sites that are identified to be adversely impacted as a result of the 1.8-foot pool raise. Coordination with the State Historic Preservation Office, the Advisory Council on Historical Properties, and the Tribes is ongoing and will include preparation of a Programmatic Agreement, which will outline and cover the processes for further testing and any necessary mitigation. Additional cultural resource information can be found in Section 7.7 of the EA and in Appendix G and Appendix M.

For Alternative 7, there would be a slight reduction of swim beach area and a one-time cost of $25,000 to re-anchor associated buoys for all 6 swim beaches. Overall, the lake elevations are expected to remain around the normal lake elevation of 867.0 feet. For other recreation features such as campsites, picnic tables and roads, a pool raise may close the sites one or two additional days per year.

A 30-day public, state, and resource agency review of the draft IFR/EA and FONSI will be completed in June-July of 2020. All comments submitted during the review period will be responded to in the Final IFR/EA and FONSI.

Pursuant to Section 7 of the Endangered Species Act of 1973, as amended, USACE determined that the recommended plan may affect but is not likely to adversely affect the following federally-listed species or their designated critical habitat: gray bat, Indiana bat, and northern long-eared bat, Niangua darter, Ozark cavefish, geocarpon, and Mead's milkweed.

Water releases from Stockton Lake were also assessed to determine if any potential flow changes could affect downstream mussel populations. Based on review of hydrologic data, no significant changes to downstream flows or elevations are anticipated with implementation of the recommended plan. The U.S. Fish and Wildlife Service (FWS) will review the Draft Final IFR/EA during the 30-day review period. It is anticipated that the FWS will concur with USACE's determination following review of the draft documentation. Final FWS concurrence will be included in Appendix F of the EA.

Pursuant to Section 106 of the National Historic Preservation Act of 1966, as amended, USACE determined that historic properties may be adversely affected by the recommended plan. USACE and the Missouri State Historic Preservation Office, along with the Osage Nation and the Ponca Tribe and the Advisory Council on Historic Preservation entered into a Programmatic Agreement (PA), dated XX. All terms and conditions resulting from the agreement shall be implemented in order to minimize adverse impacts to historic properties.

Pursuant to the Clean Water Act of 1972, as amended, the discharge of dredged or fill material associated with the recommended plan has been found to be compliant with Section 404(b)(1) Guidelines (40 CFR 230). The proposed new water intake structure within existing water user easements would comply with Nationwide Permit 7. The future water user pipeline alignment from the water intake structure to the users' water treatment facilities would be assessed under the USACE regulatory permitting process. City Utilities of Springfield, Missouri has a pipeline built from Stockton Lake to Fellows Lake north of Springfield, Missouri. Tri-State Water Resources Coalition plans to construct the new pipeline within City Utilities existing easement because there is sufficient room for another pipeline. Impacts from the original City Utilities pipeline was evaluated under the Environmental Macro-Corridor Study Proposed City Utilities of Springfield, Stockton Water Supply Project, November 1991. The Clean Water Act Section 404(b)(1) Guidelines evaluation is found in Sections 4.4.6 and 10.3 of the IFR/EA.

All applicable environmental laws have been considered, and coordination with appropriate agencies and officials has been completed. The Missouri Department of Conservation (MDC) was coordinated with for potential adverse impacts to the Aldrich Refuge, located along the shoreline of Stockton Lake. The MDC concurred with USACE's determination that changes in inundation days and water surface elevations with the recommended plan would be insignificant with some additional days at, above, or below normal pool elevations. Results of the Aldrich Refuge analyses are include in Section 7.4.5 of the EA.

Impacts to Hydropower and the Southwestern Power Administration (SWPA) were assessed. Hydropower benefits forgone are estimated to be $242,000; a higher pool elevation is more advantageous to generate power. Overall, there is a -0.70% change from the capacity and energy values of the Osage Federal System, which includes Stockton and Truman as compared to the No Action condition. The projected capacity and energy losses at Stockton Lake are estimated to be -1.18% as compared to the No Action condition. Truman is expected to have minor capacity value losses and minor energy value losses (less than 0.6%). A letter will be sent to SWPA following execution of the water storage agreement at Stockton Lake documenting the date of agreement execution and the average annual energy and capacity losses due to the Stockton Lake water reallocation. This letter will allow SWPA to receive credits, which will mitigate the loss of energy and capacity.

- Technical, environmental, and economic criteria used in the formulation of alternative plans were those specified in the Water Resources Council's 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. All applicable laws, executive orders, regulations, and local government plans were considered in evaluation of alternatives. Based on this report, the reviews by other Federal, State and local agencies, Tribes, input of the public, and the review by my staff, it is my determination that the recommended plan would not cause significant adverse effects on the quality of the human environment; therefore, preparation of an Environmental Impact Statement is not required.

_____
Date

_____
William C. Hannan, Jr.
Colonel, Corps of Engineers
District Commander

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Executive Summary

This report has been prepared by the U.S. Army Corps of Engineers (USACE), Kansas City District, with CDM Smith Federal Programs Corporation under contract, to present the results of a study that assesses the feasibility of reallocating water supply storage in Stockton Lake for the Tri-State Water Resource Coalition (or Southwest Missouri Joint Municipal Water Utility Commission, collectively referred to as Southwest Missouri Regional Water). The report includes an integrated environmental assessment of the proposed action. The water supply storage reallocation is in response to a request made by Southwest Missouri Regional Water in 2007, and subsequent update requests in 2014 and 2016, to obtain enough storage to meet a projected gap of 39 million gallons per day in 2070. The reallocation study received initial operations funding in fiscal year (FY) 2014.

The study concludes that reallocating 45,750 acre-feet (AF) from the multipurpose pool and 49,000 AF from the flood control pool, with a 1.8-foot increase to the normal pool elevation (i.e., a pool raise), is the most efficient means to meet the present and future needs of the water supply users without significantly impacting the currently authorized project purposes. The value of the 94,750 AF of storage in FY2020 dollars is estimated to cost $35,800,000 based on the updated cost of storage. As a test of financial feasibility, the cost of the reallocated storage was compared to the cost of the most likely, least costly alternative for a reliable source in the absence of reallocating storage at Stockton Lake. The most likely, least costly alternative was determined to be construction of a new reservoir and associated transmission and treatment lines. The results of the comparison indicate reallocating water supply storage from Stockton Lake is the least costly alternative for Southwest Missouri Regional Water to meet its water supply gap.

Located in southwest Missouri, Stockton Lake is a USACE project operated for the authorized purposes of flood control, hydropower, water quality, recreation, fish and wildlife management, and water supply. The reallocation of an additional 94,750 AF of storage would increase the total storage reallocated from the multipurpose pool for water supply to 95,750 AF (based on an existing water supply agreement for 50,000 AF) and the total storage reallocated from the flood control pool to 49,000 AF. The total water supply storage available would be 144,750 AF of storage. This reallocation would provide sufficient water supply for the southwest Missouri region into the year 2070.

Hydrologic studies, as required by Engineer Regulation 1110-2-1156, Safety of Dams – Policy and Procedures, indicate that a 1.8-foot increase to the current pool elevation would have no impact on dam safety and no change to the incremental risk associated with Stockton dam. Based on updated USACE risk assessment guidelines, Stockton dam was recently changed from a Dam Safety Action Classification (DSAC) rating of 4 to 3 (i.e., the lower the number the higher the risk). This change is because of a change in engineering criteria for evaluating the probable maximum flood (PMF) on the dam and is not related to the reallocation action. USACE Kansas City District funded a detailed study in FY2019 to provide a more refined estimate of the PMF, which will allow a better understanding of the hydrologic risk. This study will be completed by end of FY2020 and will be used to reassess hydrologic risk at the dam.

The water supply storage reallocation study proposes a phased implementation of storage reallocation. Approval of this report will enable reallocation of the entire volume of 94,750 AF for water supply storage. However, the implementation of reallocation through water supply contracts for storage will be phased, with a recommendation to execute an immediate water storage agreement for the lesser volume of 45,750 AF from the multipurpose pool upon approval of this report. In FY2024, further dam safety evaluations will be conducted as part of the cyclical Dam Safety Periodic Assessment at Stockton Dam. The results of the assessment will determine if the DSAC should be reclassified as a 4 in accordance with the risk guidelines. If the DSAC rating is reclassified as a 4 and approved by the Headquarters USACE Chief of Engineers, a water storage agreement for the remaining 49,000 AF of storage could be executed by Southwest Missouri Regional Water and the 1.8-foot pool raise would be implemented. Southwest

Missouri Regional Water is aware of the DSAC rating and their responsibility associated with any major repairs required to restore the rating to a 4 or seek a waiver to policy if a 4 rating is not achievable.

The Recommended Plan does not seriously affect the authorized purposes of the project or involve major structural or operational changes to the reservoir. By implementing a 1.8-foot pool raise and reallocating storage from both the flood pool and the multipurpose pool, the lake elevations are less prone to severe draw-down effects during drought while on the other hand making changes during high water insignificant based on the 63-year period of record analysis.

Summary of Authorized Purposes Impacts:

- Dam Safety: The pool raise did not impact dam safety or change its incremental risk.
- Flood Risk Management: There are no additional flood risk management impacts or increased inundation downstream.
- Hydropower: Hydropower benefits forgone are estimated to be $242,000; a higher pool elevation is more advantageous to generate power. Overall, there is a -0.70% change from the capacity and energy values of the Osage System, which includes Stockton and Truman as compared to the No Action condition. The projected capacity and energy losses at Stockton Lake are estimated to be 5.5% as compared to the No Action condition. Truman is expected to have minor capacity value losses and minor energy value losses (less than 0.6%). A letter will be sent to SWPA following execution of the water storage agreement at Stockton Lake documenting the date of agreement execution and the average annual energy and capacity losses due to the Stockton Lake water reallocation. This letter will allow SWPA to receive credits, which will mitigate the loss of energy and capacity.
- Recreation: Negligible differences between the recommended plan and the base condition. The model projects only one day less or more under various elevation ranges during the recreation season. The pool raise offsets drawdown effects during drought. A one-time $25,000 cost to relocate swim buoys has been identified for swimmer safety.
- Environmental: Only minor, negligible impacts were identified. The downstream gage readings change negligibly.
- Cultural Resources: Although cultural resources mitigation has been identified, the impact is expected to be minimal based on the comparison to the current condition. Coordination is ongoing with the State Historic Preservation Office, the Advisory Council on Historical Properties, and the Tribes to sign a Programmatic Agreement.

The recommended plan provides approximately $9.8 million in net benefits and it better meets the study objectives outlined in the main report by minimizing impacts to other authorized purposes. Southwest Missouri Regional Water is in agreement, that even though the Recommended Plan is slightly more costly than the other alternative evaluated of a multipurpose pool only reallocation, the outcome will be less impactful to all authorized purposes, while still reducing the risk of water shortages during drought. An Environmental Assessment, as directed by the National Environmental Policy Act (NEPA), is integrated into this report. The Recommended Plan to reallocate 45,750 AF from the multipurpose pool and 49,000 AF from the flood control pool for water supply, with a 1.8-foot increase to the normal pool elevation, complies with the requirements of NEPA.

In addition to the upfront cost of storage, Southwest Missouri Regional Water also will be responsible for its proportional share of the annual operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) costs, including costs for dam safety. Total estimated costs are based on 6.60 percent of total usable storage; the user is estimated to pay approximately $1,797,000 annually for 30 years at the current FY2020 water supply interest rate of 2.875 percent and is adjusted every 5 years. Approximately $190,000 annually will be paid for OMRR&R costs as long as the project is operational.

1.0 Purpose and Authority

1.1. Study Overview

The following document has been prepared by the U.S. Army Corps of Engineers (USACE), Kansas City District and with CDM Smith under contract, to present the results of a study that assesses the feasibility of reallocating water supply storage in Stockton Lake for the Tri-State Water Resource Coalition (or Southwest Missouri Joint Municipal Water Utility Commission, collectively referred to as Southwest Missouri Regional Water). The report includes an integrated Environmental Assessment of the proposed action. The water supply storage reallocation is in response to a request made by Southwest Missouri Regional Water in 2007, and subsequent updated requests in 2014 and 2016, to obtain enough storage to meet a projected gap of 39 million gallons per day (MGD) in 2070.

1.2. Purpose and Need

The purpose of this reallocation report is to provide information to support a water supply reallocation from the useable multipurpose pool and/or flood control pool at Stockton Lake to satisfy 39 MGD of immediate and future water supply needs for southwest Missouri. Because of increasing populations and the lack of additional readily available water supply and delivery, water demands will not be met in the coming decades. Southwest Missouri Regional Water is the nonfederal sponsor of the project and is seeking a reallocation of water storage at Stockton Lake to meet the forecasted water demands of 2070.

1.3. Nonfederal Sponsor

Southwest Missouri Regional Water refers to two organizations: Tri-State Water Resources Coalition and the Southwest Missouri Joint Municipal Water Utility Commission. The sole purpose of the Coalition and the Commission is to ensure adequate, affordable, long-term water supply for southwest Missouri. The current 16-county footprint includes approximately 850,000 people living in the metropolitan statistical areas of Joplin, Springfield, Branson, and communities in between.

Upon forming, the Tri-State Water Resource Coalition investigated current and future water supply, demand and potential gaps. They also investigated potential sources of additional future water supply. The Coalition concluded that water from already impounded sites was preferable. In 2007 the Coalition submitted requests to USACE for reallocation of water storage from Stockton Lake (Kansas City District) and Table Rock Lake (Little Rock District). Pomme de Terre Lake (Kansas City District) was later added for consideration. The Coalition also investigated 17 additional new reservoir sites.

As the sister organizations (referred to throughout this report as Southwest Missouri Regional Water) move closer to a possible reallocation of water storage from Stockton Lake both the Coalition and the Commission anticipate that the Commission (the public water utility/governmental subdivision) will become the more dominant organization. Tri-State Water Resource Coalition, the 501c4, is in the process of transitioning to a role of education and advocacy. The Southwest Missouri Joint Municipal Water Utility Commission will be the purchaser of future water supply for the region, including the potential purchase of reallocated water storage from Stockton Lake (and/or other USACE lakes). The Commission will also be the organization to build one or more infrastructure projects to deliver future water supply to regional communities.

The following is a list of Southwest Missouri Regional Water members as of March 2020:

BARRY COUNTY

City of Monet

Pierce City (Barry/Lawrence County)

CEDAR COUNTY

City of Stockton

CHRISTIAN COUNTY

City of Nixa

City of Ozark

City of Republic (Christian/Greene County)

GREENE COUNTY

City of Springfield

City Utilities of Springfield (City Utilities)

City of Willard

Greene County

JASPER COUNTY

Carthage Water and Electric

City of Joplin

Jasper County

LAWRENCE COUNTY

City of Mount Vernon

MEMBERS AT LARGE

Empire District Electric Company

Missouri-American Water Company

TANEY COUNTY

City of Branson

STONE COUNTY

Stone County

1.4. Authority and Federal Interest

1.4.1. Water Supply Act of 1958, As Amended

The Water Supply Act of 1958 (Title III of Public Law 85-500), as amended, 43 United States Code (U.S.C.) § 390b, authorizes the Secretary of the Army to cooperate with local interests to provide water supply storage for USACE projects. The local interests must agree to pay the cost associated with the storage space. Paragraph 3-8 (5) of USACE ER 1105-2-100, provides guidance for reallocation of storage from other project purposes to water supply. The Chief of Engineers has the discretionary authority to reallocate 15 percent or 50,000 acre-feet (AF), whichever is less, of the total storage capacity allocated to all authorized project purposes, provided the reallocation has no severe effect on other authorized purposes or will not involve major structural or operational changes to the project. If reallocation or addition of storage seriously affects other authorized purposes or would involve major structural or operational changes, then congressional approval is required.

1.4.2. Water Reservoir Act of 1963 Public Law 88-140, Recognizing Permanent Rights to Storage

A nonfederal interest may acquire a permanent right to the use of storage under the authority of Public Law 88-140 (October 16, 1963). This Act is applicable to all dams and reservoirs constructed by the federal government (acting through USACE). This right is available to the nonfederal interest as long as the space designated is physically able to meet the purpose, considering any equitable reallocation among project purposes because of sedimentation. This right is obtained by the nonfederal interest upon completion of payment of the costs for the reallocation and may be utilized as long as the project is operated by the government. The nonfederal interest shall be responsible for their portion of the cost of water supply storage, and the associated percentage of joint-use annual operation, maintenance, reconstruction, rehabilitation, and replacement (OMRR&R) costs for project features.

1.4.3. Water Resources Development Act of 1986, Public Law 99-662

The Water Resources Development Act (WRDA) of 1986, Pub. L. No. 99-662, sharply modified the federal role that had been largely defined in the Water Supply Act of 1958 to place greater financial responsibility on nonfederal sponsors. Sections 103 and 932 of WRDA 1986 codified the following amendments to the Water Supply Act: elimination of the 10-year, interest-free period; reduction of the cost of storage payback period from 50 to 30 years from the date on which the storage is made available; requisite annual reimbursement of the operation and maintenance (O&M) cost (although it had been established policy that these costs be repaid on an annual basis); establishment of the nonfederal cost share assigned to an allocation of storage space in a project for municipal and industrial (M&I) water supply as 100 percent; modification of the interest rate formula; addition of a rate of 0.125 percent for transaction costs; and recalculation of the interest rate every 5 years.

1.4.4. Additional Study Guidelines

Water Rights in Missouri

All water supplies within the state are regulated by the Missouri Department of Natural Resources (MoDNR). Missouri follows the “reasonable use” theory of water use by riparian landowners whose property borders a watercourse, stream, or lake. Landowners may beneficially use water as long as they do not cause unreasonable damage to fellow users and landowners. Groundwater is also subject to the reasonable use doctrine (MoDNR 2015).

2.0 Project History

2.1. Project Background and Study Area

Federal, state, and local agencies and organizations have completed numerous studies to gain a better understanding of future regional water demand and supply availability as populations continue to rise in southwest Missouri. Among these is a three-phase Southwest Missouri Water Resource Study funded in partnership with the USACE Planning Assistance to States program and MoDNR. In the Phase I – Future Demands study, regional water demands for the 16-county region were estimated to increase by up to 72 percent by 2060 under a high-growth scenario. Using the more conservative medium-growth scenario, demands are expected to increase by approximately 125 MGD for all water use sectors by 2060, a nearly 40 percent increase.

The Phase II – Supply Availability study was conducted to evaluate current and future supply availability through 2060. Regional surface water and groundwater availability were evaluated under both normal and drought conditions. Future supplies were aligned with future estimated subregional demands from the medium-growth scenario developed in Phase I. Analysis indicated some slight future gaps, or deficits between supply and demand, during normal weather conditions. However, under drought conditions, regional daily gaps were immediately apparent. Under the advisement of Southwest Missouri Regional Water and MoDNR, a supply scenario was developed, which combines regional estimated drought surface water flows with U.S. Geological Survey (USGS) groundwater availability estimates representing current rate of groundwater use with continual declines in groundwater availability. Under this scenario (Phase II – Scenario 5), a regional average annual daily gap of 53 MGD in 2060 was calculated. Phase III, completed in March 2018, included a facilities assessment for treatment and conveyance of water throughout southwest Missouri.

Gaps in supply during drought years are expected to be immediately apparent during summer months for some portions of the region. The most immediate need identified was in the Barry, Barton, Jasper, McDonald, and Newton Counties subregion, where during an extended drought, there is neither sufficient flow nor storage in Shoal Creek to meet base flow requirements and subregional demands. This was observed during the drought of 2012, and based on drought of record conditions, the gap between supply and demand is estimated to be 19 MGD in the early planning horizon and could potentially grow to over 50 MGD by the end of the planning horizon. The threat of supply shortage is immediate, and the threat grows year after year throughout the study region.

2.1.1. Study Area and Scope

Stockton Lake is in the Osage River basin, which covers roughly 15,000 square miles in eastern Kansas and west-central Missouri, as shown in Figure 2-1. Along with Stockton Lake, there are six other major lakes within the Osage River Basin including Harry S. Truman Reservoir, Lake of the Ozarks, and Pomme De Terre Lake in Missouri, and Hillsdale Lake, Melvern Lake, and Pomona Lake in Kansas.

Figure 2-1. Osage River Basin Map.

The 16-county study area is in southwestern Missouri and includes Barry, Barton, Cedar, Christian, Dade, Greene, Hickory, Jasper, Lawrence, McDonald, Newton, Polk, St. Claire, Stone, Taney, and Vernon counties, as shown in Figure 2-2. Stockton Lake lies within the bounds of the study area and is in southeastern Cedar County, northeastern Dade County, and southwestern Polk County, Missouri. Stockton Lake is on the Sac River, approximately 40 miles from Springfield, Missouri and 50 miles from Joplin, Missouri. The location of Stockton Lake is shown in Figure 2-3.

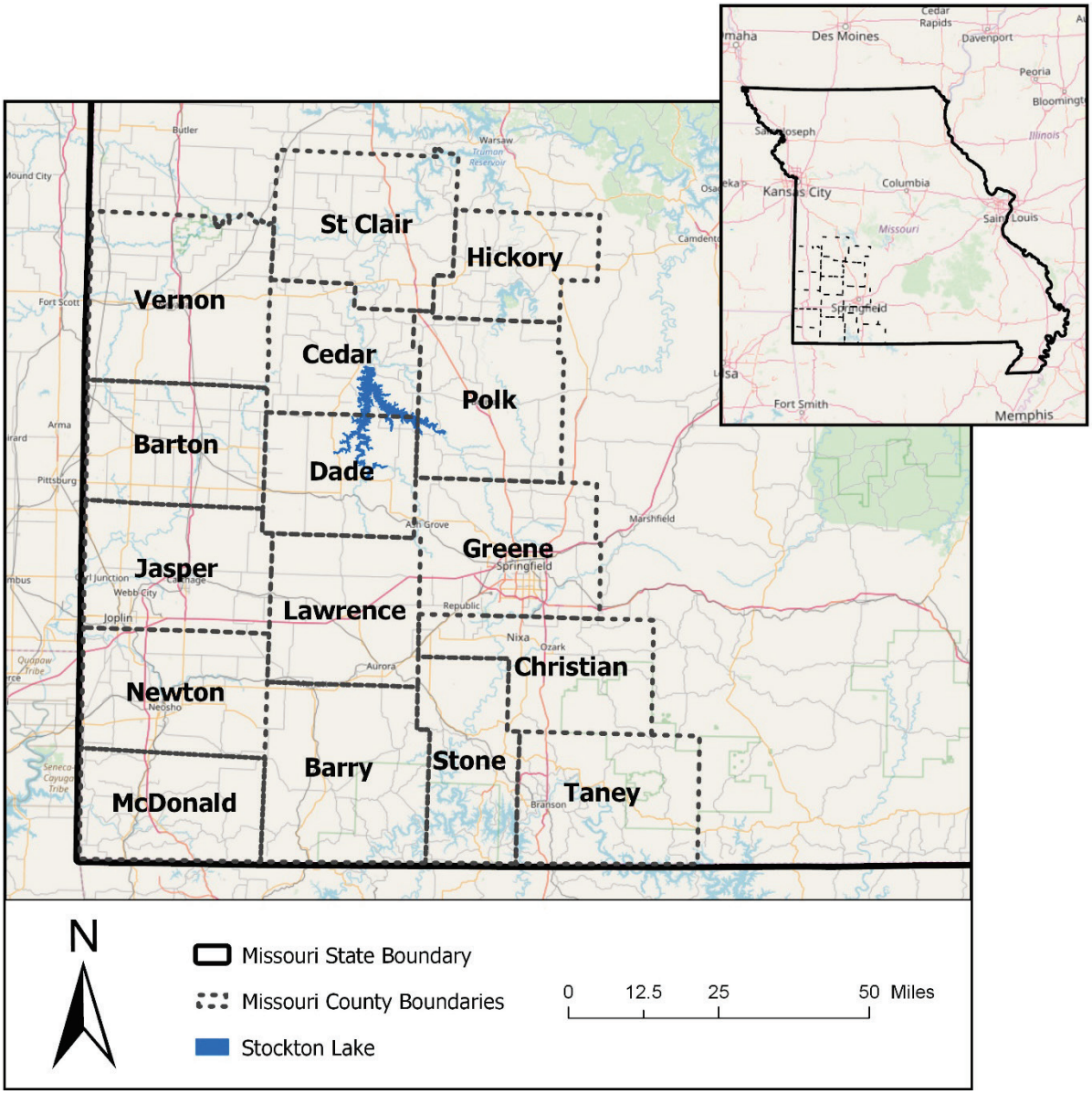


Figure 2-2. Southwest Missouri 16-County Region Study Area.

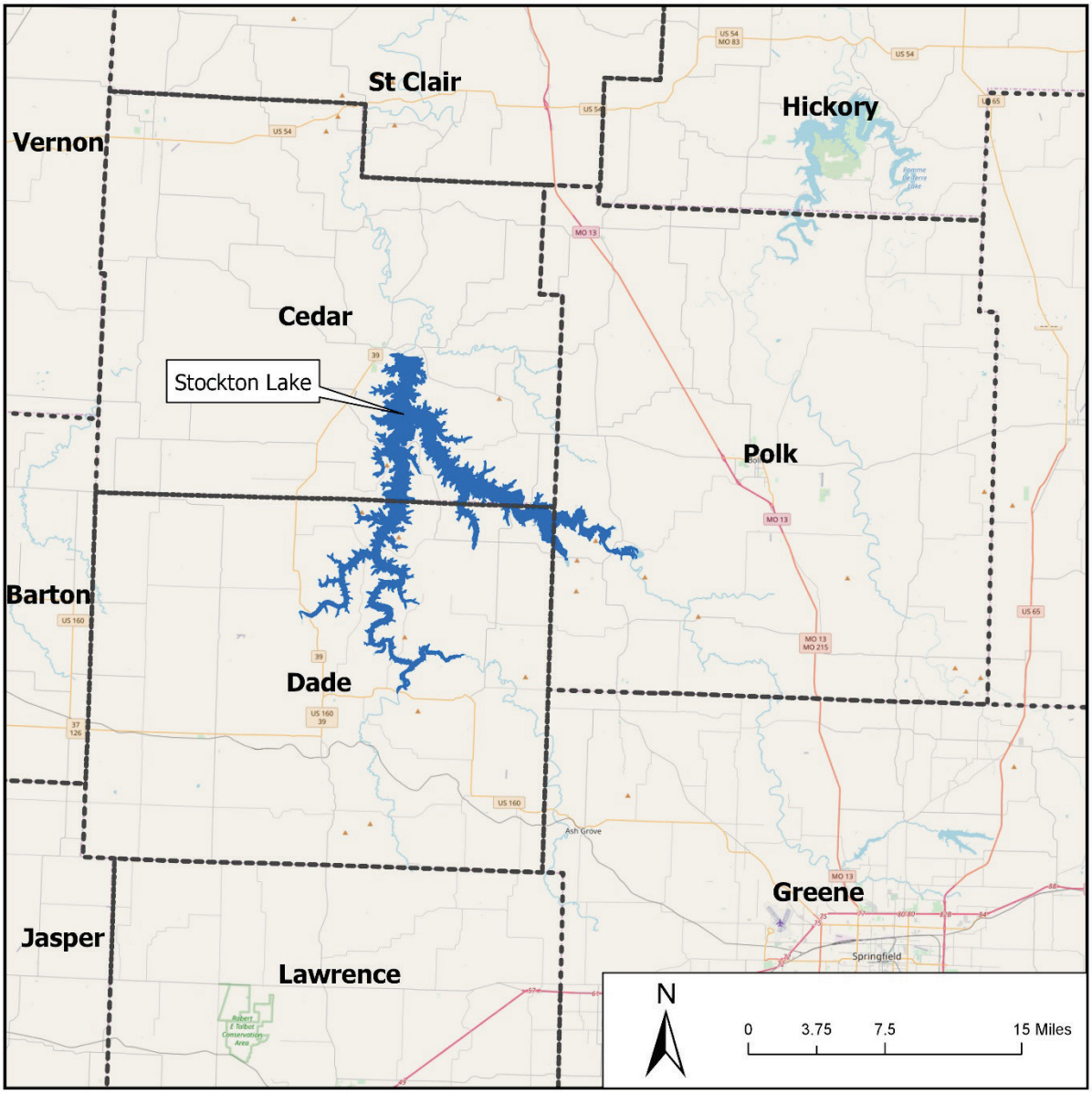


Figure 2-3. Stockton Lake Location Map.

The scope of this study is to evaluate and compare water supply storage reallocation alternatives to address future water supply shortages, evaluate the impacts of storage reallocation on other project purposes, and determine the environmental effects of the storage reallocation alternatives. This report identifies the price of water supply storage to be paid by the user and includes an analysis of the cost for water supply storage within Stockton Lake.

2.1.2. Project Authorization, Construction and Pertinent Data

The Flood Control Act (approved in 1954) authorized Stockton Lake as a multipurpose project with water storage allocation for flood control (flood risk management[1]), hydroelectric power, water quality,

[1] USACE terminology has evolved from flood control to flood risk management. Older reports and plans of regulation still refer to the legacy terminology, thus both terms are used in this report.

recreation, and fish and wildlife management. USACE initiated construction in June 1964 and impoundment was initiated on December 12, 1969 (USACE 1977). The lake first filled to the top of the multipurpose zone (867.0 feet National Geodetic Vertical Datum of 1929 [NGVD 29]) on December 18, 1971. In 1993, a water supply agreement for 50,000 AF of storage from the multipurpose pool was reallocated for use as water supply and contracted by City Utilities of Springfield, Missouri.

Table 2-1, Table 2-2, and Figure 2-4 provide pertinent elevation data and storage data on Stockton Lake and its dam.

Table 2-1. Pertinent Elevation Data on Stockton Lake.

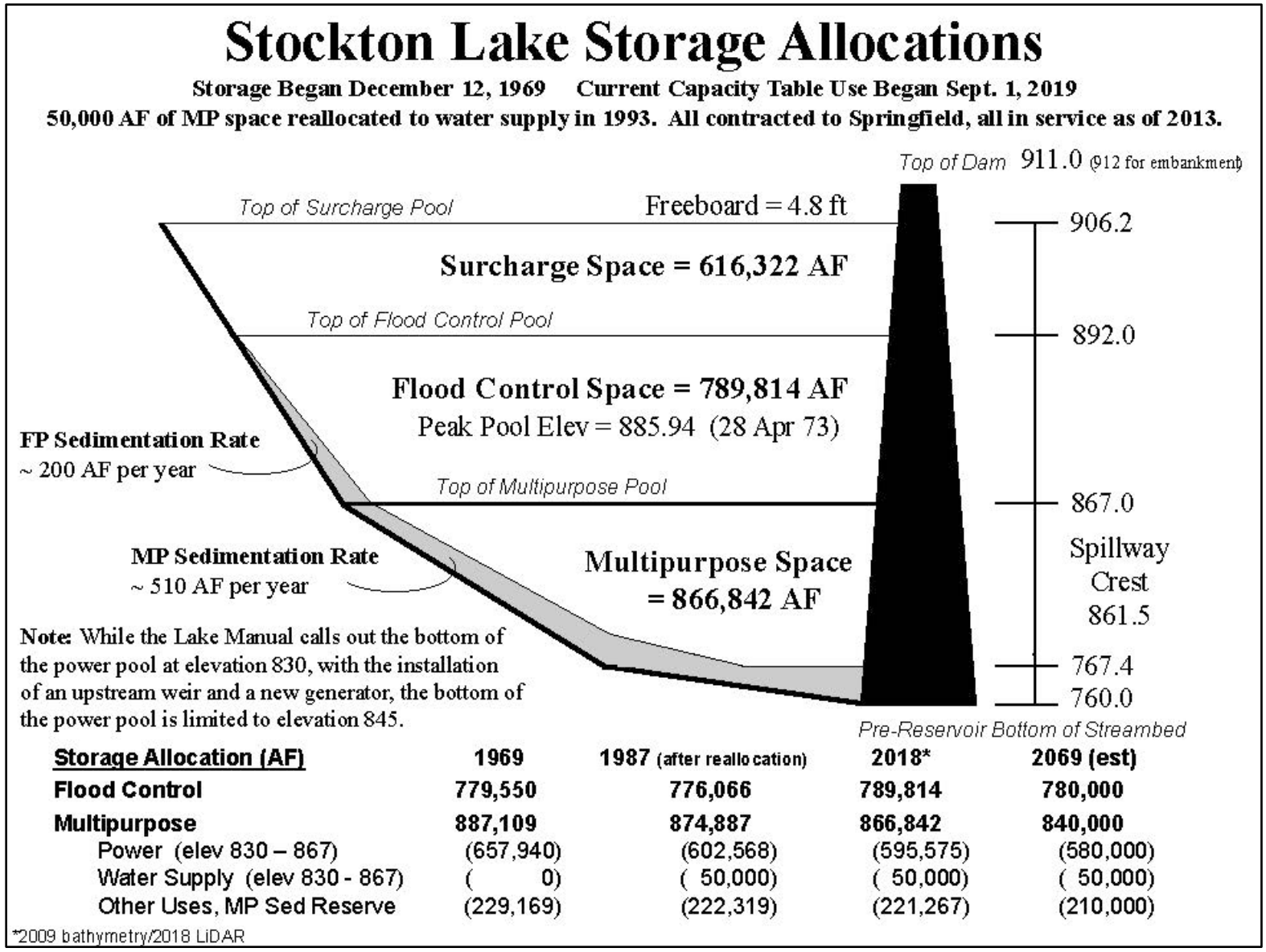
Feature	Elevation[1]
Top of dam	911.0
Top of surcharge pool	906.2
Top of flood control pool	892.0
Top of multipurpose pool[2]	867.0
Spillway crest	861.5
Probable maximum drawdown	845.0
Streambed	765.0

[1] NGVD 29
[2] Current operation

Table 2-2. Storage Data on Stockton Lake.

Feature	Elevation[1]	Area (acres)	Storage Volume (AF)[3]
Surcharge storage	892–906.2	48,053	616,322
Flood control storage	867–892	38,281	789,814
Multipurpose storage	765–867	24,632	866,842
Hydropower[4]	830–867	-	(595,575)
Water Supply	830–867	-	(50,000)
Other Multipurpose	Below 830	-	(221,267)
Total Useable Storage[2]			**1,435,389**

Notes: [1] NGVD 29
[2] Total useable storage = flood control storage + multipurpose storage
[3] Rounded values
[4.] Southwestern Power Administration (SWPA) is not able to generate below elevation 845 feet NGVD 29



Storage Allocation (AF)	1969	1987 (after reallocation)	2018*	2069 (est)
Flood Control	**779,550**	**776,066**	**789,814**	**780,000**
Multipurpose	**887,109**	**874,887**	**866,842**	**840,000**
Power (elev 830 – 867)	(657,940)	(602,568)	(595,575)	(580,000)
Water Supply (elev 830 - 867)	(0)	(50,000)	(50,000)	(50,000)
Other Uses, MP Sed Reserve	(229,169)	(222,319)	(221,267)	(210,000)

*2009 bathymetry/2018 LiDAR

Figure 2-4. Stockton Lake Storage Allocations.

2.2. Prior Reports and Existing Projects

Final Integrated Storage Reallocation Report and Environmental Assessment for Stockton Lake, Missouri, October 1993. Feasibility report that documented the review of reallocating 50,000 AF from the multipurpose pool to water supply storage for the City of Springfield, Missouri (USACE, Kansas City District 1993).

Source of Supply Investigation for Joplin, MO Final Report, February 2003. A regional groundwater study was conducted in 2003 for Jasper and Newton Counties in southwestern Missouri, which developed a hydrogeologic model of the Ozark aquifer (Wittman Hydro Planning Associates of Bloomington, Indiana 2003) *Final Report Source of Supply Investigation for Joplin, Missouri*. Prepared for Missouri-American Water Company).

Water Supply Study Report, September 2006. This report evaluated the future water needs in certain portions of Missouri, Kansas, and Oklahoma, as well as identified sources to meet those needs by 2050 (Black and Veatch 2006). *Tri-State Water Resource Coalition Water Supply Study*. B&V Project No. 41395. Prepared in cooperation with USACE, Little Rock District).

Water Supply Reservoir Screening Study, July 2009. This screening study identified potential reservoir sites in the tri-state area defined 14 potential reservoir locations; 10 to supply the western side of the area and 4 to supply the eastern side (Freese and Nichols 2009). *Water Supply Reservoir Screening Study*. City of Monett and MoDNR in conjunction with the Tri-State Water Resource Coalition.

Supplemental Reservoir Screening Study Memorandum, July 2010, Addendum to Supplemental Reservoir Study September 2010. This study was to further investigate reservoir water supplies from the previous screening studies. The addendum investigated three potential reservoir sites in more detail, along with withdrawing water from below Stockton Dam (Freese and Nichols 2010). *Supplemental Reservoir Screening Study*. Memorandum to the Tri-State Water Resource Coalition.

USACE Southwest Missouri Water Resource Study – Phase I: Forecast of Regional Water Demands (2010 to 2060), September 2012, revised November 2012. This study provided a regional water demand forecast for publicly supplied, self-supplied, and agricultural water use sectors within the 16-county region of Southwest Missouri through 2060 (CDM Federal Programs Corporation [CDM Smith] 2012). *Southwest Missouri Water Resource Study – Phase I: Forecast of Regional Demands (2010-2060)*. USACE Kansas City District and Little Rock District, MoDNR in conjunction with the Tri-State Water Resource Coalition.

USACE Southwest Missouri Water Resource Study – Phase II: Regional Supply Availability (2010 to 2060), March 2014. This study evaluated current and future water supply availability through 2060 as demanded by primarily M&I/commercial sectors (CDM Smith 2014). *Southwest Missouri Water Resource Study – Phase II: Regional Supply Availability (2010–2060)*. USACE, Kansas City District and Little Rock District, and MoDNR in conjunction with Tri-State Water Resource Coalition.

USACE Southwest Missouri Water Resource Study – Phase III Study, 2015. This study provided a planning-level evaluation on Table Rock Lake being a potential source of water for the southwest Missouri region. The study also included a summary of the existing drinking water treatment facilities assessment, the environmental assessment and environmental impact statements, the water supply gap demands for utilities in southwest Missouri, and an overview of the preliminary pipeline alternatives and costs. This study also focused on developing a range of storage reallocation requirements from USACE reservoirs including determination of immediate need, high-level determination of impending need, and preliminary location and alignment of new water supply infrastructure (CDM Smith 2015). *Southwest Missouri Water Resource Study – Phase III: Summary of Studies for Table Rock Lake Alternatives*. USACE, Kansas City District and Little Rock District and MoDNR.

2.3. Previous Water Supply Storage Reallocations

In September 1990, the City of Springfield, Missouri requested USACE, Kansas City District complete a study to determine if storage in Stockton Lake could be reallocated to water supply storage. City Utilities was seeking a source of water to supply an additional 30 MGD to meet its needs through 2040. Projected water shortages during drought conditions in the City Utilities' area of service was projected to increase from 2.4 MGD by 2000, to 30 MGD by 2040. In 1993, USACE approved the Stockton Lake Reallocation report. This report authorized the reallocation of 50,000 AF of storage from the multipurpose pool to water supply storage under the authority of the Water Supply Act of 1958 (Title II of Public Law 85-500, as amended, 43 U.S.C. § 390b). A water supply contract for 50,000 AF of storage between the United States and the Board of Public Utilities of the City of Springfield, Missouri was entered into on November 18, 1993. As a standard practice, hydropower benefits forgone were calculated to estimate the impact of the reallocation of storage to hydropower generation. However, a unique and nonstandard calculation was conducted for the hydropower credit. The assessment assumed that every megawatt (MW) of capacity requires 1,200 hours of generation.. As a result of the calculation, SWPA was granted a $600,000 credit per year to recoup revenues lost as a result of the 50,000 AF reallocation. The water supply storage contract also included deviated language that limits the City Utilities' withdrawal rate to 30 MGD. This means that even if the City Utilities' column of storage is overflowing (or above 867.0 feet NGVD 29), they are restricted to withdrawing only 30 MGD to provide storage for SWPA and the ability to generate power. This type of clause is not typical compared to other water supply contracts.

2.4. Reservoir Operations

Reservoir operations are guided by the Stockton Lake Water Control Manual. Multipurpose operations are defined by the lake at or below elevation 867 feet NGVD 29. During these occasions, releases from multipurpose storage are authorized in support of hydropower generation, downstream water quality, and M&I water supply. Water supply withdrawals occur independent of water released to support hydropower and downstream water quality. City Utilities of Springfield, Missouri has an intake in Dade County on the southeastern portion of the lake.

Flood control operations are in effect when inflows are sufficient to elevate the lake above elevation 867 feet NGVD 29, and water rises into the flood control storage allocation. During this time, releases from storage are scheduled as efficiently and safely as downstream conditions permit, providing protection for downstream communities. Releases in support of flood control operations typically generate hydropower but are commonly passed through the Tainter gates during scheduled maintenance.

Surcharge operations prioritize safety and integrity of the dam over downstream conditions. These conditions exist when flood control storage is full and the dam is potentially in danger of being overtopped by an extreme flood event. Under these circumstances, as much water is passed as necessary regardless of downstream conditions. Section 4.2 provides additional details on lake operations.

2.5. Dam Safety Classification Rating

ER 1110-2-1156, Safety of Dams – Policy and Procedures outlines how USACE operates and implements its Dam Safety Program. One component of the program is the Dam Safety Action Classification (DSAC) System, which provides consistent and systematic guidelines for managing dam safety issues and deficiencies of the USACE dam portfolio. A dam's DSAC rating is based on the combination of probability of failure and potential life safety consequences. Probability of failure is driven by the dam's expected performance under the full range of loading, while consequences are a function of the population at risk located downstream of the dam.

Expected dam performance is informed by routine dam safety O&M inspections, which are completed annually. Periodic inspections (PIs) and periodic risk assessments (Pas) are conducted every 5 and 10 years, respectively. DSAC ratings range on a scale from DSAC 1 to DSAC 5. A DSAC 1 rating is for a

dam with extremely high likelihood of failure, while a DSAC 5 rating is for a dam with low likelihood of failure and with tolerable residual risk. USACE screened its dam portfolio between 2005 and 2010 by completing Screening for Portfolio Risk Analysis (SPRA) studies. Stockton Dam was originally classified as a DSAC 3 based on the 2007 SPRA study. The screening-level risk assessment has since grown into the current risk assessment methodology used by USACE.

In April 2014, USACE, Kansas City District conducted a PA for Stockton Dam in accordance with the requirements of ER 1110-2-1156. The PA consisted of a facilitated potential failure modes analysis, which identified potential risk driving failure modes. The risk assessment was informed by hydrologic loading conditions, dam performance reported in the 2014 periodic inspection, and consequences based on understanding of evacuation of downstream communities. The results of the incremental risk identified in the PA, followed by discussions within the Dam Safety Oversight Group (DSOG) and USACE, Kansas City District, resulted in an assigned DSAC 4 rating for Stockton dam.

Per Dam Safety Program guidance when conducting reallocation study, a review of the potential failure mode analysis was completed in February 2019. Since 2014, methodologies and guidance for assessing projects have evolved. In 2018, there was a national change in criteria for assessing dam overtopping for events that exceed the design event. The review of the potential failure modes that began in 2018 and was completed in 2019 used the updated national USACE methodology. While the proposed pool raise did not increase the likelihood of failure of any potential failure modes, as a result of the review and updating the hydrology methodology, the DSAC rating was changed from a 4 to a 3. Additional details on this analysis and correspondence with the nonfederal sponsor can be found in Section 5.11.

3.0 Plan Formulation and Evaluation of Alternatives

Plan formulation and evaluation of alternatives for this study were conducted in accordance with USACE's Planning Guidance Notebook (ER 1105-2-100) and USACE's Water Supply Handbook, both originating from the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Planning Act (P.L. 89-80) and Executive Order (EO) 11747, which was approved by the U.S. Water Resources Council in 1982 and by the president in 1983.

Based on guidance and policy, USACE has a well-defined, six-step process used to identify and respond to problems and opportunities associated with federal water resources planning objectives and specific state and local concerns:

1. Identify problems and opportunities.
2. Inventory and forecast conditions.
3. Formulate alternative plans.
4. Evaluate alternative plans.
5. Compare alternative plans.
6. Select recommended plan.

The remainder of this section describes each step of the process as it applies to this study.

3.1. Problems and Opportunities

The water resource problem to be addressed is the unreliable supply of water in southwest Missouri during drought conditions and insufficient supply to meet increased demand that is projected for the region because of population growth. The regional gap in water supply was determined separately in previous Planning Assistance to States (PAS) studies over a period of several years prior to this reallocation study. Under the Southwest Missouri Resource Study Phase I (CDM Smith 2012), it was determined that the 16-county region of southwest Missouri is projected to experience population and employment growth that is estimated to substantially increase regional water demand in the future. Under Phase II (CDM Smith 2014), the growth in demand was compared to estimated future water supply and availability, resulting in the identification of gaps in water supply during drought conditions occurring as early as 2020. The results of the Phase I and Phase II studies were estimated to calculate the need of additional water supply in units of MGD needed to avoid future projected water supply gaps. This future water supply need was based on the demands of current Southwest Missouri Regional Water members, with a projected additional 30 percent contingency for future growth in membership. Based on these estimates, the annual average day Southwest Missouri Regional Water membership gap in water supply by 2060 is estimated to be 30 MGD, which rises to 39 MGD with the contingency added for future members of Southwest Missouri Regional Water. Following evaluation of risks and uncertainties (described in Section 5.2 of this report), it was concluded that this reallocation amount will provide sufficient water supply for the region into the year 2070. The issues to address include the combined effects of population growth on water supply, overuse of localized groundwater, and potential future overuse of existing surface water supplies.

Problems

- The current water supply is unreliable and cannot meet current demand during drought conditions for the 16-county region
- The current water supply is insufficient and will not meet future M&I demand to support population growth for the 16-county region

Opportunities

- Provide the southwest Missouri region with additional water supply storage to meet projected water demands during drought and increased demand in the future from expected population growth
- Provide water supply of equivalent quality as currently supplied by groundwater and surface water sources over the 50-year period of analysis to 2070
- Become less reliant on nonrenewable groundwater over the 50-year period of analysis to 2070

3.1.1. Urgency and Need for Water

Under drought conditions and groundwater management assumptions that anticipate continued declines at current rates of growth, the subregion surrounding Joplin, Missouri is expected to experience immediate water supply deficits. Under the same conditions, the subregion surrounding Springfield, Missouri is expected to experience supply deficits as early as 2020. Based on future population and employment estimates, increasing water supply deficits are expected regionally through 2060.

3.1.2. Water Demand

The Southwest Missouri Water Resource Study – Phase I resulted in a regional water demand forecast for the 16-county region of southwest Missouri. This analysis is based on water billing and consumption data, demographic and socioeconomic data, historical agricultural data, and weather data. Additionally, MoDNR provided general demographic data and historical and projected population and employment data with estimates for high-, medium-, and low-growth scenarios. In an effort to provide useful regional planning information based on trends in current and future water use, water demands were forecast at the county level. Baseline demands were established for the year 2010, then projected through 2060 in 10-year increments using a computational "driver times rate of use" approach. The Phase I study found that under a medium-growth scenario, the overall regional water usage was estimated to increase by 36.8 percent from approximately 338 MGD in the baseline year to an estimated 464 MGD in 2060, an increase of approximately 125 MGD across the sectors evaluated including publicly supplied residential and nonresidential, self-supplied residential and nonresidential, and agricultural uses. The Water Needs Analysis report is provided in Appendix A.

3.2. Objectives

Planning objectives are used to describe the intended purposes and outcomes of the planning process. The Stockton Lake Water Supply Storage Reallocation study objective is to determine if there is an economically viable alternative to meet the current and future water supply demand pursuant to Southwest Missouri Regional Water's request for water supply storage. Alternatives will be formulated, evaluated, compared and screened to identify a recommended plan that is consistent with the following objectives:

Primary Objectives

- Reduce, to the extent practicable, water supply shortages forecasted for M&I water users over the 50-year period of analysis to 2070
- Improve the reliability of water supply during drought conditions over the 50-year period of analysis to 2070 for the 16-county area
- Minimize effects on authorized purposes and maintain lake operating levels as close as possible to base condition

Secondary Objectives

- Provide water supply of equivalent quality as currently supplied by groundwater and surface water sources over the 50-year period of analysis to 2070
- Become less reliant on nonrenewable groundwater over the 50-year period of analysis

3.3. Planning Constraints

Planning constraints are restrictions that can limit the extent of the planning process. These constraints can be legal, policy-related, or study-specific. The following constraints were developed by the project development team (PDT):

- Ensure there is no induced or significantly increased flood damages or any increased life safety risk.
- Water supply storage reallocation must not significantly affect other USACE-authorized purposes at Stockton Lake. The authorized purposes include flood risk management, hydropower, recreation, water supply, and fish and wildlife. The schedule and timeline to acquire new supplies need to be minimized to meet immediate needs.
- The financial burden must not be excessive.
- Maintain adequate downstream flows and water quality over the 50-year period of analysis to 2070.

3.4. Inventory of Existing and Future Conditions

3.4.1. Historical and Current Water Use

Communities and businesses are challenged during drought conditions to meet the existing water demands. In the 1950s, Lamar and Springfield, Missouri responded to the drought of record by constructing municipal lakes. Since 1996, Springfield has relied on as much as 19 MGD in supplemental surface water supplies from Stockton Lake and is able to currently pump an annual average of 15 MGD. In 2012, in response to drought conditions, Missouri-American Water in Joplin, Missouri added an additional 2 feet of height to Grand Falls Dam to hold an additional 68 million gallons to address shortfalls in supply.

Existing Water Supplies

The study area includes existing water supplies from both groundwater and surface water sources. These sources are discussed in this section.

Groundwater

The main groundwater aquifers used for water supply within the study region include the Springfield Plateau and Ozark aquifers. All of the counties within the study region depend on groundwater for a portion of their water supply, which was also included in the assumptions of future supply availability.

Because of historical mining activities in southwestern Missouri, high concentrations of lead and cadmium are present within the underlying Springfield Plateau aquifer. Additional contamination from industrial activity has recently contaminated the groundwater from the release of solvents such as trichloroethylene into the environment. Since this region is comprised of karst features characterized by underground drainage systems resulting from the dissolution of soluble rocks, a network of pathways exists for contaminants to travel causing widespread contamination within the aquifer. Therefore, most wells in this region are drilled into the deeper, confined Ozark aquifer.

Surface Water

Overall, Missouri's surface water quality is relatively high quality. Because of rolling topography, thin soils, and poor soil fertility, there are few agricultural practices in the southwest part of the state. Many areas in southwest Missouri have mine sites that could potentially affect water quality on a site-by-site basis. Regional surface water sources are discussed in additional detail below.

Lake Taneycomo

The Branson area of Taney and Stone Counties is using Lake Taneycomo as a surface water source from which 90 percent of the city's water demand of 1.2 billion gallons annually is met.

Fellows and McDaniel Lakes

Both Fellows and McDaniel Lakes are water supply reservoirs owned by City Utilities. These combined sources generally account for approximately 45 to 65 percent of Springfield's water demand.

James River

City Utilities receives water from one intake on the James River. The use of this water supply source is highly dependent on precipitation because of minimum flow requirements. Approximately 20 to 30 percent of Springfield's total water demand is met through the James River intake.

Stockton Lake

In 1993, 50,000 AF (which yields approximately 30 MGD) of Stockton Lake storage was reallocated from multipurpose pool storage to water supply storage use and contracted by City Utilities of Springfield, Missouri. The allocation is currently utilized by City Utilities as a supplemental water supply source.

Lamar Lake

Lamar Lake, located in Barton County, serves as the primary water supply source for the City of Lamar. According to MoDNR Reservoir Operations Study Computer Program (RESOP) studies, the safe yield is 1 MGD (Edwards et al. 2005) and optimum yield is 0.427 MGD. Annual average water demand for the City of Lamar currently exceeds the optimum yield of Lake Lamar, and RESOP modeling completed in 2005 indicates the lake is at risk for not meeting the community's water demand during periods of drought (Edwards et al. 2005).

Shoal Creek

Shoal Creek serves as the primary water supply source for the cities of Joplin and Neosho. Joplin withdraws approximately 8 to 14 MGD, while Neosho withdraws approximately 1.6 MGD.

3.4.2. Future Conditions

Missouri American Water is currently developing plans for a new off-channel water supply reservoir of up to 1,500 acres near Shoal Creek to serve the Joplin area. In addition to storing water pumped from Shoal Creek, if a reallocation is granted to Southwest Missouri Regional Water, the new reservoir would be used to store water from the reallocation (Larimore 2018).

3.4.3. Water Supply Needs Analysis

The Southwest Missouri Water Resource Study – Phase II, included evaluation of water supply availability based on past studies of the groundwater and surface water resources for the region. The analysis compared M&I demands completed under Phase I against normal and drought supply under management scenarios. Scenarios evaluated both conditions using USGS groundwater models, with current rate of growth reflecting continual declines or sustainable groundwater management, assuming a fully saturated Ozark aquifer. The gap analysis indicated there are sufficient available surface water

supplies to supplement localized declines in groundwater under normal weather conditions. However, the necessary infrastructure is not currently in place to meet the future demands for the entire 16-county region. Additionally, during drought conditions and a groundwater management option that anticipates continued declines at current rates of groundwater use, the region can expect a gap in supply as early as 2020. This gap particularly applies to the subregions, which include Barry, Barton, Christian, Greene, Jasper, Lawrence, McDonald, Newton, Polk, and Stone Counties. The most likely drought scenario indicates a regional (16-county) drought gap in water supply of 53 MGD by 2060.

To translate the results of the Phase I and Phase II studies, annual average estimates were calculated based on anticipated participation in acquisition, funding, and development of the alternative source. As such, it was assumed that the reallocation gap in water supply should include demands of only current Southwest Missouri Regional Water members, with a projected additional 30 percent contingency for future Southwest Missouri Regional Water members. The needs analysis was approved for use in this reallocation study by the Water Management and Reallocation Studies Center of Expertise (WMRS PCX) in April 2018. Table 3-1 shows the average daily water supply gap for existing 2017 Southwest Missouri Regional Water members with 2060 estimated annual average day supply gaps.

Table 3-1. Estimated 2060 Southwest Missouri Regional Water Customer Supply Gap.

County	Municipality	Average Day Supply Gap (MGD)
Barry	Monett	1.31
	Cassville	0.46
Barton	Lamar	0.69
Jasper	Carthage	2.14
	Missouri American Joplin	7.47
	Wholesale Missouri American Joplin Customers	0.90
	Webb City	2.21
Christian	Nixa	1.40
Greene	Springfield	12.85
Lawrence	Mount Vernon	0.34
	30% Contingency for New Members	9.00
TOTAL		39.00

3.4.4. Reservoir Sedimentation

Stockton Lake has a sedimentation rate of approximately 710 AF per year (AFY). Most of the sedimentation is occurring in the multipurpose pool with a rate of 510 AFY. Approximately 200 AFY is occurring in the flood control pool. Sedimentation in the flood control pool is of little impact to the water supply reallocation.

The sediment load is estimated from three historic surveys. Original range line surveys were taken in 1968 and updated in 1988. The latest survey was a compilation of 2009 bathymetry for the multipurpose pool and 2018 LiDAR for the flood control pool. Different survey methods are a source of uncertainty about the actual rate of sedimentation, but the historic surveys still give a valuable indication of the sedimentation rates. Between the beginning of storage in 1969 and the last survey in 2009, the multipurpose pool has lost 20,300 AF of storage. Between 1969 and 2018, the flood control pool has lost 10,000 AF of storage. This amount exceeds the allocated sediment reserve of 25,000 AF (8,000 AF in the flood control pool and 17,000 AF in the multipurpose pool). However, significant unallocated storage remains below pool elevation 830 feet NGVD 29 (the bottom of the water supply and power allocation) that can accumulate sediment with minimal impacts to the project purposes. Below 830 feet NGVD 29 is the inactive pool as defined in ECB 2019-13. Approximately 221,267 AF remain for other uses such as recreation, water quality releases, and sediment reserve. Only a small portion of this storage is estimated to be used by sediment over the 50-year life of the project. Since the power pool can use storage above

elevation 845 feet and the water supply contracts can use storage above elevation 830 feet, the accumulation of sediment below these levels will not impact these project purposes.

The full hydrology and hydraulics (H&H) considerations for this report can be found in Appendix C.

3.4.5. Water Conservation

Information on conservation activities was gathered from available resources, including the Baseline Water Use Dataset and water provider websites. The baseline forecast was developed using recent water use data from these sources; therefore, savings resulting from implementation of current conservation programs is inherent in the baseline demands. For example, City Utilities (Greene County) is implementing the most progressive water conservation activities, including:

- Educational programs for children and adults
- A website with conservation water savings tips, leak detection measures, and residential and commercial meters
- Residential and commercial water use audits among other programs

The City of Joplin, Missouri currently uses the following conservation techniques:

- Inclining water rates
- Meetings with industrial customers to see if there are ways to reuse water or save on water use
- Annual mailers with water-saving tips to all residential customers

3.4.6. Drought Planning

Many of the Southwest Missouri Regional Water members also have drought plans, which are implemented once the area has declared a drought. Some examples of the measures are:

- Alternate day watering
- Water rates based on usage and penalties assessed for going over a specified amount
- Closure of car washes
- Encourage the collection of rainwater to water plants, trees, and landscaping
- No washing sidewalks, driveways, etc.

In late 2017 and early 2018, Southwest Missouri Regional Water conducted 3,287 online and telephone interviews among residents of the 16-county southwest Missouri region to assess the opinions and perceptions about water supply and water usage. Within the survey, users were asked to quantify the amount of water consumption they could temporarily reduce in the event of a severe drought requiring emergency conservation measures. Approximately two-thirds (64 percent) of respondents indicated that they could temporarily reduce consumption by 10 percent or more (Opinion Research Specialists, LLC 2018).

3.4.7. Climate Change

A climate change assessment was conducted for Stockton Lake. Overall, no strong indication exists within the qualitative analysis that was conducted to identify any definitive impacts climate change could hold on the project hydrology and streamflow of the region. The strongest consensus amongst the literature supports a trend of increasing temperatures and precipitation in the region, resulting in increased frequency in the occurrence of extreme storm events. Extremes in climate will also magnify periods of wet and dry weather resulting in longer more severe droughts and larger more extensive storms. The literature is conflicted as to projected peak magnitude, duration, and volume of extreme events, with the uncertainty being largely attributed to the uncertainty of the climate models themselves.

Based on this assessment, the recommendation is to treat the potential effects of climate change as occurring within the uncertainty range calculated for the current hydrologic analysis of the Sac River near Dadeville, Missouri; the Little Sac River near Morrisville, Missouri; and the Sac River at Highway J below Stockton, Missouri, including observed flows and Stockton Lake pool elevations. If the periods analyzed were initiated after the reservoir reached multipurpose pool, significant nonstationarities were not detected. The periods of record for each gage should utilize the full record for statistical analyses to reduce the uncertainty caused by using shorter records. There may be other indicators of climate change, such as changes in biotic communities, but this analysis is focused on climate changes as they relate to hydrology and hydraulics. Methods of translating climate change impact uncertainty for an engineering-based analysis do not currently exist.

The Water Supply business line is the principal focus of the Stockton Lake Water Supply Storage Reallocation project and is the primary business line discussed in detail. The USACE Watershed Climate Vulnerability Tool indicates the Gasconade-Osage watersheds are among the 20 percent most vulnerable to the impacts of climate change on water supply relative to the other 202 hydrological unit code-4 watersheds in the continental United States. A qualitative analysis using projected hydrometeorological data and the USACE Watershed Climate Assessment Tool indicates overall flows will increase in the Gasconade-Osage watersheds. These trends, while indicative of increasing flows over time, are not relatively large in magnitude. Pool reallocations should be relatively resilient to gradual changes in flow regime such as increased variation in monthly flows. However, additional consideration should be given to the need for sediment inflow reduction for future reservoir sustainability. The Future With Project (FWP) conditions will have no significant effect on climate change. The full climate change analysis can be found in Appendix D.

3.5. Preliminary Alternatives – Evaluation and Screening of Alternatives to the Final Array

3.5.1. Initial Array of Alternatives

ER 1105-2-100, Planning Guidance Notebook, requires certain alternatives to be considered during a water reallocation study. These include the no action alternative, a water reallocation alternative, and a nonfederal action in absence of the federal action of a reallocation. For this evaluation, building a new reservoir would be considered as the most likely nonfederal alternative to water reallocation at Stockton Lake that would also meet future water supply needs. For National Environmental Policy Act (NEPA) alternative comparison purposes in the integrated EA, the Federal No Action/Future Without Project (FWOP) condition is the existing Plan of Regulation at Stockton Lake (Alternative 1). By comparing the existing Plan of Regulation to proposed water reallocation alternatives at Stockton Lake, the effects of the water reallocation can be assessed for potential impacts to the human and natural environment. The Non-Federal Action, in lieu of Federal Action condition, is the construction of a new reservoir to meet future water supply needs (Alternative 2). This alternative is used to compare costs and benefits of the most likely nonfederal alternative and the most likely federal alternative of reallocation of water supply in Stockton Lake.

A water reallocation study is performed to meet the immediate need of an existing water contract holder or some other entity in a nearby area. In this instance, the water reallocation is being requested to meet the water needs of members of Southwest Missouri Regional Water, which is a regional need.

Water reallocation alternative guidance requires identification of the least cost alternative compared to water reallocation for comparison purposes and National Economic Development (NED) purposes. In order to do this, the information gathered by the PDT and the nonfederal sponsor is utilized. A summary of the alternatives to provide the requested water is presented below:

Alternative 1 – Federal No Action/FWOP-Existing Stockton Lake Plan of Regulation

Alternative 2 – Construction of a New Reservoir

Alternative 3 – Increased Conservation

Alternative 4 – Groundwater

Alternative 5 – Reallocation from Multipurpose Pool at Stockton Lake

Alternative 6 – Reallocation from Flood Control Pool at Stockton Lake

Alternative 7 – Reallocation from Combination of Multipurpose Pool and Flood Control Pool at Stockton Lake

Alternative 8 – Reallocation from Inactive Pool at Stockton Lake

Alternative 9 – Water Importation

Alternative 10 – Local River or Stream Withdrawal

Alternative 11 – Pomme de Terre Lake Reallocation

Alternative 12 – Table Rock Lake Reallocation

3.5.1.1. Alternative 1 – Federal No Action/Future Without Project (FWOP) Condition

The Federal No Action/FWOP condition represents no federal action implemented at Stockton Lake, i.e., a reallocation of storage at Stockton Lake would not occur and the existing Plan of Regulation is used for the project life. In this case, additional storage would not be reallocated to water supply and the operation of Stockton Lake would remain the same. Since there would be no change to the operation of Stockton Lake, there would be no observable impacts to resources within the study area.

Under this alternative, several communities throughout the region would not have a sufficient or reliable water supply under drought conditions and users would have to examine other water sources. Additionally, current water supply cannot support projected future growth throughout the region under normal weather conditions, which could impede future regional growth and development. Current water conservation efforts would continue, but alone do not sufficiently decrease the gap in supply.

Council on Environmental Quality (CEQ) guidelines require this alternative to be considered and evaluated against all other proposed water reallocation alternatives at Stockton Lake to assess potential effects of proposed actions on the human and natural resources, and the authorized purposes of the lake.

3.5.1.2. Alternative 2 – Construction of a New Reservoir

The most likely, least cost alternative in absence of a reallocation would be construction of a new reservoir. The concept of building a reservoir has been explored in southwest Missouri in response to potential identified gaps in water supply. In 2009, Freese and Nichols performed a screening study of potential reservoir sites in southwest Missouri to meet an upper limit demand of 124 MGD in 2050, which included residential and commercial/industrial use sectors (Freese and Nichols 2009). This 2009 study identified 14 different potential reservoir sites that could supply the reliable needed firm yield as either a single reservoir or a mixture of multiple reservoirs. Eleven potential reservoir sites were evaluated for a conceptual development cost excluding treatment and distribution costs. A supplemental reservoir screening study (Freese and Nichols 2010), focused on meeting the water needs of some of the smaller demand centers within Southwest Missouri Regional Water service area. This report evaluated two options for the Joplin, Pittsburg, Lamar, Empire Electric, and rural water districts in the west subregion that could yield 35 and 36 MGD. The 36 MGD reservoir option is further evaluated within this report as it would be the most viable option to address the approximate 39 MGD regional gap. This alternative for nonfederal action is used to compare costs and benefits of the most likely nonfederal alternative and the most likely federal alternative to reallocate water supply in Stockton Lake.

3.5.1.3. Alternative 3 – Increased Water Conservation

For purposes of this study, implementation of conservation scenarios is considered voluntary both at the utility and customer level. While potential reductions in water use are conservatively assigned to reflect some nonconformance, the reliability of supply from conservation savings is low. The conservation measures considered including installation of residential and commercial meters, measures to reduce nonrevenue water, educational programs, and water audits, require an investment by water utilities, and because these programs are expected to provide long-term cost benefits to the utility, implementation may not be possible because of immediate financial constraints. Additionally, potential reductions in demand under consideration in the screening analysis are assumed under drought conditions. While it has been shown that significant reductions in water use due to conservation during drought conditions are achievable, these are generally attributable to reductions in outdoor water use, and additional reductions such as those outlined in the Plan Formulation appendix (Appendix L) may not be cumulatively considerable with standard drought water use reduction measures.

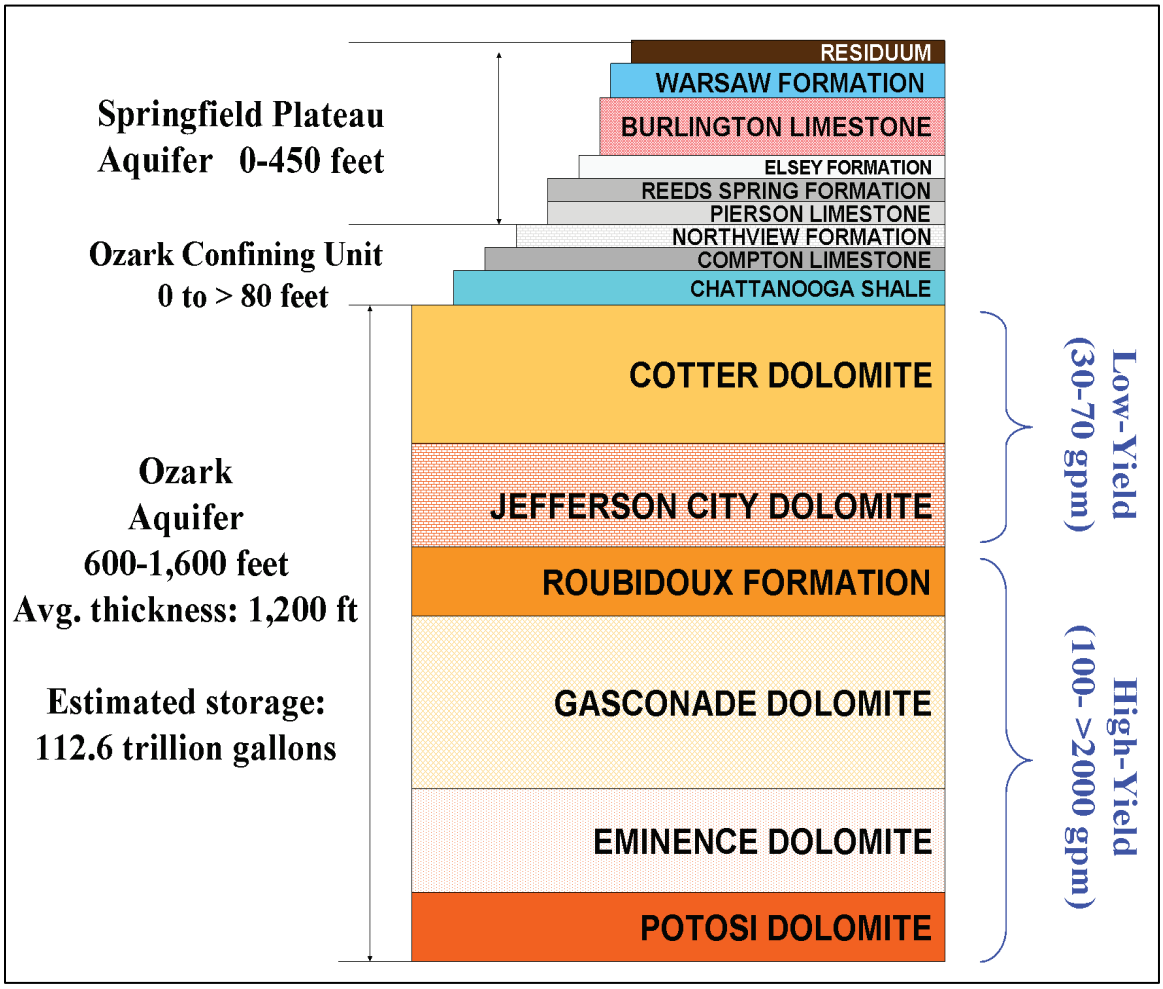


Figure 3-1. Springfield Plateau and Ozark Aquifer. *Source: MoDNR Water Resources Center.*

3.5.1.4. Alternative 4 – Groundwater Sources

As populations and industry increase in southwestern Missouri, the strains on existing groundwater resources rise as well. An increased reliance on groundwater wells within the Ozark aquifer has led to issues with further developing well fields in this region. The two major issues present when developing wells in southwestern Missouri are contamination of the groundwater from mining and industrial

activities, and increased drawdown of the water table because of the lack of recharge within the aquifer. As a result, existing groundwater sources are both unreliable and insufficient, and are not able to meet current drought demands and future growth demands. Additionally, in areas of contamination, groundwater sources are generally inefficient because wells must be drilled deeper to avoid having a contaminated supply. The aquifers underlying southwest Missouri include the Springfield Plateau and Ozark aquifers. As seen in Figure 3-1, the confined Ozark aquifer underlies the Springfield Plateau aquifer.

3.5.1.5. Alternative 5 – Multipurpose Pool from Stockton Lake

Stockton Lake is in southeastern Cedar County, northeastern Dade County, and southwestern Polk County, Missouri. It is on the Sac River in southwest Missouri, approximately 40 miles northwest of Springfield and 50 miles northeast of Joplin. The lake is V-shaped and covers 39 square miles, with 298 miles of shoreline.

When storage is reallocated from the multipurpose pool, there is no change in the normal pool elevation of 867 NGVD 29. However, there can be impacts to the other authorized purposes, which will be evaluated during the screening process. The reallocation does impact the hydropower storage and reduces the hydropower storage and yield. The construction of an intake structure is required for the reallocation and is considered as part of this alternative.

USACE, Kansas City District is coordinating with SWPA, who has voiced its concerns that the economic impacts of the reallocation alternatives be properly evaluated. The USACE Hydropower Analysis Center (HAC) has evaluated reallocation alternatives for impacts to hydropower. Benefits forgone, revenues forgone, replacement cost of power, and updated cost of storage will be calculated per ER 1105-2-100, Planning Guidance Notebook. The PDT will continue stakeholder and agency coordination in compliance with NEPA and USACE policies.

3.5.1.6. Alternative 6 – Flood Control Pool from Stockton Lake

If reallocation is made from the flood control pool (a “pool raise”), storage in the multipurpose pool is increased by reallocation from the flood control pool, and the yield/storage relationship changes. A pool raise occurs because a flood control pool reallocation requires raising the multipurpose pool elevation into the flood control pool. The construction of an intake structure is required for the reallocation and is considered as part of this alternative.

To determine the yield as the storage is increased, it is necessary to reference the Stockton Lake yield/storage curve. Preliminary H&H modeling indicates that to achieve a yield of 39 MGD the multipurpose pool would have to be raised approximately 4 feet to 871 feet NGVD 29. When storage is taken from the flood control pool, the amount of storage allocated to each existing water supply user must be increased to maintain the expected yield. This additional storage is called dependable yield mitigation storage, or 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.” Therefore, no DYMS is added to hydropower, which results in the storage remaining constant and the yield decreasing. Each time additional storage is requested for reallocation from the flood control pool, a calculation is made estimating the requested safe yield and the DYMS for existing users. The DYMS cost is the water supply requestor’s responsibility, as stated in EC 1105-2-216, “All costs associated with the additional storage that are necessary to meet the current users estimated yield will be paid for by the new user of the new water supply storage space (i.e., the water supply requestor).”

3.5.1.7. Alternative 7 – Combination of Multipurpose Pool and Flood Control Pool at Stockton Lake

A reallocation from both pools would have some of the same effects as a reallocation singularly from either pool. Alternative 7 would raise the multipurpose pool by 1.8 feet, to 868.8 feet NGVD 29. Based on professional judgment, a smaller pool raise would help lessen the impacts of full reallocation from either the multipurpose pool or the flood control pool. The construction of an intake structure is required for the reallocation and is considered as part of this alternative. The intensities of the effects to authorized purposes are leveled out as less water is drawn from the multipurpose pool, and the flood control pool's impacts are reduced by the smaller pool raise, causing lake elevations to fluctuate less. A DYMS analysis is also required for this alternative.

3.5.1.8. Alternative 8 – Inactive Pool from Stockton Lake

Reallocation from the inactive pool (elevation 830 to elevation 760 feet NGVD 29) would increase the size of the multipurpose pool by lowering the bottom of the multipurpose pool into the inactive pool. The construction of an intake structure is required for the reallocation and is considered as part of this alternative. The inactive pool at Stockton Lake contains storage for the following purposes: hydropower head, recreation head, fish habitat, water quality, and sediment storage space. Hydropower head would be impacted more from this pool. The hydropower units are unable to generate power below elevation 845 NGVD 29 because of a skimming weir that was constructed shortly after the dam was built. The skimming weir was constructed to address dissolved oxygen issues and must remain a part of the project.

3.5.1.9. Alternative 9 – Water Importation

Water importation was evaluated to determine if purchasing water within southwest Missouri or through interstate water purchases would be a viable option to meet the projected regional supply gap of 39 MGD. The primary challenge for importing water within Missouri or from interstate water purchases is finding a water supply and obtaining water rights, because some states limit or prohibit the transfer of water supplies outside state boundaries. With political and legal ramifications of water being transported over state lines, lakes in Kansas and Oklahoma are not options for Southwest Missouri Regional Water as all their members are located within Missouri. Additionally, regions in neighboring states do not have excess water supply during drought conditions, eliminating the feasibility of transfer of water to outside entities during drought when it is most needed.

3.5.1.10. Alternative 10 – Local River or Stream Withdrawal

There are no streams within the study area capable of providing enough dependable yield for this purpose. The city of Joplin currently draws most of its water from Shoal Creek, which has yield problems in dry weather. The city previously increased the height of their dam by 2 feet to create more storage to help mitigate periods of low flow. Joplin is Southwest Missouri Regional Water member with the most immediate need, and this need is compounded by economic growth and expansion created by the recovery programs that were implemented after a tornado destroyed a significant portion of the town in 2011.

3.5.1.11. Alternative 11 – Reallocation from Pomme de Terre Lake

Pomme de Terre Lake is the next closest lake after Stockton Lake for Southwest Missouri Regional Water to request a water supply storage reallocation. It is smaller than Stockton Lake and situated further from Southwest Missouri Regional Water members. Pomme de Terre Lake is in northern Polk County and southern Hickory County, in the west central part of Missouri. Pomme de Terre Lake is approximately 60 miles north of Springfield and approximately 130 miles northeast of Joplin. This lake has a multipurpose pool elevation of 839 feet NGVD 29 and has approximately 113 miles of shoreline. The primary authorized purposes for Pomme de Terre Lake include flood control, recreation, water quality, and fish and wildlife management. Preliminary analysis of storage available indicates it is unlikely that Pomme de Terre Lake could provide the amount of storage that Southwest Missouri Regional Water is requesting to

meet the demand and the added distance between the water source and the water treatment facility would increase the cost of the required transmission infrastructure.

3.5.1.12. Alternative 12 – Reallocation from Table Rock Lake

Table Rock Lake is located along the border of southern Missouri and northern Arkansas. Table Rock Lake is approximately 55 miles south of Springfield and approximately 100 miles southeast of Joplin. Based on the 2014 Master Plan, the land use document for Table Rock Lake, the nominal top of the multipurpose pool for Table Rock Lake is 915 feet amsl. The primary authorized purposes for Table Rock Lake include flood control, hydroelectric power, recreation, and fish and wildlife habitat (USACE 2014). Reallocation studies at Table Rock Lake are on a moratorium while a study of the entire White River Basin is undertaken by the Little Rock District. The timelines for a basinwide study added to a reallocation study are problematic as some members of Southwest Missouri Regional Water such as Joplin have a more immediate need for water than would be met by Table Rock Lake's reallocation study timeline. While Table Rock Lake is approximately the same distance as Pomme de Terre Lake is for Southwest Missouri Regional Water members, the terrain and the size and shape of Table Rock Lake make the transmission infrastructure costs significantly higher.

3.5.2. Screening Criteria

Screening is the ongoing process of eliminating potentially viable alternatives from further consideration if they do not meet required criteria, Criteria are derived from the specific planning study, based on the planning objectives, project goals, schedules, total costs, implementation constraints, and the opportunities and problems of the study/project area.

Screening criteria include a comprehensive evaluation of each potential supply source to assess feasibility based on the following applicable criteria:

- Reliability and Availability of Source – Is the water source reliable and is there enough available to meet the needs of the user.
- Potential for Environmental Impacts or Impacts to Authorized Purposes – There could be impacts to the environment or, if at federal reservoir, impacts to congressionally authorized purposes (authorized purposes typically include flood risk management, hydropower, water supply, recreation, fish and wildlife, and water quality).
- Operation, permitting, and stakeholder considerations.
- Quality of Water – Water must meet or be cost-effectively treated to meet applicable water quality requirements for M&I purposes.
- Cost of Storage – This reflects the cost to the user to obtain the necessary amount of storage to meet their future needs.
- Mileage and Cost of Transmission Lines and Treatment – Under all of the alternatives, new transmission and treatment lines will need to be constructed.
- Timeline for Supply Availability – The region is currently in need of water during drought conditions. What is the estimated timeframe for the new supply of water to be available?

If an alternative was determined to comprise a screening criterion that was detrimental to the progression of the alternative, then no further screening of the alternative relative to the remaining criteria was performed.

3.5.3. Preliminary Screening

Consistent with identified planning objectives and constraints, measures involving large costs, prohibitive logistics or legal agreements, or excessive environmental impacts were eliminated in favor of local, cost-effective, and sustainable measures.

Alternative 1, the Federal No Action/FWOP Alternative, is used as a point of comparison in the screening process. Alternative 2, construction of a new reservoir, was screened from further analysis based on high environmental impacts and large cost of storage. As the most likely, least cost nonfederal alternative, Alternative 2 is used in the test of financial feasibility in Section 9. Increased water conservation, under Alternative 3, is estimated to provide only a portion of the future supply needed for the region and relies heavily on customer compliance with recommended conservation measures. While increased water conservation does partially fulfill the need for water supply within this region, it will not fully address future needs. It will likely be used as a means to address supply shortages, where applicable, during the timeline of the water reallocation project. Alternative 4, additional groundwater sources, was screened from further analysis based on regional drawdown of the water table and regional contamination issues. This alternative is not a reliable source of long-term additional water supply.

Alternatives 9 and 10, water importation and local river or stream withdrawal, respectively, were eliminated from further analysis based on prohibitive logistics associated with water importation and lack of regional nonfederal surface water availability to provide additional water supply. Alternatives 11 and 12, a reallocation from Pomme de Terre Lake and Table Rock Lake, respectively, were eliminated from this analysis based on additional costs associated with transmission because of their location relative to the study area compared to Stockton Lake. Pomme de Terre is also a smaller reservoir and it is unlikely it could supply the entire need. Additionally, stakeholder constraints are anticipated to be high at Table Rock Lake.

Alternative 6, a reallocation from the Stockton Lake flood control pool, was screened from further analysis based on dam safety considerations associated with the 4-foot pool raise. Alternative 8, a reallocation from the Stockton Lake inactive pool, would have the highest impact on hydropower operations, reducing available hydropower head, and as such, was eliminated from further consideration.

Alternative 5, a reallocation from the Stockton Lake multipurpose pool, and Alternative 7, a reallocation from the Stockton Lake combination pool, were carried forward for further analysis into the final array of alternatives. Each alternative was found to provide an efficient, reliable, affordable adequate supply for the region throughout the study period.

The results of the screening process are presented in Table 3-2 below and further explained in Appendix L. Quantitative criteria were evaluated on a measurable scale such as volume of water or cost in dollars or years. Qualitative criteria were given a “low,” “medium,” or “high” score. For qualitative scoring, “high” indicates the alternative has potentially high impact and is not ideal for implementation because of constraints of that criteria category. “Low” indicates the alternative is feasible for implementation with limited to no impact on that criterion. “TBD” (to be determined) indicates analysis for this criterion has not yet been completed. “N/A” indicates the criterion was not evaluated because of a previously analyzed criterion that was determined to be detrimental to the progression of the alternative. Consistent with the identified planning objectives and constraints, those measures involving large costs, prohibitive logistics or legal agreements, or excessive environmental impacts were eliminated in favor of more cost effective and sustainable measures.

Table 3-2. Preliminary Screening Analysis.

Alternative #	2	3	4	5	6	7	8	9	10	11	12
Screening Criteria	**New Reservoir Construction**	**Increased Water Conservation**	**Additional Groundwater Sources**	**Stockton Multipurpose Pool Reallocation**	**Stockton Flood Control Pool Reallocation**	**Stockton Combination Pool Reallocation**	**Stockton Inactive Pool Reallocation**	**Water Importation**	**Local River or Stream Withdrawal**	**Pomme de Terre Lake Reallocation**	**Table Rock Lake Reallocation**
Water Availability (MGD)	39 (1)	10 to 26.6 (2) (26 to 69% of needed supply)	39	39 (3) (90,200 AF)	39 (3) (100,000 AF)	39 (3) (94,750 AF)	39 (3) (90,200 AFY)	N/A	N/A	39 (3) (55,000 AF)	39 (3) (56,000 AF)
Reliability of Source	Very Reliable	Somewhat Reliable	Not Reliable	Very Reliable	Very Reliable	Very Reliable	Very Reliable	Not Reliable	Not Reliable	Very Reliable	Very Reliable
Environmental Impacts	High	Low	Low	Medium	Medium	Medium	Medium	Low	Low	Medium	Medium
Operational Constraints	Medium	Low	N/A	Medium	Medium	Medium	Medium	N/A	N/A	Medium	Medium
Dam Safety/Flood Risk Management				Low	High	Low	Low			TBD	TBD
Hydropower				Low	Low	Low	Medium			TBD	TBD
Recreation				Medium	Low	Low	Medium			TBD	TBD
Permitting and Stakeholder Requirements/ Constraints	High	Low	N/A	Medium	Medium	Medium	Medium	N/A	N/A	Medium	High
Quality of Water	High Quality	High Quality	N/A	High Quality	High Quality	High Quality	High Quality	N/A	N/A	High Quality	High Quality
Cost of Storage	$273 M (1)	TBD (4)	N/A	$34.1 M	$37.8 M	$35.8 M	$34.1 M	N/A	N/A	$14.9 M	$8.5 M
Mileage of Transmission Lines Required (miles)	150	N/A	N/A	170	170	170	170	N/A	N/A	190	190
Cost of Transmission	$1,500 M	N/A	N/A	$1,700 M	$1,700 M	$1,700 M	$1,700 M	N/A	N/A	$1,800 M	$2,300 M
Timeline for Supply Availability (number of years)	15 to 20	TBD (4)	N/A	7 to 9 (5)	7 to 9 (5)	7 to 9 (5)	7 to 9 (5)	N/A	N/A	9 to 11 (5)	13 to 15 (5)
Status (Screened Out or Carried Forward)	**Screened Out**	**Screened Out**	**Screened Out**	**Carried Forward**	**Screened Out**	**Carried Forward**	**Screened Out**	**Screened Out**	**Screened Out**	**Screened Out**	**Screened Out**

Notes: Alternative 1, the Federal No Action/FWOP Alternative, is not included in this table but is carried forward as a comparison to FWP alternatives.

[1] Based on most economical single reservoir option in existing documentation and adjusted from 36 MGD to 39 MGD to meet future demand (Freese and Nichols 2010).

[2] Based on medium growth for conservation Scenarios I and II.

[3] Modeling of availability has not yet been completed. Storage available at Pomme will prohibit providing the necessary amount of 39 MGD. Current evaluated amounts are based on total Southwest Missouri Regional Water supply gap in 2060.

[4] Costs and timeline must be evaluated at the provider level and are dependent on current conservation implementation.

[5] Assuming 5 to 7 years following contract acquisition for construction of necessary transmission facilities to deliver reallocated water.

3.5.4. Final Array of Alternatives

The final array of alternatives following initial screening are listed below. Alternative 1 is the Federal No Action/FWOP condition that is included in the final array so that an impacts comparison and assessment can be conducted between No Action and other viable alternatives. Alternative 2, construction of a new reservoir, is included as the least costly Non-Federal Action that would most likely be taken in lieu of a federal action. It is used for comparison purposes in the Test of Financial Feasibility (Section 9) but is otherwise not further evaluated because of the high cost and environmental impacts.

The alternatives carried forward for additional evaluation include:

- Alternative 1: No Federal Action/FWOP Condition (existing Stockton Plan of Regulation) – the region would still be in need of water and shortages are likely to occur during drought.
- Alternative 5: Multipurpose Pool from Stockton Lake (90,200 AF)
- Alternative 7: Combination of Multipurpose Pool and Flood Control Pool at Stockton Lake (45,750 AF from the multipurpose pool and 49,000 AF from the flood control pool)

4.0 Affected Environment

This chapter discusses the existing conditions in the project area, referred to as the affected environment. The affected environment is the baseline against which potential impacts caused by the proposed alternatives are assessed. This chapter focuses on those resources specific to the proposed project area that have the potential to be affected by a water supply storage reallocation at Stockton Lake.

4.1. Project Setting

Stockton Lake is a man-made lake on the western edge of the Missouri Ozarks within Cedar County, Dade County, and Polk County, Missouri. Figure 2-3 shows the location of the lake. Stockton Lake was authorized by the Flood Control Act of 1954 as a multipurpose project with the following authorized purposes: flood control (flood risk management), hydroelectric power, recreation, water supply, navigation, fish and wildlife management, and water quality. Stockton Lake is operated for flood control, hydroelectric power, water supply (some multipurpose storage was reallocated to water supply storage in 1993), recreation, water quality, and fish and wildlife. The project is not operated for navigation; it is an incidental benefit.

The lake was formed from damming the Sac River about 2 miles east of the City of Stockton, Missouri. USACE began construction on the dam in June 1964; closure occurred in September 1968. USACE manages and operates the lake. Stockton Lake is V-shaped and covers 39 square miles, with 298 miles of shoreline. The federal fee and flowage easement boundary is shown in Figure 4-1.

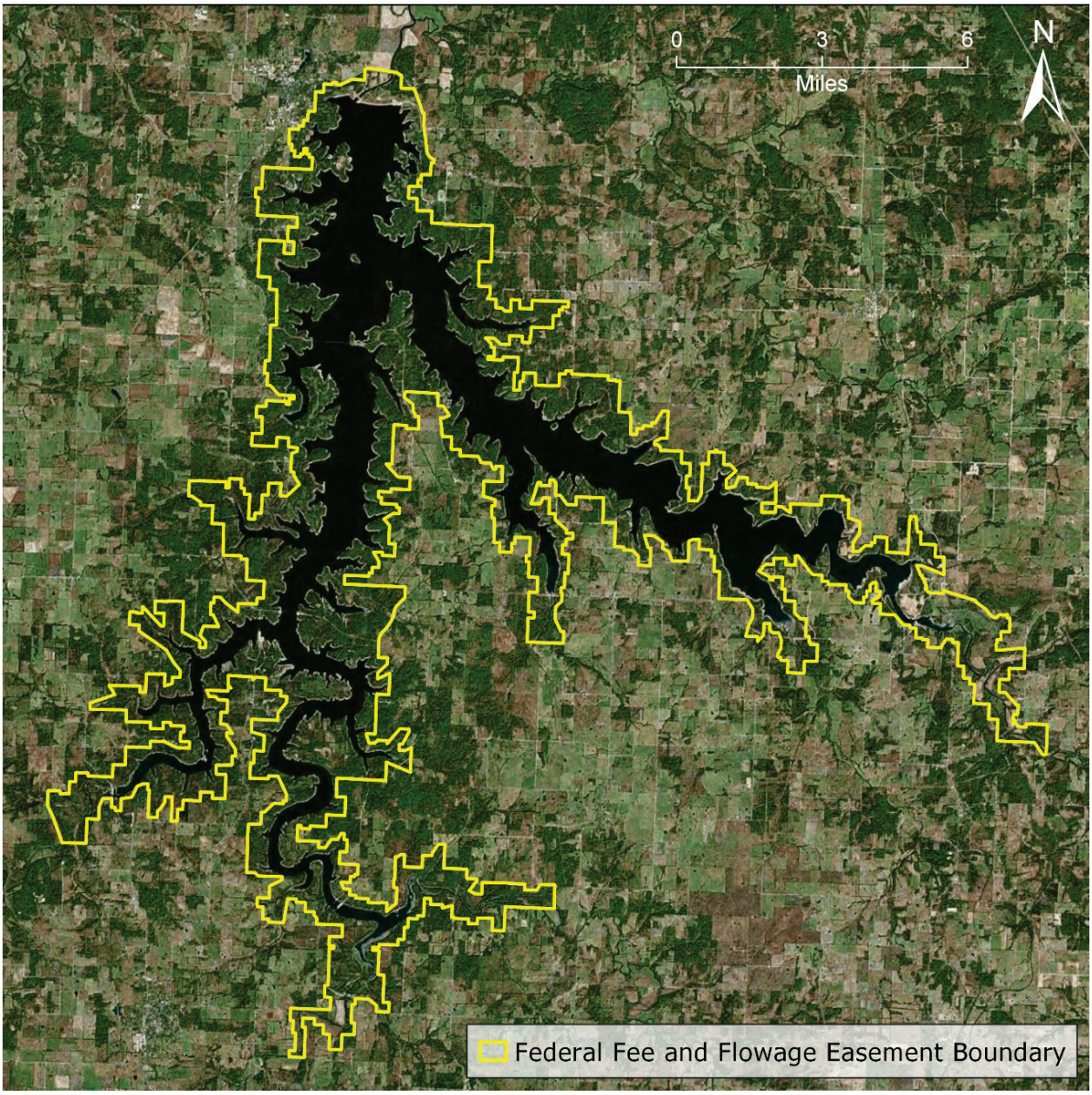


Figure 4-1. Stockton Lake Federal Fee and Flowage Easement Boundary.

According to the Stockton Lake Association, Stockton Lake is rated one of the top 10 sailing lakes in the United States. The great sailing conditions are fueled by winds consistently blowing from west to east across the lake. In addition to sailing, visitors to Stockton Lake enjoy a wide variety of recreational opportunities including water skiing, scuba diving, swimming, and fishing.

While the immediate area surrounding the lake is rural, it is located only approximately 50 miles northwest of Springfield, Missouri, which has an estimated population of approximately 167,000[2].

[2] U.S. Census Bureau ACS 2011-2015, 5-Year Estimate

4.2. Lake Operations

4.2.1. Plan of Regulation

Multipurpose operations are defined by the lake at or below elevation 867 feet NGVD 29, during which time releases from multipurpose storage are authorized in support of hydropower generation and downstream water quality. Water supply withdrawals occur independently from an existing water intake structure located on the lake.

Inflows to the multipurpose pool are typically managed by SWPA by scheduling hydropower generation from the Stockton Lake dam's one turbine-generator unit. This unit was upgraded in 2015 and can generate approximately 52 MW, contributing to peak regional power demands managed and marketed by SWPA. In 1973, a skimming weir was constructed in the lake up to elevation 845 feet NGVD 29 for the purpose of maintaining downstream water quality during hydropower generation. This weir precludes hydropower generation below elevation 845 NGVD 29, however, the lowest three reservoir elevations experienced throughout the project's 49 years of operation have been 851.86, 858.66, and 858.74, occurring in 1977, 2006, and 1981, respectively.

During times when Stockton Dam is not generating hydropower, low-flow releases of 40 cubic feet per second (cfs) are maintained to ensure downstream water quality, flows, and environmental conditions.

Water supply withdrawals occur on an as-needed basis from an existing water intake structure located on the lake. The water intake is operated by City Utilities within the limits of their water storage contract, with daily usage reported on a monthly basis.

Flood control operations are in effect when the lake is above elevation 867 feet NGVD 29 but below elevation 892 feet NGVD 29. The flood control allocation is divided into three horizontal zones or phases, each with an authorized maximum allowable release and downstream limiting flow requirements at two USGS stream gage locations, Highway J and Caplinger Mills. Figure 4-2 identifies the seasonal guidelines by Phase I, Phase II, and Phase III that define total and percent of flood control storage and associated releases by elevation and month.

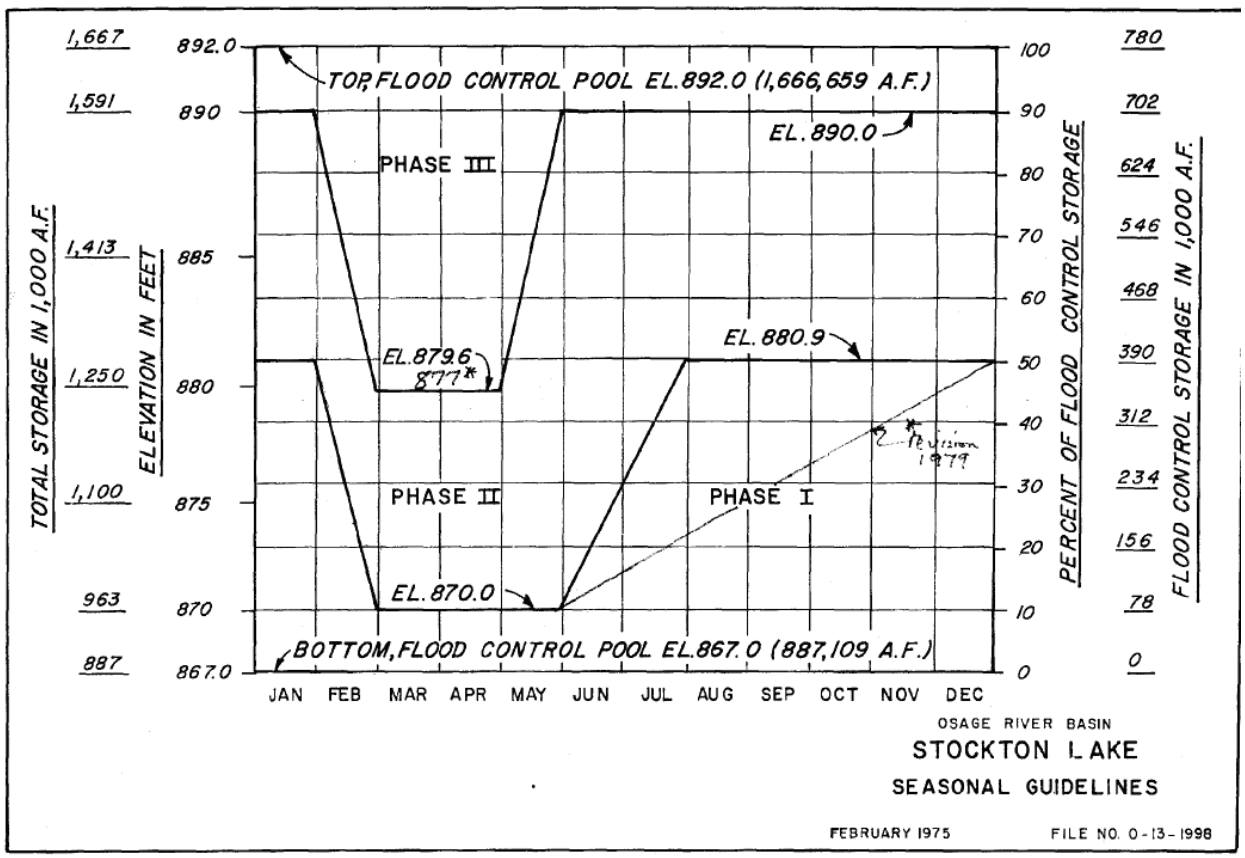


Figure 4-2. Stockton Lake Seasonal Guidelines for Flood Control Release.

The Kansas City District Water Management communicates daily to SWPA regarding the required average water release rate for the current 24-hour period. Water releases are sized so as not to exceed phase-dependent, available channel space criteria at Highway J and at Caplinger Mills, respectively. The 24-hour change in reservoir storage, plus estimated inflows for the next 24 hours, are generally assessed to empty all water from flood control storage over a 10-day period.

Throughout the project's 49 years of operation, the top of the flood control storage allocation has never been equaled or exceeded. The highest three pool elevations on record (feet NGVD 29) are 885.94, 885.27, and 884.54, occurring in calendar years 1973, 2019, and 1993, respectively.

Surcharge water storage exists above the top of flood control pool, elevation 892 feet NGVD 29. This temporary storage only becomes available above 892 feet NGVD 29 as the project's four Tainter gates are raised in unison to prevent these gates from being overtopped by rising lake waters. As flood control storage is exceeded, surcharge operations pass only the amount of water necessary to control an incoming flood event. Surcharge releases are sized and scheduled to protect the dam from overtopping. In this manner, surcharge releases protect the dam while not causing a flood event below the dam that is larger than what would have happened if the dam never existed. Induced surcharge releases can occur prior to exceeding pool elevation 892 feet NGVD 29 if very large inflows are observed. All induced surcharge releases are conduced according to specified rates of inflows for a given pool elevation as defined in the water control manual.

4.2.2. Downstream Releases

When the lake is at or below elevation 867 feet NGVD 29, releases from the Stockton Lake dam will be attributable either to hydropower generation or to water quality minimum releases. Under these circumstances, releases in support of hydropower generation will typically coincide with morning and or

evening peak demands for electricity. These releases generate flows that typically rise and fall within the existing downstream channel and dissipate within the backwater area of the Truman Lake dam. Water quality releases of 40 cfs pose no threat to out-of-bank flooding.

When the lake rises above elevation 867 feet NGVD 29, releases from flood control storage of Stockton Lake cannot exceed a maximum limit based upon the phased guidelines. Releases are further constrained by "not to exceed" flow criteria limits at downstream USGS gage sites, or control points.

4.3. Physiography, Geology, and Topography

Stockton Lake is in the Sac River Basin. The Sac River Basin encompasses parts of two physiographic regions: the Ozarks Plateaus and the Ozark Plains. It is further divided between the Springfield and Salem plateaus within the larger Ozark Dome, an elongated dome that encompasses most of the southern half of Missouri. The plateaus rise from the surrounding plains and are composed of igneous rock overlain by limestone and dolomite. Most of Stockton Lake lies within the Springfield Plateau, which contains mostly Mississippian-age limestone and chert from the Boone Formation. Salem Plateau lies essentially north and east of the lake. The Salem Plateau is the lowest of the plateaus making up the Ozark Plateau province and contains Ordovician dolostones, sandstones, and limestones. The units of the Springfield Plateau and Ozark aquifers are shown in Figure 4-3.

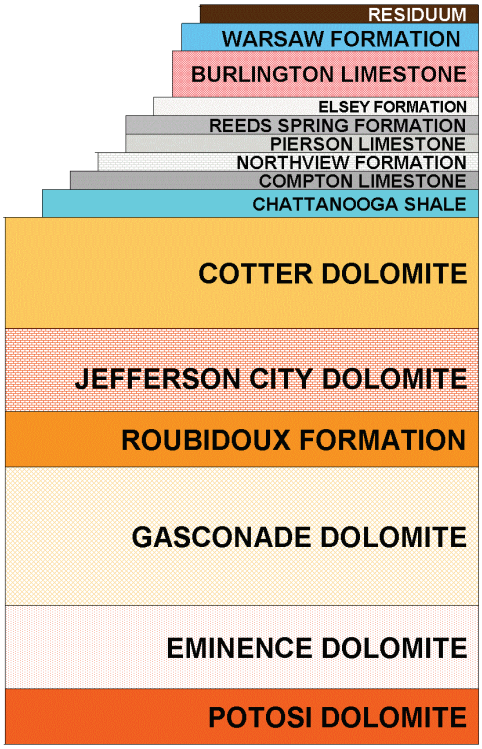


Figure 4-3. Stratigraphic Units Comprising the Springfield Plateau and Ozark Aquifers in Southwestern Missouri. *Source: MoDNR*.

The uplands in the Sac River Basin are mantled with a thin layer of loess ranging from less than 2 feet thick in the headwater's areas to about 4 feet thick in the lower portions of the basin. The headwaters originate on Mississippian-aged limestones and dissect progressively younger strata going downstream. Ordovician dolomites and thin layers of shale are also incised progressing downstream. The lower Sac River ends up incising Pennsylvanian-aged shale around its confluence with the Osage River/Truman Reservoir. Figure 4-4 shows the topography surrounding Stockton Lake.

Karst areas are found in the Sons Creek sub-basin, along the Sac River upstream of Stockton Lake and throughout the portion of the basin found in Greene County. Caves, sinkholes, springs, and other natural features related to karst terrain are most numerous in the southeastern section of the basin and become progressively less numerous to the northwest.

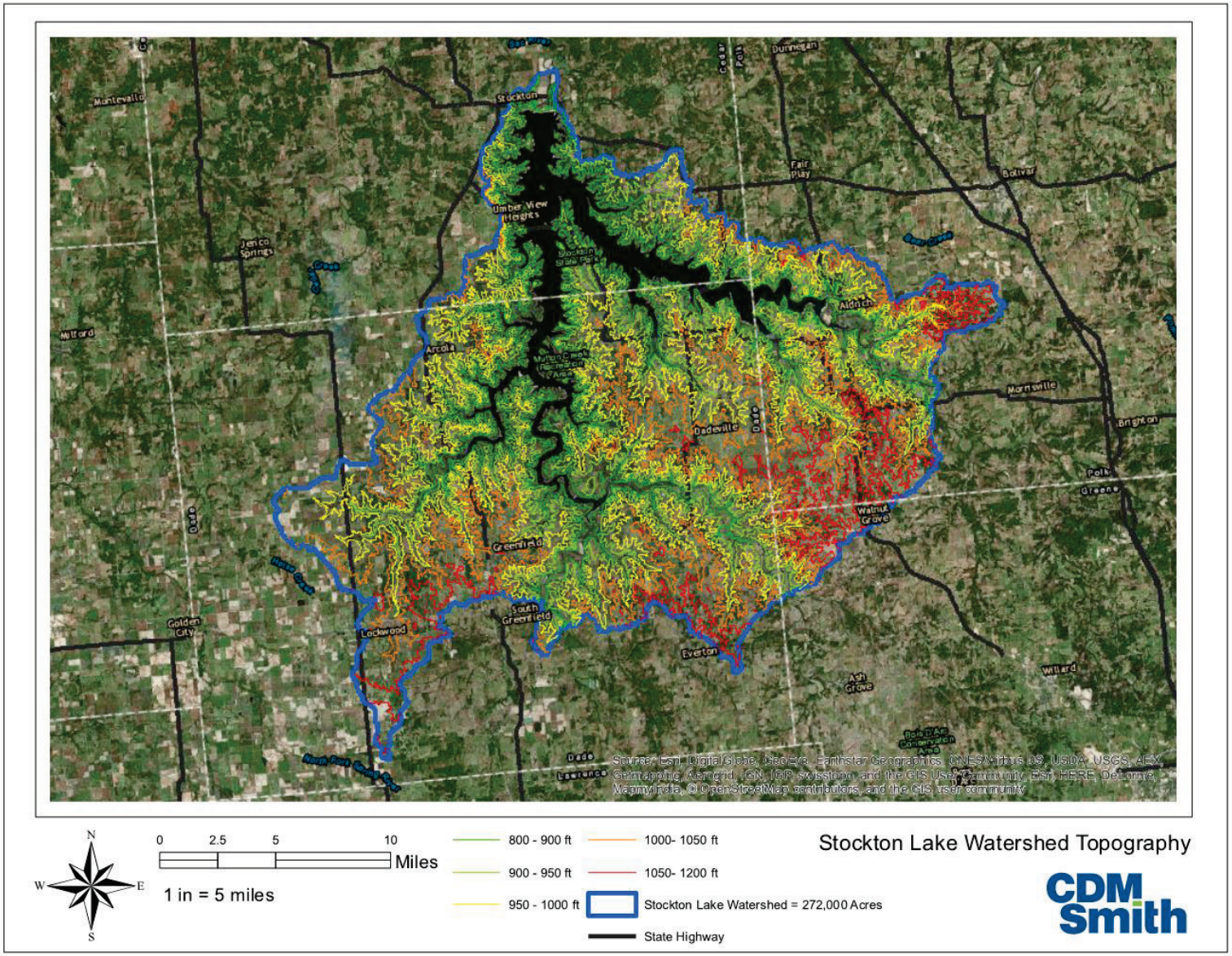


Figure 4-4. Topography Surrounding Stockton Lake.

4.4. Water Resources

4.4.1. Surface Water

Surface water resource area of interest for evaluating impacts include the lake and the below the dam. Stockton Lake is a 24,900-acre reservoir created by impounding the Sac River. The Sac River originates in Greene County, just west of Springfield, Missouri. It flows generally northward until reaching the Osage River. Named tributaries in the project area include Sons Creek, Mutton Creek, Greaser Creek, Googer Creek, Hawker Branch, Sac River, Miller Branch, Cothwell Branch, and Edge Branch. These tributaries are shown on Figure 4-5.

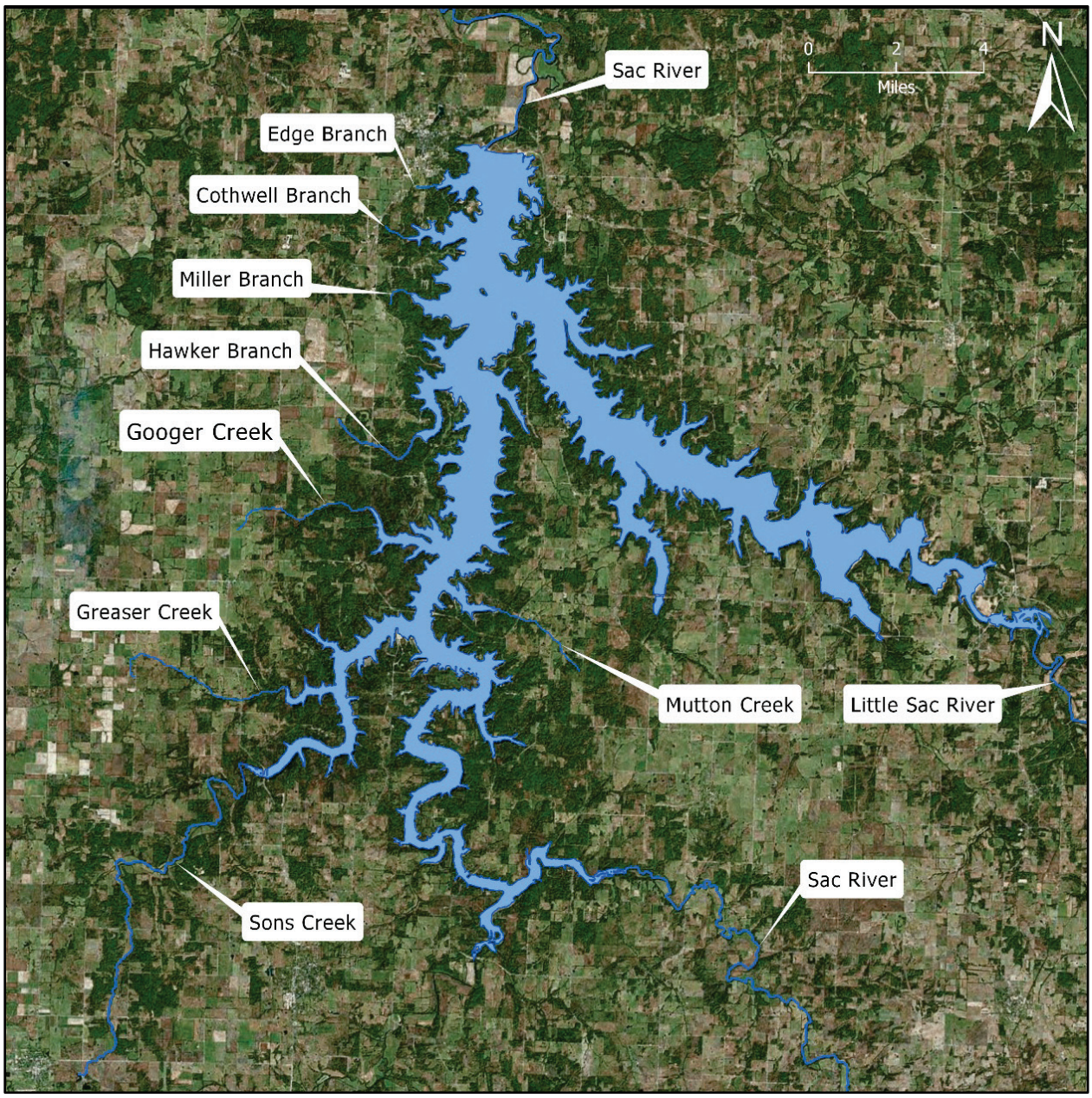


Figure 4-5. Named Tributaries of Stockton Lake.

The Sac River, Turnback Creek, and Sons Creek form the headwaters of Stockton Lake. The Sac River and Turnback Creek drain most of the deeply dissected areas in the eastern half of Dade County. Sons Creek traverses across the central portion of Dade County.

4.4.2. Groundwater/Aquifer

Three significant bedrock aquifers in the Springfield Plateau groundwater province, St. Francois, Ozark, and Springfield Plateau, are the areas of interest for groundwater and aquifers.

The Precambrian-age igneous and metamorphic rock beneath the St. Francois aquifer has very low hydraulic conductivity and forms the basement confining unit. Because of its depth and generally modest yield potential, few wells produce from the St. Francois aquifer in the province.

The most widely used and important formations comprising this aquifer are the Derby-Doerun, Eminence, Potosi, Gasconade, Roubidoux, Jefferson City, and Cotter. The Ozark aquifer is a confined or artesian aquifer throughout most of the province. As such, the water levels in tightly cased wells drilled into the aquifer are above the top of the aquifer. In a few places where the artesian head in the Ozark aquifer is high enough, wells drilled into it flow water at land surface. In most places though, water levels in the Ozark aquifer are well below land surface.

Mississippian-age strata comprise the Springfield Plateau aquifer; however, due to historical mining activities in southwestern Missouri, high concentrations of lead and cadmium are present within the underlying Springfield Plateau aquifer. Additional contamination from industrial activity has recently contaminated the groundwater from the release of solvents such as trichloroethylene into the environment (MoDNR Springfield Plateau Groundwater Province). Since this region is comprised of karst features, a network of pathways exists for contaminants to travel causing widespread contamination within the aquifer. Therefore, most wells in this region are drilled into the deeper, confined Ozark aquifer.

Groundwater quality in the Springfield Plateau region is generally high quality. The water from all three aquifers typically meets primary and secondary maximum contaminant levels for drinking water. The major differences in water quality between the Springfield Plateau aquifer and deeper Ozark and St. Francois aquifers is the degree of mineralization and the dissolved constituents present. Water from the Springfield Plateau aquifer typically has the lowest levels of mineralization and is a calcium-bicarbonate type of water reflective of the limestone that the water has been in contact with. Water produced from the Ozark and St. Francois aquifers generally has a higher total dissolved solids level and is a calcium-magnesium-bicarbonate type as a result of the dolomite bedrock.

4.4.3. Water Quality

Stockton Lake is currently designated for whole-body-contact recreation, drinking water supply, protection of warm water aquatic life, and livestock and wildlife watering. The water quality of Stockton Lake in 2019 did not exceed Missouri State Water Quality Standards for the designated uses. However, inflow stream, Turnback Creek, is on the MoDNR impaired waters list because of impacts of Escherichia coli bacteria to swimming and wading since 2010.

The USACE Water Quality Program collects monthly water samples at Stockton Lake from April through September. This data is used to help assess water quality conditions, trends, and changes over time related to management for USACE-authorized purposes as well as state water quality standards required for specific designated use.

While nutrients including phosphorus and nitrogen are essential for aquatic life, excess nutrients from urban, agricultural, or natural sources accelerate the natural aging and eutrophication process in lakes. This excess can cause algal blooms, create low dissolved oxygen (DO) levels affecting fish survival, and lead to taste and odor issues in drinking water. MoDNR led a multiagency work group to establish Missouri Numeric Nutrient Criteria for Lakes (Table 4-1) to minimize adverse effects of nutrient enrichment on aquatic life in Missouri lakes (10 CSR 20-7.031(5)(N)). The new state water quality

standards provide nutrient screening thresholds for each Missouri Ecoregion, which help identify nutrient related problems that may exist under certain conditions, and also provide criteria for impaired water body designation using chlorophyll-a concentration based on the premise that chlorophyll is the end product of excess nutrients. Data collected at Stockton Lake from 2010 to 2019 provides a good assessment of potential nutrient impairment, according to MoDNR nutrient criteria.

Table 4-1. Missouri Lake Ecoregion Chlorophyll-a Criteria and Nutrient Screening Values.

Lake Ecoregion	Chl-a Criterion (µg/L)	Screening Values		
		Total Phosphorous (TP mg/L)	Total Nitrogen (TN mg/L)	Chl-a (µg/L)
Plains	30	0.049	0.843	18
Ozark Border	22	0.040	0.733	13
Ozark Highland	15	0.016	0.401	6

Notes: Chl-a = chlorophyll-a, mg/L = milligrams per liter, TP = total phosphorus, TN = total nitrogen, µg/L = micrograms per liter.

Lakes with water quality that exceed nutrient criteria are deemed impaired for excess nutrients. Lakes with water quality that exceed screening values for Chl-a, TN, or TP are deemed impaired for excess nutrients if any of the following eutrophication impacts are documented for the respective designated uses within the same year. Eutrophication impacts for aquatic life uses include the following:

(I) Occurrence of eutrophication-related mortality or morbidity events for fish and other aquatic organisms.
(II) Epilimnetic excursions from dissolved oxygen or pH criteria.
(III) Cyanobacteria counts in excess of 100,000 cells per milliliter.
(IV) Observed shifts in aquatic diversity attributed to eutrophication.
(V) Excessive levels of mineral turbidity that consistently limit algal productivity during the period May 1 – September 30.

Geometric means ("geomean" on graphs) of pertinent data compiled for May through September at the site near the dam (e.g., ST-25) indicate that excess TN is present and exceeds the established screening value of 0.401 mg/L (Figures 4-6a,b and c). The 10-year geometric mean of chlorophyll-a does not exceed the screening value of 6 ug/L and is less than half of the chlorophyll-a criterion, which would lead to impaired status if exceeded. Stockton Lake TP and TN levels measured at a sampling site nearest the dam are typically the lowest and least variable of the 18 district lakes. Based on current nutrient concentrations, Stockton Lake is classified as mesotrophic. Mesotrophic lakes are characterized by moderate levels of nutrients and optimum sunlight penetrations to provide good growing conditions for aquatic plants and algae, which in turn, benefit the aquatic food chain including sportfish.

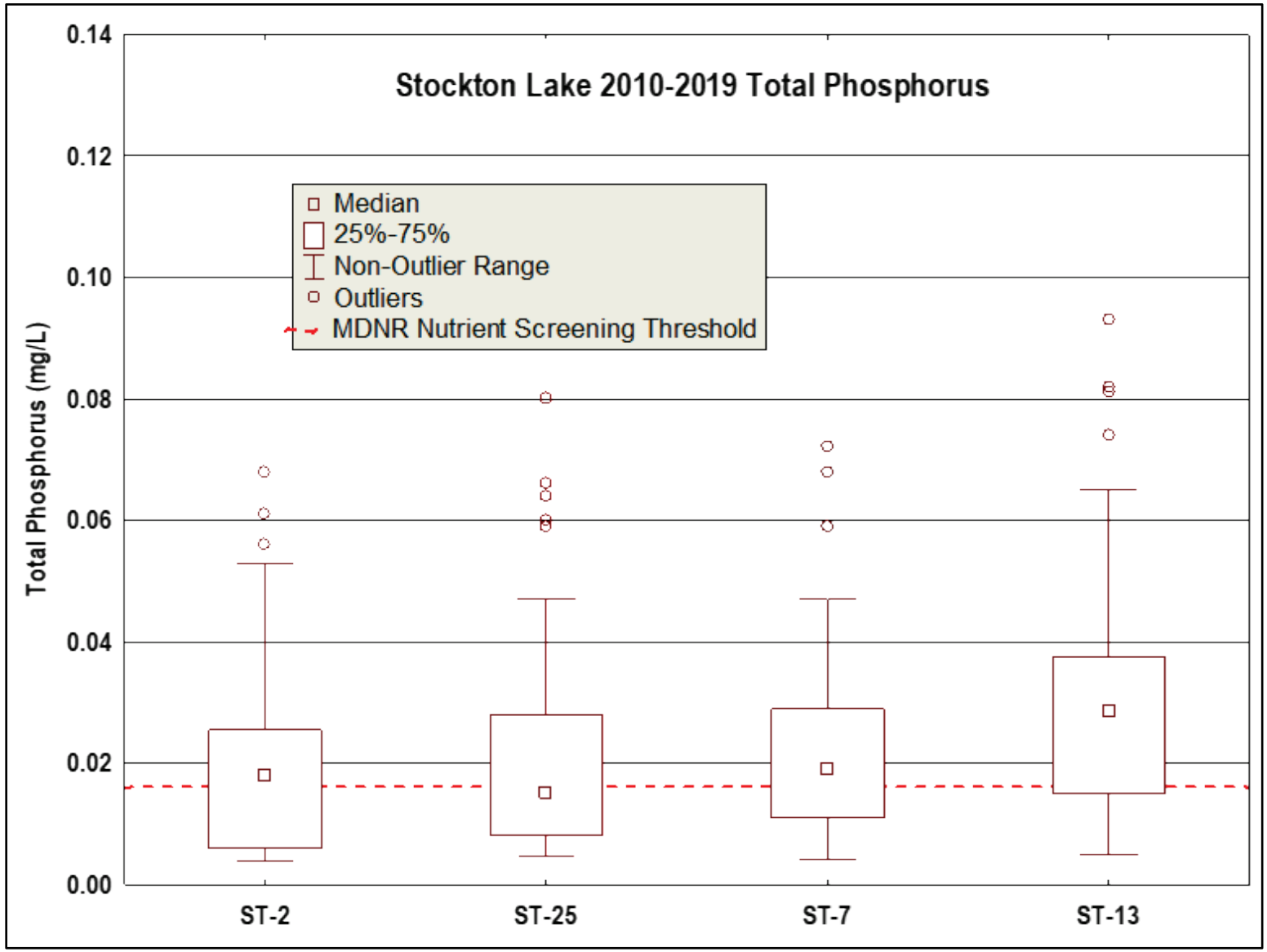


Figure 4-6a. Stockton Lake 10-Year Total Phosphorus, Total Nitrogen, and Chlorophyll.

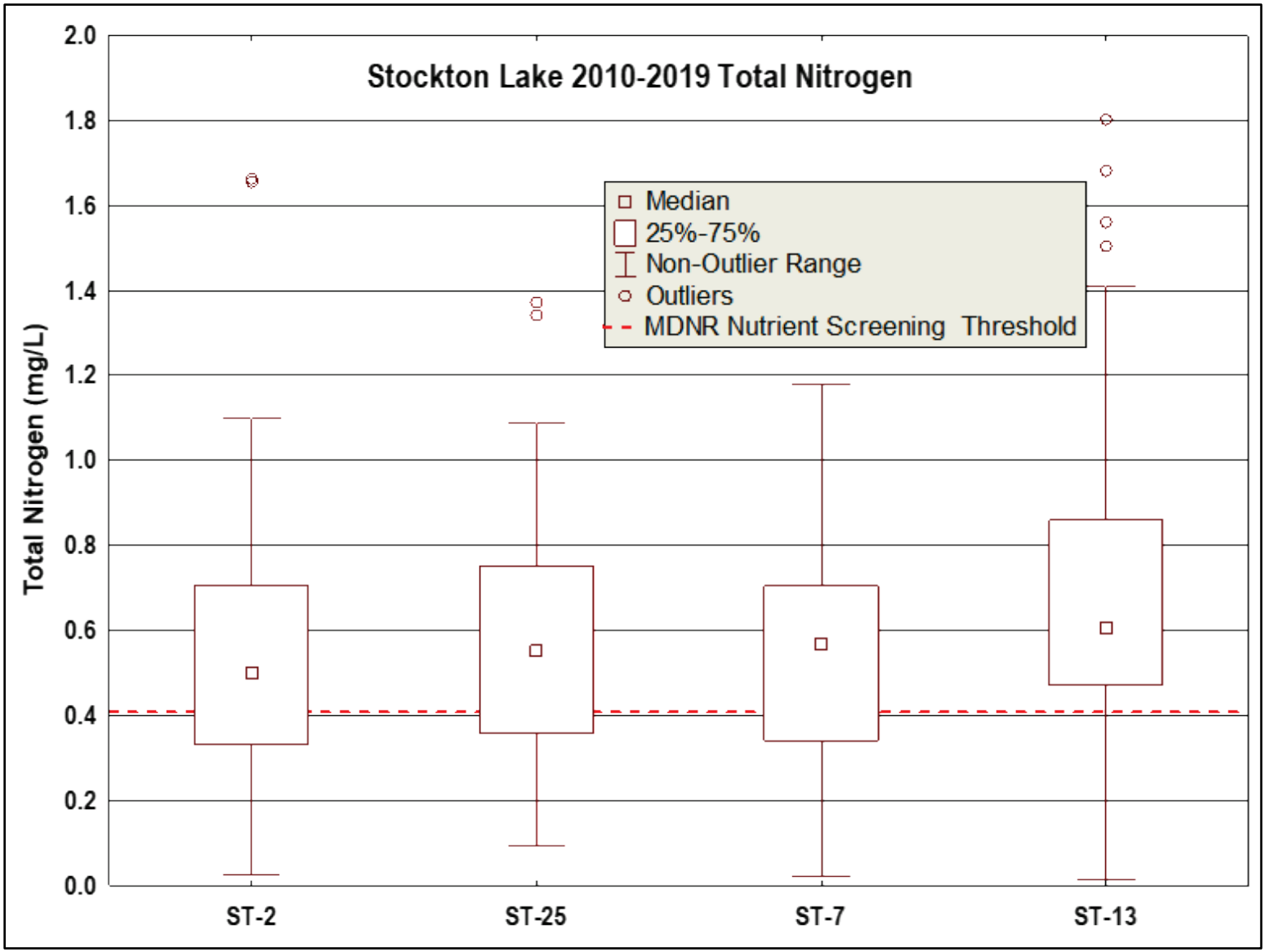


Figure 4-6b. Stockton Lake 10-Year Total Phosphorus, Total Nitrogen, and Chlorophyll.

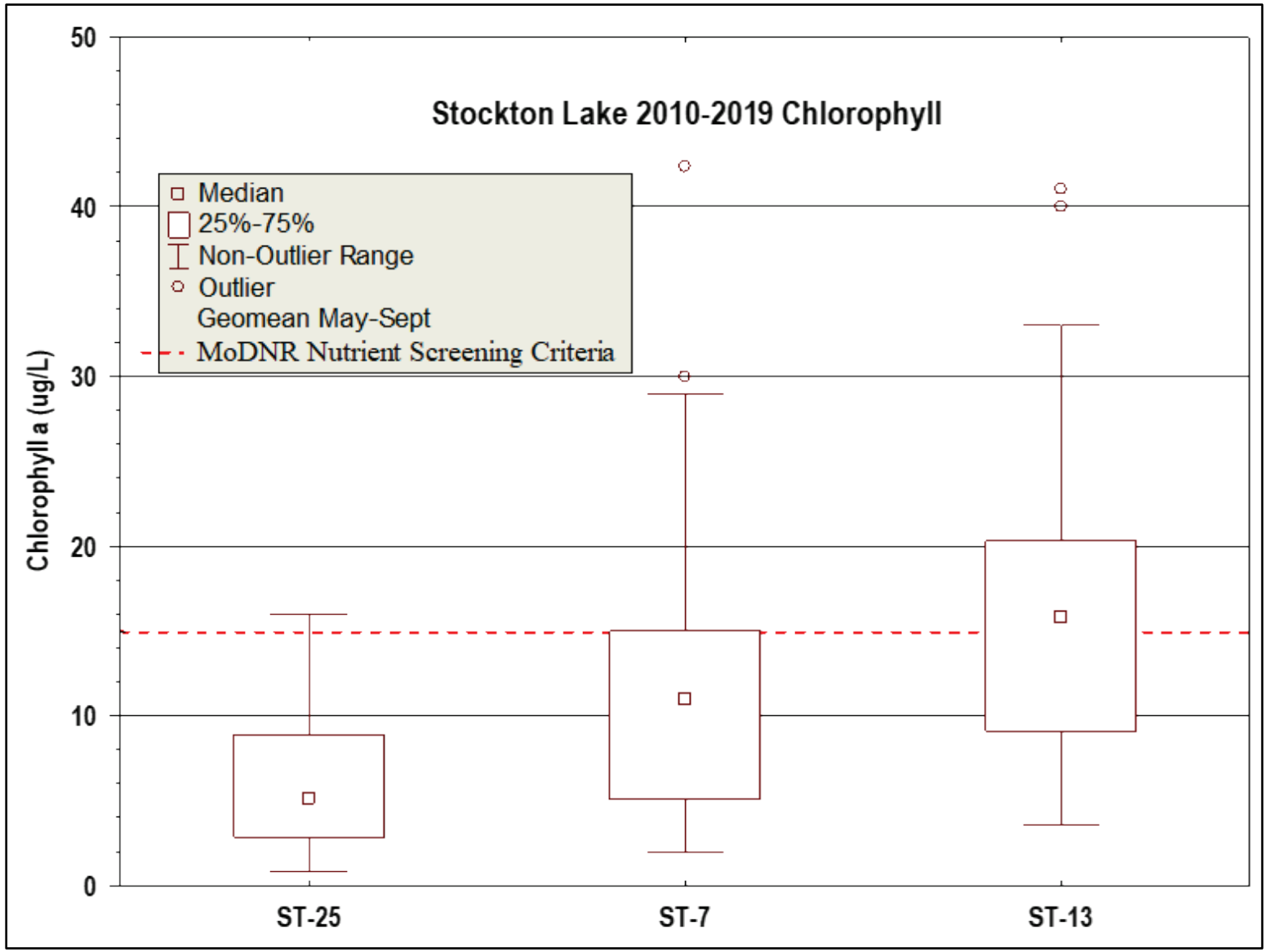


Figure 4.6c. Stockton Lake 10-Year Total Phosphorus, Total Nitrogen, and Chlorophyll.

Dissolved oxygen is an important factor in aquatic species location, growth, and ultimately, survival in lakes. Some lakes undergo a process called stratification, where they develop layers based on temperature and oxygen content. When stratified, the thermocline is the thin layer of water that divides the cold and warm strata, which usually relates to oxygen and chemical strata. Figure 4-7 depicts DO measured in the water column in 1-meter intervals from April to September 2019 near the dam at Stockton Lake. The thermocline in Figure 4-7 is the thin transition between blue and red blocks in the summer. While Stockton Lake stratifies during the summer, adequate DO is typically available in the top 6 meters of the lake. Oxygen-related fish stress or fish kills have not been documented at Stockton Lake.

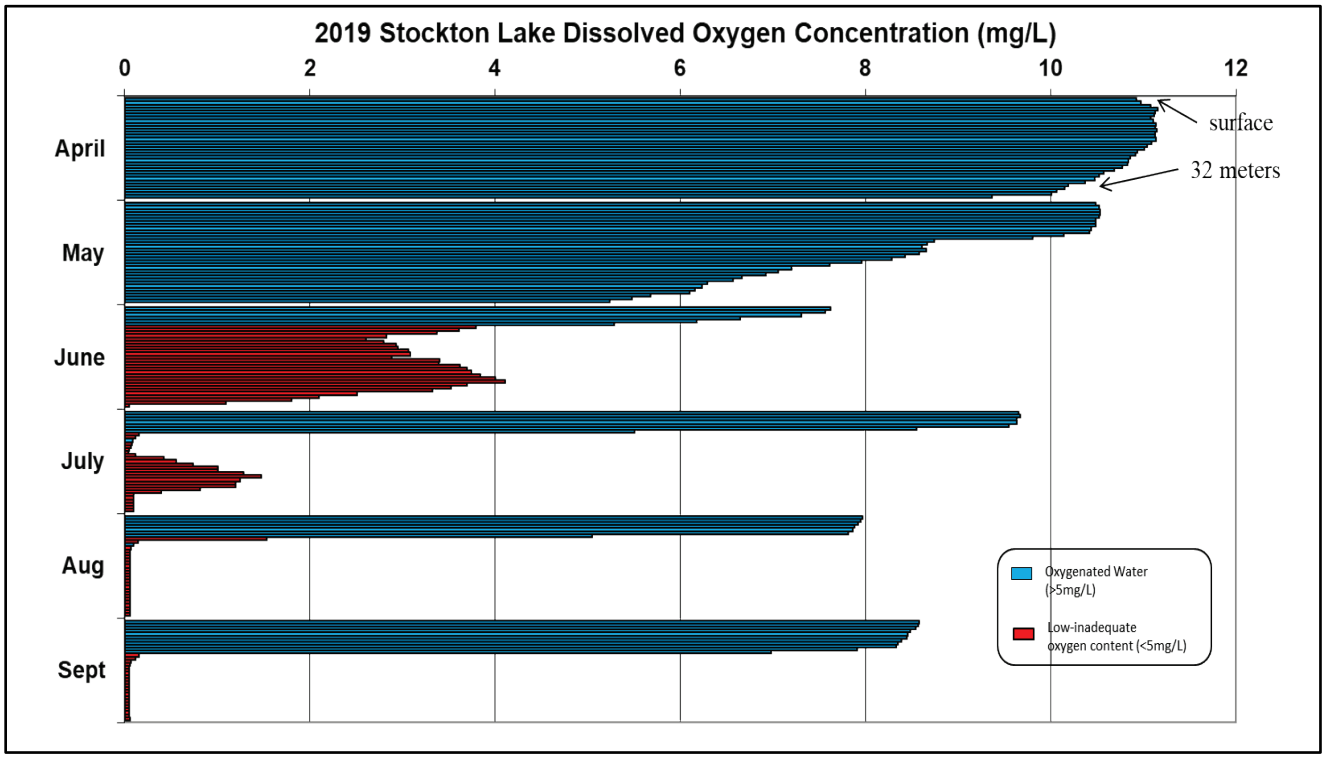


Figure 4-7. DO Concentration Measured in 1-Meter Intervals.

Low-DO water releases during power generation can become a concern requiring intensive management during critical periods in flood events. Stockton Lake is a bottom-withdrawal lake that has a skimming weir, or rock barrier, that prevents low-DO water from being discharged in large quantities to the river downstream during hydropower generation during stratified conditions. The functionality of this physical barrier is extremely reliable under most situations. Short periods of low-DO water in releases measured at the Stockton Lake Powerhouse are mitigated by the addition of high-DO surface water, which mixes and oxygenates the river downstream. During flood conditions in July and August 2019, the surface elevation was approximately 19 feet above multipurpose pool elevation. The thermocline, or layer of water separating the warm oxygenated water from the cold, low-DO water, moves vertically in relation to the surface elevation depending on mixing conditions from currents and wind action. Figure 4-8 graphically depicts the effectiveness of the skimming weir at maintaining adequate DO during power generation, even during high water.

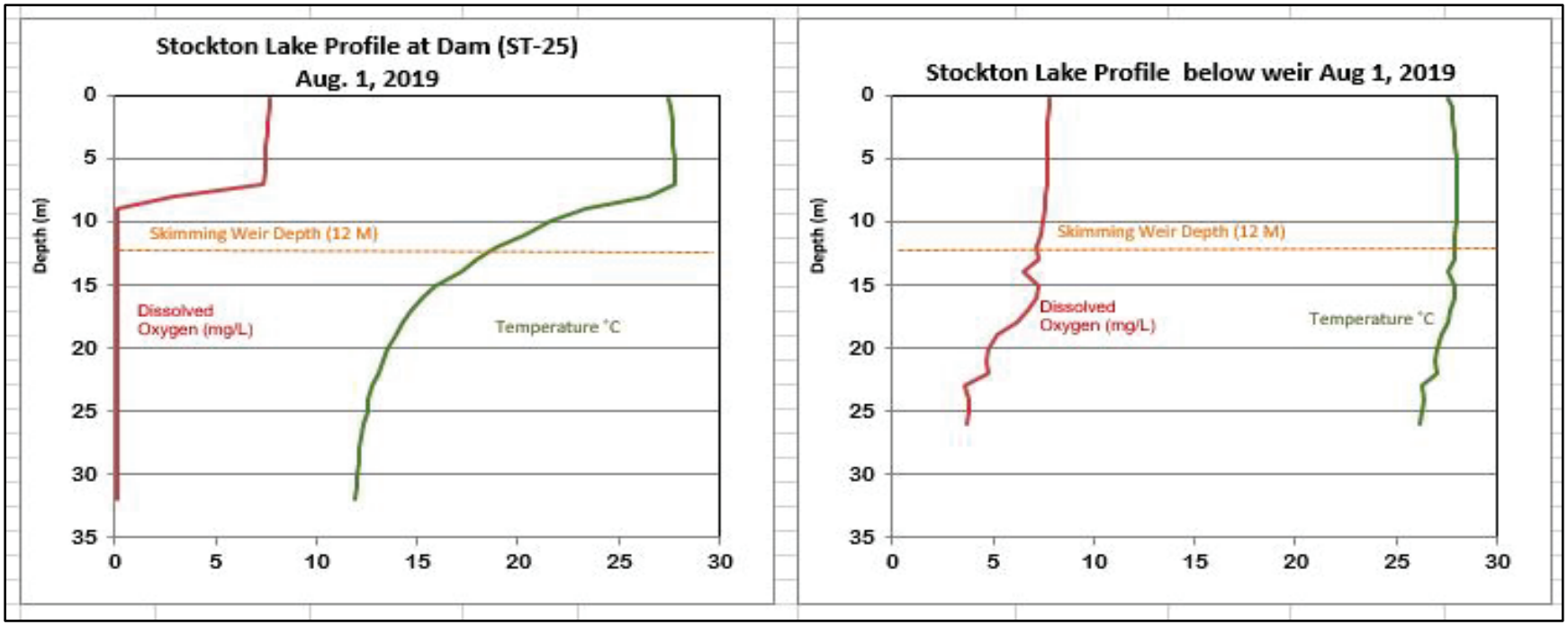


Figure 4-8. Temperature and DO Profiles Above and Below Skimming Weir above Stockton Dam.

The year 2019 represents a worst-case scenario of a high-water event where the thermocline elevation is significantly higher than the functional range of the skimming weir at sample site ST-25. The graph on the left side of Figure 4-8 shows the sudden DO and temperature gradient (i.e., thermocline) apparent upstream of the weir at ST-25 is not present downstream of the skimming weir near the dam. Although a small volume of cold and low-DO water was passing over the skimming weir when this data was collected, the temperatures and DO moderate in the mixing zone between the skimming weir and dam before discharging into the river during power generation. Water quality beneficial to aquatic life support in the river below Stockton Dam can be successfully maintained with benefits provided by the skimming weir during power generation and the required minimum flow.

4.4.4. Aquatic Habitat

The aquatic habitat area of interest includes the area within Stockton Lake. Most of the main channel of Stockton Lake was cleared of vegetation before the lake began to fill up in 1969. Standing timber left in the upper ends of the lake is still visible. Impoundment by Stockton Dam led to the creation of 298 miles of shoreline habitat.

Freshwater lakes are typically made of up of three biological zones linked to the physical structure of the lake. The littoral zone adjoins the shore where sunlight penetrates all the way to the sediment and allows aquatic plants to grow. The limnetic zone is the open water area where light does not generally penetrate all the way to the bottom. The profundal zone is below the limnetic zone in deep water beyond the depth of effective light penetration. The main area of analysis regarding this project would be the littoral zone, or shoreline area. Stockton Lake's littoral zone generally has steep shorelines but high transparency (Secchi depth of over 2.5 meters) to allow light to reach greater depths.

Fifty-five brush structures have been installed to provide habitat that concentrates fish for anglers. The structures are marked with green reflective signs on the shoreline. In January every year, USACE along with the Missouri Department of Conservation (MDC) install and refresh fish habitat structures on Stockton Lake. The structures are generally in about 10 to 20 feet of water, depending on current lake elevations. Five to 10 trees are installed to create new fish habitat structures, and three to five trees are used to refresh existing habitat structures. The trees range in size from 15 to 25 feet tall, with very brushy limbs.

4.4.5. Wildlife Management Area

The Aldrich Refuge area of interest is shown in Figure 4-9. The Aldrich Refuge is a 750-acre portion of the Stockton Lake Management Lands on the Little Sac Arm of Stockton Lake. Mostly shallow water mudflat, Aldrich Refuge provides ideal habitat for migratory waterfowl and shorebirds. When Stockton Lake is at its normal water level, more than 500 acres of the refuge is covered in water less than 2 feet deep.

The Aldrich Refuge is unique in that it provides large shallow water mudflats that are attractive to migratory shorebird species during the spring and summer months. Numerous shoreline birds feed on naturally occurring plankton and bloodworms in the mudflats. Inundated mudflats during the fall and winter months also provide habitat for migratory waterfowl species. The focus is on waterfowl species, such as dabbling ducks, that prefer feeding on moist soil plants. The Aldrich Refuge is operated by MDC. No changes to the current operations and management of the Aldrich Refuge are anticipated under the Federal No Action/FWOP condition.

Semipalmated Sandpiper.

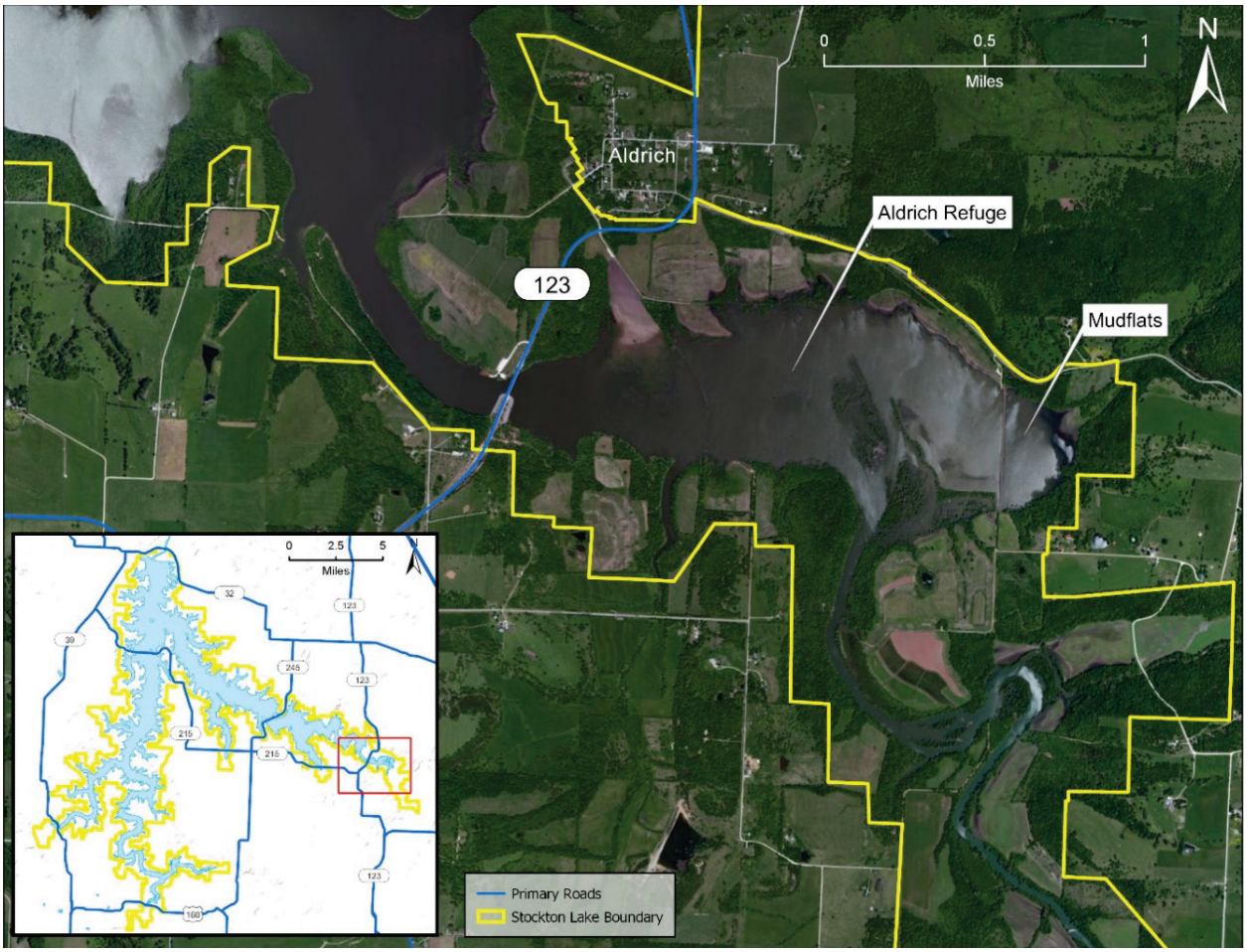


Figure 4-9. Location of Aldrich Refuge Within Stockton Lake.

4.4.6. Wetlands

The area of interest for wetlands includes the federal flow boundary of the lake. Wetlands are recognized as important features in the landscape that provide numerous beneficial functions for people and for fish and wildlife. Some of these functions include protecting and improving water quality, providing fish and wildlife habitats, storing floodwaters, and maintaining surface water flow during dry periods. Wetlands also provide recreational opportunities, aesthetic benefits, sites for research and education, and commercial fishery benefits. These beneficial functions are the result of the inherent and unique natural characteristics of wetlands.

As a result of the importance of wetlands and all water resources, these resources are regulated under the Clean Water Act (CWA). Section 404 of the CWA is the primary federal statute that implements federal regulatory policies concerning the protection of wetlands and other waters of the United States. Section 404 of the CWA prohibits the discharge of material into "Waters of the U.S." unless exempted or authorized by USACE.

The U.S. Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI) indicates there are approximately 375 acres of wetlands occurring throughout the federal property surrounding Stockton Lake. Most of this wetland acreage is classified as palustrine forested, either seasonally or temporarily flooded. Table 4-2 lists the types of wetlands present at Stockton Lake with acreages, and Figures 4-10 through 4-13 show the locations of these wetlands.

Table 4-2. Wetlands Within Stockton Lake Study Area.

Wetland Type	Acres
Palustrine Emergent	56.66
Palustrine Forested	229.48
Palustrine Unconsolidated Bottom	45.34
Riverine Unconsolidated Bottom	43.25

Source: USFWS, National Wetland Inventory.

In addition, the National Land Cover Database (NLCD) was reviewed, which identified 895 acres across federal property around Stockton Lake. The wetlands in the NLCD were evenly split between emergent wetlands (at 476.81 acres) and woody wetlands (at 418.32 acres). NLCD is a high-level evaluation using 30-meter by 30-meter imaging to identify overall land cover. It is understood that these maps represent a high-level view of potential habitat and a high degree of error or land use miss-identification is likely.

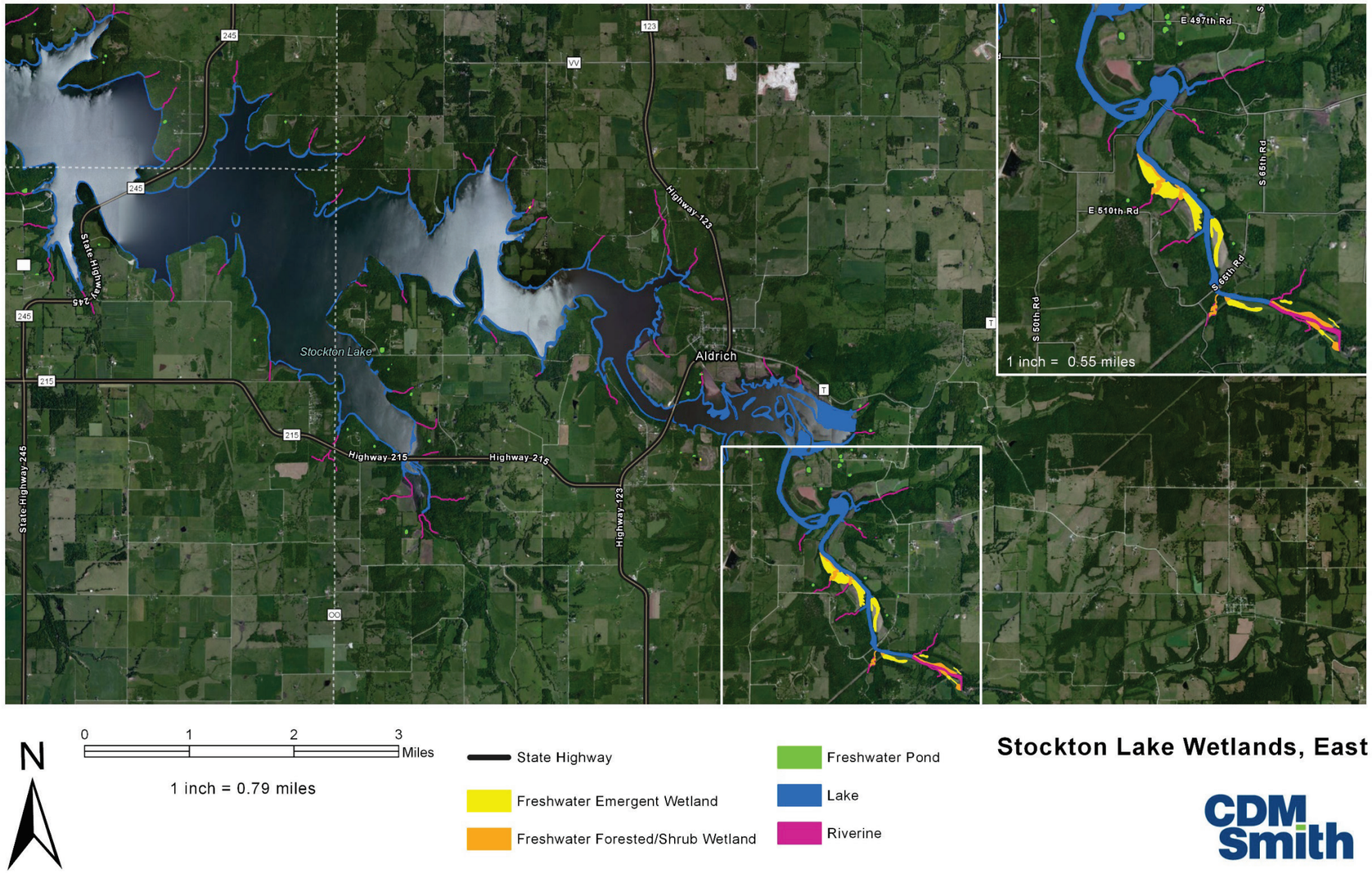


Figure 4-10. Stockton Lake Wetlands (East).

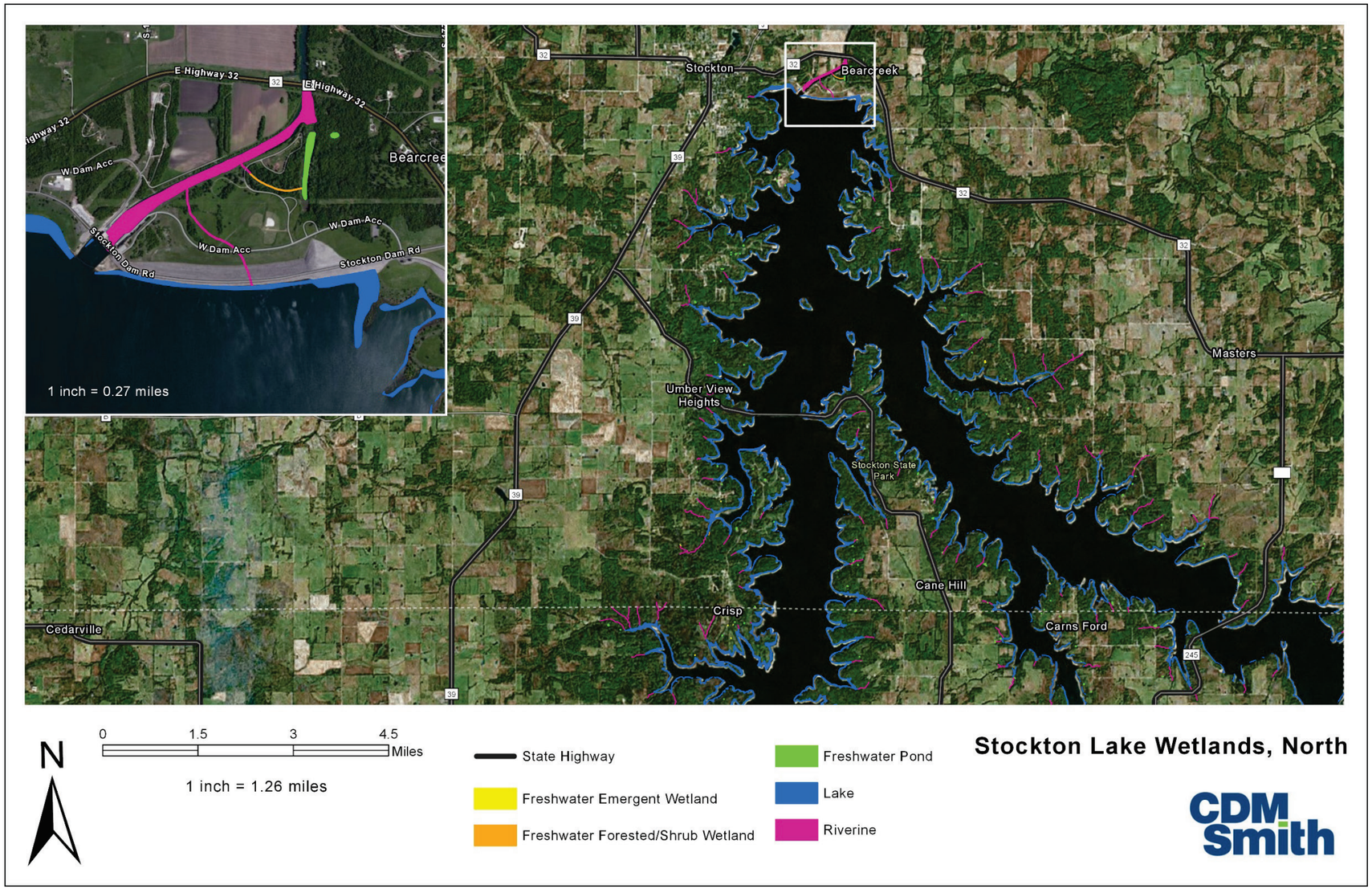


Figure 4-11. Stockton Lake Wetlands (North).

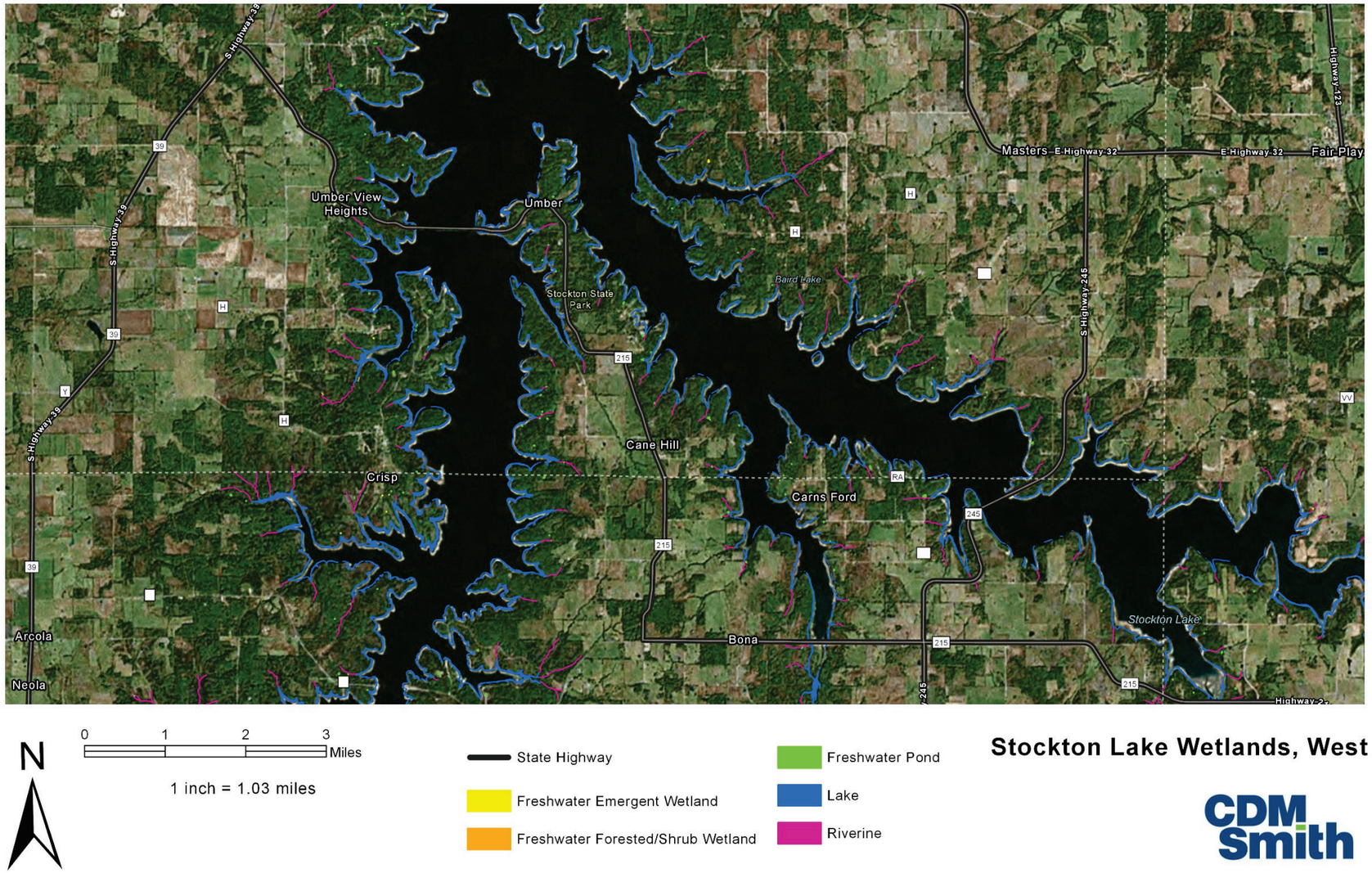


Figure 4-12. Stockton Lake Wetlands (West).

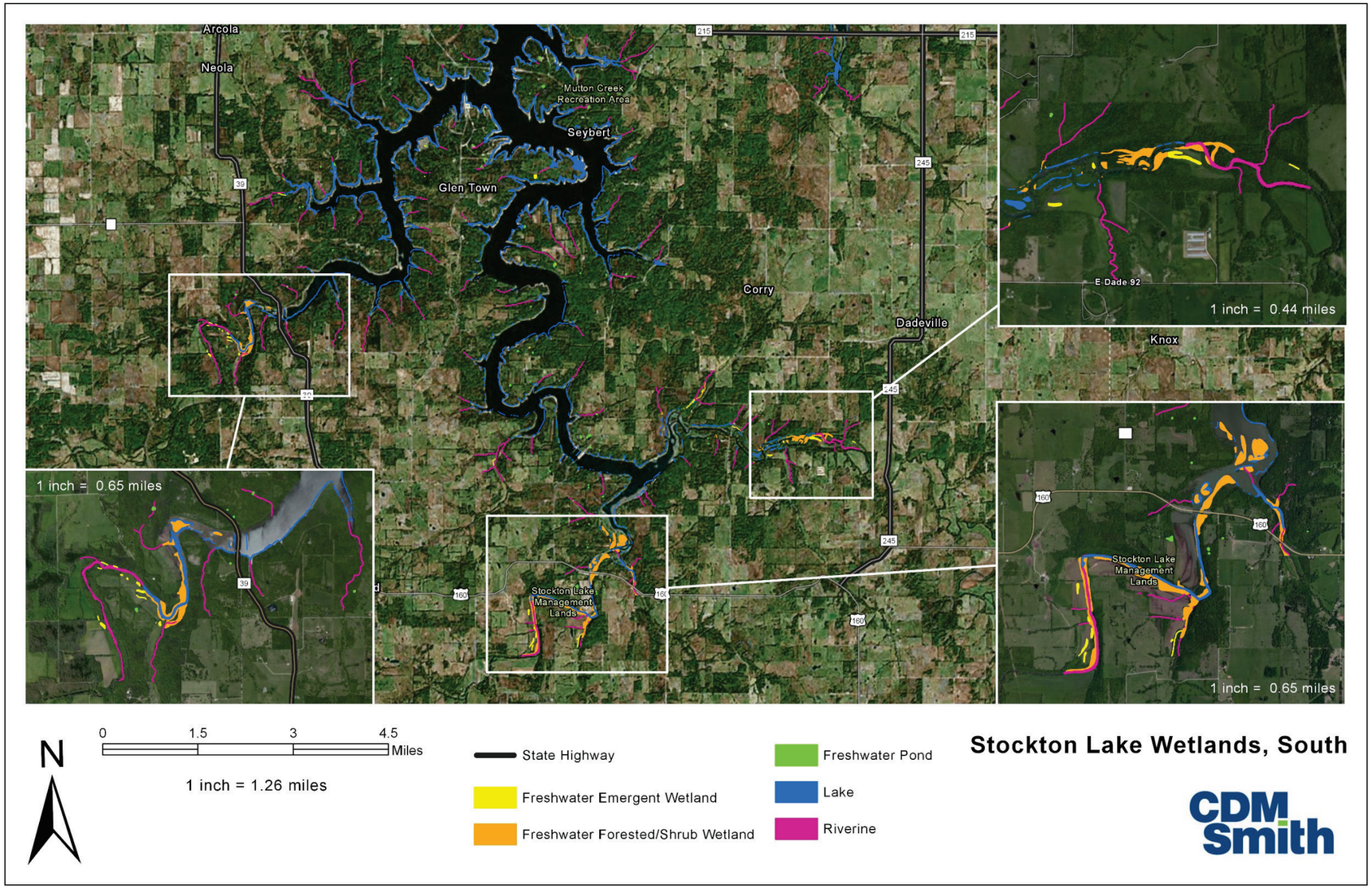


Figure 4-13. Stockton Lake Wetlands (South).

4.4.7. Wild and Scenic Rivers

No wild and scenic rivers (Wild and Scenic Rivers Act, 16 U.S.C. 1271, et. seq.) are within the Stockton Lake study area.

4.4.8. Floodplains

The project area includes portions of the 100-year floodplain associated with the Sac River, to include Stockton Lake (Cedar, Dade, and Polk Counties) and the Sac River and associated downstream tributaries into St. Clair County. EO 11988, Floodplain Management, requires federal agencies to consider the potential effects of their proposed actions to floodplains. The following eight-step decision-making process was used for the proposed project:

1. Determine if a proposed action is in the base floodplain.
2. Conduct early public review, including public notice.
3. Identify and evaluate practicable alternatives to locating in the base floodplain, including alternative sites outside the floodplain.
4. Identify impacts of the proposed action.
5. If impacts cannot be avoided, develop measures to minimize the impacts and restore and preserve the floodplain, as appropriate.
6. Re-evaluate alternatives.
7. Present the findings and a public explanation.
8. Implement the action.

4.5. Terrestrial Resources and Land Use

4.5.1. Land Use

The land use area of interest includes the federally owned property around the lake. The land surrounding Stockton Lake is typically undeveloped land and is generally steeply sloped, with very few residences or docks. There are 10 campgrounds and 3 marinas around the lake. Over 80 percent of the area surrounding Stockton Lake is forest and woodland area, with just over 8 percent in cropland and pasture. Developed land and barren land are each around 5 percent, with very small portions of grassland and shrub/scrub making up the remaining area surrounding the lake. The location and extent of wetland habitats are identified in Section 4.4.6. Table 4-3 lists the types and amount of land cover around Stockton Lake.

Table 4-3. Land Cover Types Within Stockton Lake Study Area.

Land Type	Acres	Percent of Study Area
Developed Land	1,676	4.8%
Barren Land	1,834	5.2%
Forest	28,035	79.5%
Shrub/Scrub	60	0.2%
Grassland	346	1.0%
Crop Land	2,932	8.3%
Wetlands	375	1.1%
Total	35,258	100.00%

Source: National Land Cover Database.

4.5.2. Terrestrial Habitat

The terrestrial habitat area of interest includes the federally owned property around the lake. The area surrounding Stockton Lake is mostly forested. Trees and shrubs around the lake include cottonwood, sycamores, elms, green ash, box elder, shagbark hickory, walnut, red cedar, coral berry, gooseberry, American hazel, and sumac. Various species of native prairie grass are found around the lake as well. There are almost 400 glades adjacent to Stockton Lake, covering approximately 400 acres.

The Missouri Department of Conservation website (https://nature.mdc.mo.gov/discover-nature/places/stockton-lake-ml) states MDC manages 16,572 acres of land around Stockton Lake that supports various wildlife species. The MDC-managed portion has a diverse mix of open grasslands, timbered areas, glades, and old fields, as well as a waterfowl refuge.

4.5.3. Fish and Wildlife

The fish and wildlife area of interest includes the federally owned property around the lake. Common terrestrial species in the Stockton Lake area include white-tailed deer, coyotes, gray and red fox, bobcats, skunks, river otters, weasels, minks, opossums, eastern cottontail rabbits, eastern gray and fox squirrels, chipmunks, beavers, muskrats, eastern wild turkeys, and bobwhite quail, as well as several mouse, bat, and other species.

The most common game fish species in Stockton Lake include crappie, bluegill, walleye, white bass, spotted bass, largemouth bass, smallmouth bass, and flathead and channel catfish. Gizzard shad production has been exceptional the past few years and has kept sport fishing growing at a good pace. Gizzard shad are the primary forage in the lake. Various minnows, brook silversides, crayfish, aquatic insects, and the young of other fish species are also important parts of the food chain.

At the Aldrich Refuge (Section 4.4.5), ducks, geese, pelicans, shorebirds (e.g., plovers, avocets, and sandpipers), and large wading birds (e.g., egrets and herons) inhabit the abundant wetland environment at various times throughout the year.

4.5.4. Invasive Species

The invasive species area of interest includes the federally owned property around the lake. In accordance with EO 13112, an invasive species means an alien species whose introduction causes or is likely to cause economic or environmental harm, or harm to human health. Invasive species can be microbes, plants, or animals that are nonnative to an ecosystem. In contrast, exotic species, as defined by EO 11987, include all plants and animals not naturally occurring, either presently or historically, in any ecosystem of the United States. Invasive species can take over and out-compete native species by consuming their food, taking over their territory, and altering the ecosystem in ways that harm native species. Invasive species can be accidentally transported, or they can be deliberately introduced because they are thought to be helpful in some way. Invasive species cost local, state, and federal agencies billions of dollars every year. Stockton Lake and the area surrounding it are not protected from the spread of invasive species. The most common and problematic invasive species currently found in and near Stockton Lake are Lespedeza, Johnson grass, and musk thistle. USACE Stockton Lake personnel are also taking measures to prevent the introduction of zebra mussel, hydrilla, and emerald ash borer.

4.6. Threatened and Endangered Species

The threatened and endangered species area of interest includes the federally owned property around the lake. The Endangered Species Act (ESA) of 1973, as amended, was enacted to provide a program for the preservation of endangered and threatened species and to provide protection for the ecosystems upon which these species depend for their survival. All federal agencies are required to implement protection programs for designated species and to use their authorities to further the purposes of the act. Responsibility for the identification of a threatened or endangered species and development of any potential recovery plans lies with the Secretary of the Interior and the Secretary of Commerce.

An endangered species is a species in danger of extinction throughout all or a significant portion of its range. A threatened species is a species likely to become endangered within the foreseeable future throughout all or a significant portion of its range. Proposed species are those that have been formally submitted to Congress for official listing as threatened or endangered. Species may be considered endangered or threatened when any of the five following criteria occurs: (1) the current/imminent destruction, modification, or curtailment of their habitat or range; (2) overuse of the species for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) the inadequacy of existing regulatory mechanisms; and (5) other natural or human-induced factors affecting continued existence. In addition, USFWS has identified species that are candidates for listing as a result of identified threats to their continued existence. The candidate designation includes those species for which USFWS has sufficient information to support listing the species as endangered or threatened under ESA.

There are eight different threatened and endangered species that reside in the area around Stockton Lake. These are summarized in Table 4-4. Three bat species (the gray bat, the Indiana bat, and the northern long-eared bat) dwell mostly in caves and forested areas around the lake. Two fish species (the Niangua darter and the Ozark cavefish) inhabit the lake area. The Niangua darter inhabits the rivers and streams around Stockton Lake. To thrive, this species prefers cool, clear, shallow water with slow currents and plenty of herbaceous aquatic vegetation present. The Ozark cavefish inhabits cave streams and springs around the lake. Geocarpon, Mead's milkweed, and Missouri bladderpod are threatened plant species. These plant species all have different habitat requirements but are primarily upland species.

Table 4-4. Potential Threatened and Endangered Species in Stockton Lake Study Area.

Species	Status	Habitat
Gray Bat (*Myotis grisescens*)	Endangered	Caves
Indiana Bat (*Myotis sodalis*)	Endangered	Hibernates in caves and mines; maternity and foraging habitat in small stream corridors with well-developed riparian woods and upland forests
Northern long-eared bat (*Myotis septentroinalis*)	Threatened	Hibernates in caves and mines, swarming in surrounding wooded areas in autumn; roosts and forages in upland forests during spring and summer
Niangua darter (*Etheostoma nianguae*)	Threatened	Rivers and streams
Ozark Cavefish (*Amblyopsis rosae*)	Threatened	Cave streams and springs
Geocarpon (*Geocarpon minimum)*	Threatened	Moist soils in exposed sandstone glades
Mead's milkweed (*Asclepias meadii*)	Threatened	Virgin Prairies
Missouri bladderpods (*Lesquerella filiformis*)	Threatened	Open glades in shallow limestone soils

Source: USFWS, Information for Planning and Consultation, February 17, 2020.

There are six significant natural feature sites within the federal boundary of Stockton Lake with good-quality sandstone glades and known populations of Geocarpon. Bona Glade, Maze Creek Glade, Corry Branch Glade, and Tara Glade all have known populations of the federally threatened species.

4.6.1. Migratory Birds

The migratory birds area of interest includes the federally owned property around the lake. While not protected under ESA, certain birds are protected under the Migratory Bird Treaty Act of 1918 and the Bald and Golden Eagle Protection Act of 1940. There are nine birds of conservation concern (BCC) in the area surrounding Stockton Lake. Two species are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental United States, and the remaining seven are of are of concern throughout their range anywhere within the United States. Table 4-5 lists the BCCs in the Stockton Lake area.

Table 4-5. Birds of Conservation Concern in Stockton Lake Area.

Species	Level of Concern
Blue-winged Warbler (*Vermivora pinus*)	BCC-BCR
Eastern Whip-poor-will (*Antrostomus vociferous*)	BCC Rangewide (CON)
Kentucky Warbler (*Oporornis formosus*)	BCC Rangewide (CON)
Le Conte's Sparrow (*Ammodramus leconteii*)	BCC-BCR
Lesser Yellowlegs (*Tringa flavipes*)	BCC Rangewide (CON)
Red-headed Woodpecker (*Melanerpes erythrocephalus*)	BCC Rangewide (CON)
Rusty Blackbird (*Euphagus carolinus*)	BCC Rangewide (CON)
Semipalmated Sandpiper (*Calidris pusilla*)	BCC Rangewide (CON)
Wood Thrush (*Hylocichla mustelina*)	BCC Rangewide (CON)

Source: USFWS, Information for Planning and Consultation, February 17, 2020.

The bald eagle is not a BCC within the area of interest but warrants attention because of the Bald and Golden Eagle Protection Act or for potential susceptibilities in offshore areas from certain types of development or activities.

4.7. Cultural Resources

This section will discuss the existing condition of cultural resources using an integrated approach, that is, accomplishing analyses to comply with relevant cultural resource legislation in one document, including:

- National Environmental Policy Act (NEPA)
- National Historic Preservation Act (NHPA), specifically Section 106, overseen by the Advisory Council on Historic Preservation (ACHP)
- Historic Sites Act
- Antiquities Act
- Archeological Resources Protection Act (ARPA)
- Archeological & Historic Preservation Act (AHPA)
- American Indian Religious Freedom Act (AIRFA)
- Native American Graves Protection and Repatriation Act (NAGPRA)
- Religious Freedom Restoration Act (RFRA)

NHPA of 1966, as amended, directs federal agencies to assume responsibility for all cultural resources under their jurisdiction. Section 106 of NHPA (and its implementing regulations) requires agencies to consider potential effects of their actions on historic properties, which are those properties that are listed or are eligible for listing on the National Register of Historic Places (NRHP). NHPA requires that federal agencies consult with the State Historic Preservation Officers (SHPOs), appropriate Tribal Historic Preservation Officers, federally recognized Native American tribes, and interested parties to ensure that all historic properties, including historic properties of religious or cultural significance to tribes, are adequately identified, evaluated, and considered in planning for proposed undertakings. Information regarding coordination is located in Section 10, Public Involvement, Review, and Consultation, and in Appendix G, National Historic Preservation Act Documentation and Correspondence.

NHPA considers a "historic property" as any prehistoric or historic district, site, building, structure, or object included in or eligible for inclusion in the NRHP maintained by the Secretary of the Interior (National Park Service [NPS]). NRHP eligibility criteria require a historic property to demonstrate a quality of significance in American history, architecture, archaeology, and culture. They must possess aspects of integrity of location, design, setting, materials, workmanship, feeling, and association. Section 101(d)(6)(A) of NHPA, as amended, provides for properties of traditional religious and cultural importance to Native American tribes (traditional cultural properties) to be evaluated for potential inclusion in the NRHP. In addition, cultural resources must be at least 50 years old, except in exceptional circumstances. Sites that have not been evaluated to be either "eligible" or "not eligible" for the NRHP remain "unevaluated."

An adverse effect under NHPA is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the NRHP in a manner that would diminish the property's integrity. Adverse effects may include reasonably foreseeable effects caused by the undertaking that may occur later, be farther removed in distance, or be cumulative.

NEPA considers "cultural resources," which has a broader definition and includes sacred sites, archaeological sites not eligible for the NRHP, and archaeological collections. Cultural resources include both tangible and intangible cultural materials including artifacts, archeological sites, buildings, ships, cemeteries, bridges and dams, paintings, sculptures, and landscapes. Significance is determined based on context and intensity. Impacts are analyzed in several contexts such as society, the affected region, the affected interests, and the locality. Intensity refers to the severity of effect, which includes factors such as the magnitude, geographic extent, duration, and frequency of the effect.

At present, there are 549 recorded cultural resource sites on federal fee-owned land at Stockton Lake. Most of these sites are archeological sites of prehistoric and historic post-settlement origin. Most Stockton Lake lands have not been inventoried for cultural resources, and as such, many more cultural resources likely remain unrecorded. In addition, 99 sites are recorded on federal flowage easement lands located downstream from the dam.

4.7.1. Prehistory Background

The prehistory of the Missouri Ozarks can be divided into several periods: the pre-Paleoindian (before 9,500 BC), Paleoindian (9,500 to 7,800 BC), Archaic (7,800 to 700 BC), Woodland (700 BC to AD 950), Mississippian (AD 950 to 1300), and Terminal Prehistoric (AD 1300 to 1600). The following description is adapted from Ray et al. (2019). There is tantalizing evidence for occupation of the Ozarks prior to 9,500 BC, but the earliest unequivocal evidence of habitation in the Ozark region is during the Paleoindian period, which begins as the last ice age was ending. Cultures of this period are generally characterized as hunter-gatherers who used distinctive, lanceolate-shaped spear points. These points were chipped from both the abundant local chert resources or from nonlocal cherts. The Archaic period is characterized by an increase in populations, larger seasonal encampments, and a broader food economy entailing a shift toward foraging, cultivation of native plants, and an intensive exploitation of aquatic resources. The Woodland period is characterized by the widespread use of pottery, mound construction,

permanent village settlements, the beginning of maize cultivation, the introduction of the bow and arrow, and trade in exotic items from distant places. During the Mississippian period, cultural traits from the Mississippian cultures to the east and Caddoan cultures to the south were adopted and/or brought in by immigrants. Maize agriculture intensified and was supplemented by new kinds of beans and squash. New developments included organized villages including planned, fortified civic ceremonial centers having mounds arranged around a plaza. During Terminal Prehistoric times, these civic-ceremonial villages largely fell from use as people became more mobile and oriented toward seasonal bison hunting and farming. It was during this time that the tribes that can be traced backwards from early history into prehistory, notably the Osage at Stockton Lake, developed. The Osage, as part of a larger Dhegiha Siouan-speaking group, migrated from the north and east, splitting off into the Quapaw, Omaha, Ponca, and Kaw Tribes as they moved south and west (Hunter 2013). Several large Terminal Prehistoric Osage village sites are located in the Missouri and Osage River valleys.

4.7.2. History Background

The earliest recorded European explorers in the Ozarks were of French and Spanish origin, since it was those countries who claimed this part of the midcontinent. In the late 17th century, they encountered the Osage villages in the Marias des Cygnes area and Osage and other Native American hunters throughout the Ozarks. Later, French traders, such as the Chouteau family, settled near the Osage villages for convenient trade. The Louisiana Purchase of 1803 led to a cascade of changes for the tribes living east and west of the Mississippi River. Groups were removed from the northeast and southeast to the Missouri Territory, causing pressure on the Osage. Subsequent treaties continued to shift nonlocal tribes and the Osage. Finally, an 1825 treaty expelled the Osage and other tribes from Missouri and opened the way for new Euro-American immigrants.

Immigration, mainly from the upper South, was intense prior to the Civil War. The city of Stockton was first platted as Lancaster, later changed to Fremont, and named Stockton in 1859 in honor of a Mexican War Commander, I.F. Stockton. Most of the original town was destroyed during the Civil War. After the Civil War, rail connections encouraged intensification of economic activities, such as farming, mining, and lumbering, until major droughts and the Great Depression made farming unprofitable. This, combined with the flooding of bottomland farms by Stockton Dam, spurred the development of a livestock and recreation-oriented economy.

4.7.3. Previous Investigations

A summary of cultural resource inventories at Stockton Lake is included in Table 4-6. The early pre-impoundment investigations of the 1960s generally did not provide maps or descriptions detailed enough to know exactly where their surveys took place. These early surveys and excavations targeted burial mounds/cairns, high-density open-air sites, and rock shelters, while largely ignoring historic sites. It was not until 1979, about 14 years after the bottomlands were inundated, that the first systematic survey took place at Stockton Lake. Since then, about a dozen Section 106 and 110 survey projects have been performed (Table 4-6).

Table 4-6. Summary of Previous Cultural Resources Surveys on Federal Fee-Owned Land.

Author	Institution	Date of Contract	Date of Report	Subject	Notes
Chapman, Carl H.	NPS and University of Missouri (MU)	1961	1962	Survey, testing	N/A
Wood, W. Raymond	NPS and MU	1962	1965	Excavation at mounds and cairns	N/A
McMillan, R. Bruce	NPS and MU	1962	1966	Excavations at rock shelters	N/A

Author	Institution	Date of Contract	Date of Report	Subject	Notes
Wood	MU	1963	1963	Excavations at rock shelters and mounds	Missouri Archeological Society (MAS) Newsletter No. 175
Wood and Pangborn, Rolland E.	MU	1963	1968	Excavation at Toler Mounds	MAS Newsletter No 222
Wood and Pangborn	MU	1963	1968	Excavation at Seybert Shelter	MAS Newsletter No. 223
McMillan	MU	1963	1968	Excavations at rock shelters	MAS Newsletter No. 226
Pangborn	NPS and MU	1963	1966	Excavation at Eureka Mound	Plains Anthropologist
Wood	NPS and MU	1965	1966	Excavations at mounds, cairns, rock shelters, open sites	N/A
Kaplan, Daniel H.	NPS and MU	1965	1967	Excavation at open sites	N/A
Calabrese, F.A.	NPS and MU	1967	1968	Salvage at Dryocopus and Shady Grove sites	N/A
Calabrese and Trawick H. Ward	NPS and MU	1967	1969	Lithic analysis for the Dryocopus site	N/A
Roper, Donna C.	MU	1976	ca. 1976	Petroglyph below multipurpose pool	N/A
Nichols, Peter W., et al.	Espy and Assoc.	1979	1980	462 acres, 15 sites examined	18% survey of 3 parks
Cole, Kenneth W.	MoDNR, Division of State Parks	1979	1979	20 acres surveyed	Recreation development
Mercado-Allinger, Patricia A., and Jack M. Jackson	Prewitt and Assoc.	1981	1989	1,960 acres, 57 sites examined	Survey of Fish and Wildlife lands
Girard, Jeffrey S., and Martha Doty Freeman	Prewitt and Assoc.	1981	1992	3,250 acres, 80 sites examined	40% survey of 9 parks
Grantham, Larry	MoDNR, Division of State Parks	1990	1990	Less than (<) 1 acre, 1 site examined	Picnic shelter
Sturdevant, Craig M.	Environmental Research Center (ERC); SW Bell	1990	1990	1.75 linear miles, 7 sites examined	Buried telephone line
Grantham	MoDNR, Division of State Parks	1991	1991	<1 acre, no sites found	Parking lot
Klinger, Timothy C.	Historic Preservation Association (HPA)	1992	1993a	1,372 acres, 57 sites examined	Survey and testing at 2 sites
Klinger	HPA	1992	1993b	2,000 artifacts examined	Analysis of Wimmer collection
Sturdevant	ERC; City of Springfield	1992	1993	2.1 linear miles, 5 sites examined on fee land	Water Supply corridor
Klinger	HPA	1995	1995	735 acres, 15 sites examined	MDC leased lands
Grantham	MoDNR, Division of State Parks	1997	1997	<1 acre, no sites found	Standpipe and water line
Ray, Jack H. et al.	Missouri State University	2010	2011	1,308 acres, 53 sites examined	Section 110

Author	Institution	Date of Contract	Date of Report	Subject	Notes
Cain, David I.	USACE	2011	2011	<1 acre, no sites found	Bridge replacement on easement
Ray, Jack H. et al. 2019	Missouri State University	2018	2019	555 acres, 46 sites examined	Section 110

Lucido (2002) reported in the Historic Properties Management Plans (HPMP) that an estimated 22 percent (7,516 acres of a total of 34,170 acres) of fee lands above the multipurpose pool (867 feet NGVD 29) had been professionally surveyed. Since 2002, two larger-scale Section 110 surveys (Ray et al. 2011, Ray et al. 2019) added another 1,308 acres and 555 acres, respectively. This brings the total of surveyed land to an estimated 9,379 acres or 27.5 percent of fee lands above the multipurpose pool. Several small surveys related to park development added a few more acres to the total.

Stockton Lake has about 298 miles of shoreline at the normal pool elevation of 867 feet NGVD 29. Approximately 98 miles are documented as professionally surveyed. Approximately 100 miles of this shoreline exceeds 20 percent grade and is not within the Warsaw sandstone formation (and unlikely to hold rock shelters), so has low potential to hold archeological sites. This leaves approximately 100 miles to be professionally surveyed, including steep slopes within the Warsaw formation that are likely to hold rock shelters.

4.7.4. Recorded Cultural Resources

Of the 549 recorded archeological sites on fee land at Stockton Lake, 399 are recorded as prehistoric Native American sites that include, in descending order, low- and high-density surface artifact scatters (often called “camps” in older literature), rock shelters, burial mounds (earthen) and cairns (constructed with stone), tool stone quarries, and workshops. Surface sites where durable stone tools and debris from making tools are the most frequently encountered site type. Rock shelters are formed in a suitable rock formation; in the case of Stockton, in the Warsaw sandstone formation. Perishable materials, like sandals, wood, and food plants, can be preserved in dry rock shelters. Rock shelters (shallower than caves), were often used for occupation, storage, and in some cases, burials. Thus, rock shelters are often considered sacred locations for tribes, as are mounds and cairns. These qualities also make them targets for illegal digging by relic hunters.

There are 107 Euro-American historic sites that are mostly the remains of historic farmsteads and other building ruins, maintained and unmaintained cemeteries, rock fences, and surface artifact scatters. Forty sites contain both prehistoric and historic artifacts. There is no data for three of the sites. The 99 recorded sites on easement lands are mostly along the Sac River, downstream of the dam, and include substantial Big Eddy site, a multicomponent prehistoric site found in the eroded bank of the Sac River (Lopinot et al. 1997, 1999, 2005).

The 2002 HPMP lists the NRHP eligibility status of all of the sites on USACE-owned fee land known at that time. More recent site information was gathered from survey reports. Survey reports written prior to the NHPA did not include eligibility recommendations.

None of the sites at Stockton Lake are formally listed on the NRHP but one has been recently recommended as eligible for listing: site 23DA1471, a prehistoric and historic rock art site that is located between 862 and 879 feet NGVD 29. It is included in the 278 sites that require additional investigations, such as archeological testing, to determine eligibility. Sixty-one sites that were identified before impoundment and are now inundated by the lake have not been evaluated for the NRHP. There are 206 sites that are considered “not eligible” for listing on the NRHP because they are heavily disturbed and have no integrity, have been archeologically tested and determined not eligible for the NRHP, or were completely excavated. Sites completely excavated includes several mound and rock shelter sites excavated in the mid-1960s (see Table 4-7). Although these sites are not eligible under NRHP criteria,

they may still represent important resources to tribes. Three sites have no associated site forms and no data.

There is some doubt as to the precise mapped locations and elevations of many or all the sites recorded before 2010 at Stockton Lake. This doubt arises for several reasons, including differences in the mapped locations of sites on USACE and SHPO site location maps, inconsistencies with the location descriptions on site forms, and the imprecise mapping methods and technologies available to past site recorders. Site monitoring efforts have confirmed these inconsistencies.

4.8. Air Quality

The air quality area of interest is the three-county area of Cedar, Dade, and Polk Counties. Air quality is regulated by the U.S. Environmental Protection Agency (EPA) under jurisdiction of the Federal Clean Air Act of 1970 and its amendments. The National Ambient Air Quality Standards (NAAQS) were formulated to protect public health, safety, and welfare from known or anticipated air pollutants. The most recent amendments to the Clean Air Act (CAA) contain criteria for sulfur dioxide (SO2), particulate matter (PM10, 10 micron and smaller and PM2.5, 2.5 micron and smaller), carbon monoxide (CO), nitrogen dioxide (NO2), ozone (O3), and lead (Pb). Locations that do not meet these standards are designated by EPA as nonattainment areas for each pollutant that does not meet the standards. Amendments to the Clean Air Act have established time schedules for the states to reduce pollutant levels to comply with the NAAQS in nonattainment areas.

The nearest air quality monitoring location is in El Dorado Springs, Missouri, at Highway 97 and Barnes Road. This location is a regional monitoring site for PM2.5 and ozone. The data from this monitoring site do not indicate air quality concerns and this rural portion of Missouri is in attainment. Stockton Lake dam reduces the area's reliance on existing oil- or gas-based energy sources through its clean, efficient production of hydroelectric power.

4.9. Socioeconomic Conditions

There are three counties in Missouri that surround Stockton Lake: Cedar, Dade, and Polk. Table 4-7 provides a comparative summary of population trends within those three counties. The total population of those counties was 48,648 in 2000; 53,002 in 2010; and 52,617 in 2015. While the three individual counties have experienced increases and decreases in population since 2000, collectively since 2000, the population has increased approximately 8 percent. During the same period, the United States had a population increase of approximately 12 percent.

Table 4-7. Population Demographics in Cedar, Dade, and Polk Counties, Missouri.

County	2000 Population	2010 Population	Percent Change 2000 to 2010	2015 Population	Percent Change 2010 to 2015
Cedar	13,733	13,982	1.78%	13,892	-0.64%
Dade	7,923	7,883	-0.51%	7,618	-3.84%
Polk	26,992	31,137	13.31%	31,107	-0.10%

Source: U.S. Census Bureau, 2000 Census, 2010 Census, and American Community Survey (ACS) 2011–2015, 5-year estimate.

Table 4-8 provides a comparative summary of the age and gender distributions within the three counties adjacent to Stockton Lake. The three counties have similar age distributions of their populations, with Polk County having a slightly younger population. These three counties have a similar distribution of males and females. Cedar County and Polk County have slightly higher female populations. However, when combined, the age distribution of males and females is split 50-50.

Table 4-8. Distribution of Age and Gender in Cedar, Dade, and Polk Counties, Missouri.

Category	Cedar County	Dade County	Polk County
Total Population	13,892	7,618	31,107
Under 18	23.2%	21.5%	23.9%
18 to 64	53.7%	56.7%	59.2%
65 and Older	23.1%	21.8%	16.9%
Male	49.8%	50.9%	49.0%
Female	50.2%	49.1%	51.0%

Source: U.S. Census Bureau and ACS 2011–2015, 5-year estimate.

In the three counties surrounding Stockton Lake, the per capita income is approximately $19,700 and the median household income is approximately $36,600. These are significantly lower than the United States per capita income of $28,930 and the median household income of $53,889. Of the three counties, Dade County has the highest per capita income, while Polk County has the highest median household income. Table 4-9 provides a comparative summary of the income levels of the three counties adjacent to Stockton Lake.

Table 4-9. Per Capita and Median Household Income in Cedar, Dade, and Polk Counties, Missouri.

County	Per Capita Income	Median Household Income
Cedar County	$18,255	$31,532
Dade County	$20,828	$37,035
Polk County	$19,908	$41,130

Source: U.S. Census Bureau and ACS 2011–2015, 5-year estimate.

4.10. Environmental Justice

The environmental justice evaluation area includes Cedar, Dade, and Polk Counties. Environmental Justice regulations were established to address the potential for disproportionately high and adverse human health or environmental effects that projects funded by the federal government may have on minority and low-income populations. The Environmental Justice requirements were established by EO 12898 in 1994, entitled "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." This mandates that federal agencies identify and address, as appropriate, any disproportionately high and adverse human health or environmental effects of proposed projects on minority and low-income populations. Environmental Justice builds on Title VI of the Civil Rights Act of 1964. Environmental Justice has three guiding principles:

- Avoid, minimize, or mitigate disproportionately high and adverse human health and environmental impacts, including social and economic effects on minority and low-income populations
- Ensure full and fair participation by all potentially affected communities in the decision-making process
- Prevent the denial of, reduction in, or significant delay in the receipt of benefits by minority and low-income populations

Environmental Justice analysis applies to both minority and low-income populations. For the analysis of Environmental Justice, minority populations are defined as any person who is Black, Hispanic, Asian American, American Indian, or Alaskan Native.

The U.S. Census Bureau defines a substantial low-income population as an area where 20 percent or more residents live in a household with annual median income below the poverty level.

The average percent of minorities living in the three counties adjacent to Stockton Lake is 5.5 percent. This is significantly lower than the percent of minorities living in the State of Missouri, at 19.8 percent.

Individually, Polk County has the highest percent of minorities with 6 percent. This is still significantly lower than the State of Missouri. County-specific and statewide ethnicity/race characteristics are shown in Table 4-10.

Table 4-10. Ethnicity and Race Characteristics for Cedar, Dade, and Polk Counties, Missouri.

Ethnic Group	Cedar County	Dade County	Polk County	Missouri
Total Persons	**13,892**	**7,618**	**31,107**	**6,045,448**
Total Minority Population as a Percent of All Persons	4.8%	5.7%	6.0%	19.8%
White Population (Non-Hispanic) as a Percent of All Persons	95.2%	94.3%	94.0%	80.2%
African American Population (Non-Hispanic) as a Percent of All Persons	0.1%	0.5%	1.0%	11.4%
American Indian Population (Non-Hispanic) as a Percent of All Persons	0.1%	0.5%	0.7%	0.4%
Asian Population (Non-Hispanic) as a Percent of All Persons	0.1%	0.1%	0.2%	1.7%
Hispanic Population (all races) as a Percent of All Persons	1.4%	1.8%	2.1%	3.9%
Other Race Alone as a Percent of All Persons	0.0%	0.0%	0.0%	0.1%
Two or More Races as a Percent of All Persons	3.0%	2.7%	2.0%	2.1%

Source: U.S. Census Bureau and ACS 2011–2015, 5-year estimate.

Approximately 21 percent of the persons living in the three counties surrounding Stockton Lake are below the poverty level, which is a substantial low-income population. In addition, this is higher than the percent of persons below the poverty level living in Missouri. Individually, the counties each have a higher percentage of persons below the poverty level than the state average, and Cedar County has the highest percentage at approximately 25 percent. County-specific and statewide poverty status is summarized in Table 4-11.

Table 4-11. Poverty Status for Cedar, Dade, and Polk Counties, Missouri.

Individuals Below Poverty Level	Cedar County	Dade County	Polk County	Missouri
	24.9%	19.9%	18.5%	15.6%

Source: U.S. Census Bureau and ACS 2011–2015, 5-year estimate.

This analysis indicates that while the percent of minorities living in the three counties adjacent to Stockton Lake is low, there is a substantial low-income population. Therefore, it concludes that there are Environmental Justice populations living near Stockton Lake, and any future actions taken by USACE should avoid, minimize, or mitigate disproportionately high or adverse impacts to these Environmental Justice populations.

4.11. Recreation

Stockton Lake offers many recreational activities such as camping, fishing, hunting, water skiing, swimming, boating, sailing, scuba diving, canoeing, trail riding, and others. There are 12 public use areas around Stockton Lake; 11 are operated by USACE and 1, Stockton State Park, by MoDNR. Marinas offering a full range of services and supplies are located at Stockton State Park, Mutton Creek, and Orleans Trail. Stockton Lake draws 1.2 million visitors annually. The public use areas and marinas are shown on Figure 4-14.

These public use areas include a wide variety of facilities and amenities, as shown in Table 4-12.

Table 4-12. Public Use Areas.

Area	Boat Ramp	Playground Equipment	Group Picnic Shelter	Group Campground	Picnic Area	Toilets	Water Supply	Showers	Laundry	Camping	Beach	Fishing Dock	Restaurant	Trailer Dump Station	Horse Trail	Hiking Trail	Electrical Hookups
Stockton	X	X	X		X	X	X				X			X			
Orleans Trail	X			X	X	X	X	X		X	X			X	X		
Orleans Trail Marina	X				X	X	X	X	X	X			X				X
Hawker Point	X				X	X	X	X		X				X	X		X
Ruark Bluff East		X			X	X	X	X		X	X	X		X			X
Ruark Bluff West	X	X		X		X	X	X		X				X			X
Greenfield	X					X											
Mutton Creek	X			X		X	X	X						X			
Mutton Creek Marina	X		X		X	X	X	X	X	X			X	X			X
Stockton State Park	X	X	X		X	X	X	X	X	X	X					X	X
Stockton Park Marina	X					X	X						X	X			
Cedar Ridge	X				X	X	X	X		X	X	X		X			X
High Point	X	X				X											
Masters	X				X	X	X	X		X	X	X		X			
Crabtree Cove	X	X			X	X	X	X		X		X		X			X

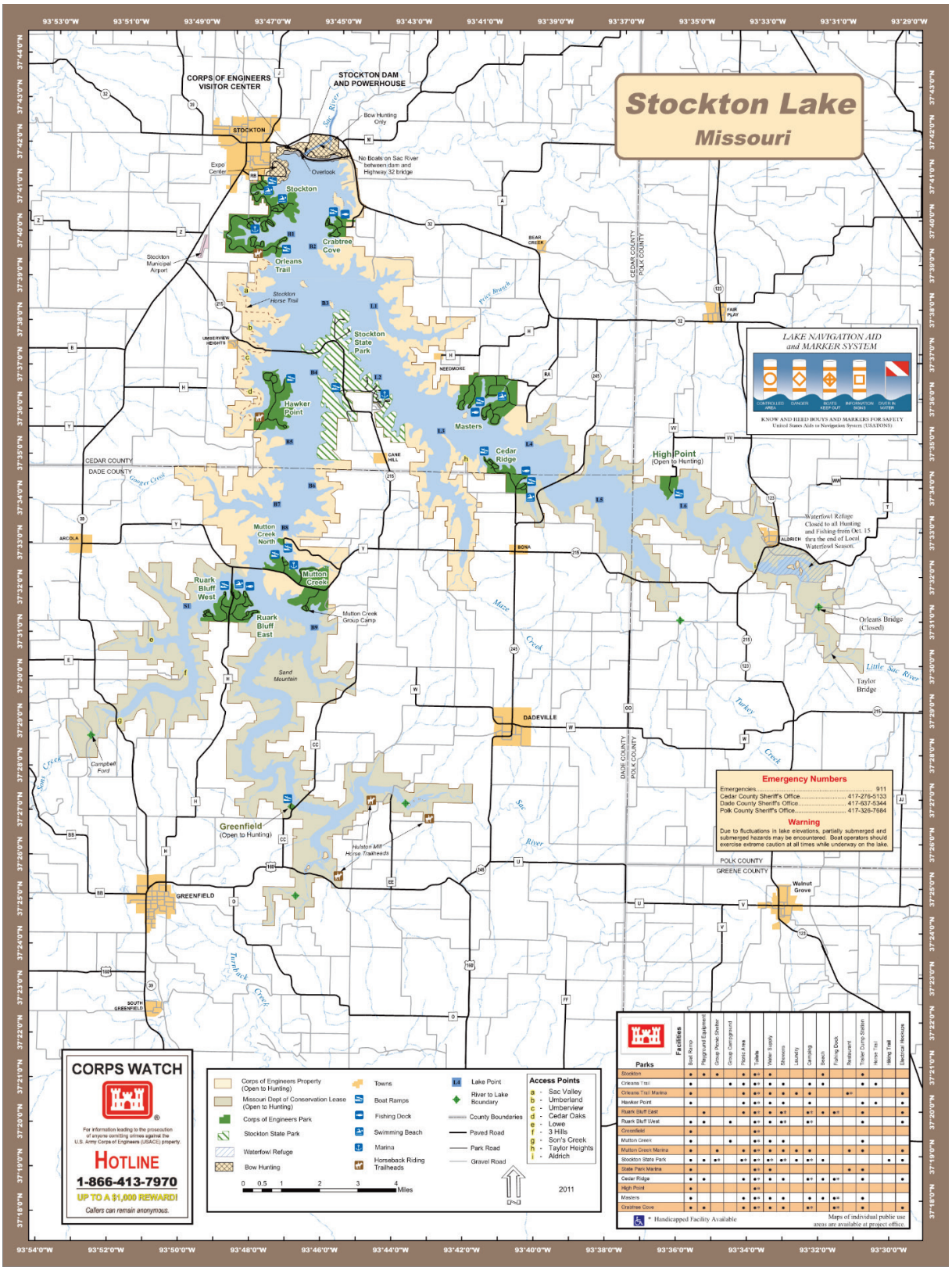


Figure 4-14. Stockton Lake Recreation Features.

4.12. Hazardous, Toxic, and Radioactive Waste

The hazardous, toxic, and radioactive waste area of interest includes the federally owned property around the lake. Using EPA's NEPAssist website and environmental data resources (EDR) reports (Appendix J), a search was conducted to identify known hazardous, toxic, and radioactive waste sites near Stockton Lake. Two sites were identified adjacent to the lake. The Stockton Dam and power plant is listed as a Resource Conservation and Recovery Act (RCRA) active Conditionally Exempt Small Quantity Generator (CESQG) with no violations. The second site, the Stockton State Park, is listed as a RCRA inactive site with no violations. In addition, both sites have been issued National Pollution Discharge Elimination System (NPDES) permits. The Stockton Dam and power plant has one effective individual permit in noncompliance, and Stockton State Park as two effective permits, individual and general, in noncompliance.

4.13. Aesthetics

The aesthetics area of interest includes Stockton Lake and its shoreline. Management objectives at Stockton Lake include maintaining scenic vistas while limiting impacts that would negatively affect aesthetics, as aesthetics are an important feature that enhances users' recreational experience. Stockton Lake is nestled among rolling, tree-covered hills in the Missouri Ozarks. The perimeter lands around the lake are owned and maintained by USACE and provide a buffer from development and manipulation of the lands surrounding the lake. Fluctuations in lake levels are one of the main contributors to changes in lake aesthetics. Increases in lake elevation could submerge vegetation and trees surrounding the lake causing aesthetic changes, including deteriorating and dead trees and vegetation. Decreases in elevation could expose rocky shorelines along the edge of the lake. These potential changes in the shoreline of Stockton Lake are typically short-term in nature but could be considered aesthetically unappealing and may discourage boaters and other recreational users from visiting the lake. Over the long-term, changes in vegetation type and extent could occur based on the dynamics of long-term changes in lake levels.

View of Stockton Lake November 9, 2012.

4.14. Noise

The noise area of interest includes the federally owned property around the lake. The noise levels in and around Stockton Lake are typical of those normally found in areas where water recreation takes place (noise from boats, jet skis, and other recreational vehicles and equipment). Recreational use and associated noise levels at Stockton Lake are not considered excessive but may increase gradually under the Federal No Action/FWOP condition as population numbers increase in the surrounding areas.

4.15. Climate Change

A climate change assessment was conducted for Stockton Lake. Overall, no strong indication exists within the qualitative analysis that was conducted to identify any definitive impacts climate change could hold on the project hydrology and streamflow of the region. The strongest consensus among the literature supports a trend of increasing temperatures and precipitation in the region, resulting in increased frequency in the occurrence of extreme storm events. Extremes in climate will magnify periods of wet and dry weather, resulting in longer more severe droughts and larger more extensive storms. The literature is conflicted as to projected peak magnitude, duration, and volume of extreme events, with the uncertainty being largely attributed to the uncertainty of the climate models themselves.

4.16. Flood Risk Management

Stockton Lake was originally authorized for flood control (now referred to as flood risk management) by the Flood Control Act of 1954. In addition to providing a high degree of flood risk management along the lower Osage River, this system is designed to substantially reduce flood crests along the lower Missouri River and along the Middle and Lower Mississippi River. Operation of the Stockton project is coordinated with the operation of other lakes in the Osage River system and the operation of the system is coordinated with the other lakes in the Missouri River Basin (USACE 1977).

4.17. Hydropower Generation

Stockton Lake was originally authorized for hydropower by the Flood Control Act of 1954. The power plant has a single unit. The original six-bladed Kaplan turbine was replaced with a new seven-bladed Kaplan turbine, which became operational in January 2015. The new unit can generate approximately 52 MW. Original expected annual generation was 55 gigawatt-hours (GWh) (the net generation in 2015 was 64.4 GWh). According to the 2017 USACE Value to the Nation Fast Facts, the one unit produced 104,924 megawatt-hours (MWh), which is an estimated $3,035,915 in NED benefits. Additional background information can be found in the Appendix E, Hydropower Analysis Report.

4.18. Real Estate

Per the 1963 Design Memorandum for Real Estate, in general, fee title was acquired to elevation 895 feet NGVD 29 or 300 feet horizontally from full pool elevation 892 feet NGVD 29 (whichever was greater). Properties in the town of Aldrich were acquired in fee to surcharge elevation 900 feet NGVD 29. In addition, lands that were necessary for construction and operation at the dam and appurtenant structures were acquired; lands required for current and future public use and access; and lands required for current and future fish and wildlife needs, under normal blocking procedures.

Flowage easements were acquired on an individual tract basis and not only in the remote areas of the reservoir where fee title is not required, being those small tracts in the very upper limits of the reservoir, which are subject either to frequent current flooding or are confined to steep and narrow draws, far remote from the multipurpose pool and have no substantial value for the protection or enhancement of fish and wildlife resources or for public outdoor recreation (USACE 1963).

5.0 Evaluation of Final Array of Alternatives

5.1. Evaluation and Comparison of Final Array of Alternatives

The study team evaluated and compared the final array of alternatives concurrently with the serious effects analysis (as directed per ER 1105-2-100). The Water Supply Act of 1958 allows the addition of water supply as a project purpose without the approval of Congress if the modification does not seriously affect the purpose for which the project was authorized, surveyed, planned, or constructed, or does not involve major structural or major operational changes. At Stockton Lake, this analysis will focus on flood risk management, hydropower impacts, recreation, and fish and wildlife. It will also account for cumulative water supply storage effects on other authorized purposes at Stockton Lake.

Alternative 1: Federal No Action/FWOP – Assumes no change in operation or storage at Stockton Lake.

Alternative 5: Water supply storage reallocation from the multipurpose pool – Reallocating storage from the multipurpose 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 an increase in water supply yield. Water supply storage reallocation from the multipurpose pool as a sole source would require 90,200 AF of storage. Normal pool elevation would remain at 867 feet NGVD 29. The total water supply storage reallocation would yield approximately 39 MGD during a 1950s-style drought.

Alternative 7: Water supply storage reallocation from a combination of the flood control pool and the multipurpose pool – Reallocating water supply storage from the flood control pool (either solely or in combination with the multipurpose pool) increases the storage amount of the multipurpose pool by increasing the normal pool elevation, which ultimately changes the yield and storage relationship. This alternative would reallocate 45,750 AF from the multipurpose pool to water supply storage, and 49,000 AF of storage from the flood control pool. Reallocating storage from the flood control pool means that the normal pool elevation would be raised from 867 to 868.8 feet NGVD 29, or a 1.8-foot pool raise. The total water supply storage reallocation of 94,750 AF will yield approximately 39 MGD during a 1950s-style drought.

5.2. Risks and Uncertainties

The Stockton Lake water supply storage reallocation study includes analysis of resource impacts and project costs. Varying degrees of uncertainty are associated with the assumptions used in these analyses. This section discusses the main sources of risk and uncertainty. Standard models and conservative assumptions were used in the study to reduce the uncertainties and account for risk.

Reservoir modeling of Stockton Lake plays a central role in this study and relies upon a construction of the entire Osage River Basin in Hydrologic Engineering Center Reservoir System Simulation (HEC-ResSim) Model software. Output from these modeling efforts are used in the analyses of impacts to all authorized purposes including hydropower, flood control, water supply, recreation, water quality, and fish and wildlife.

The analyses assess the impacts that result from an assumed daily water usage equal to the anticipated future mean daily demand. This conservative assumption, consistent with industry practices and ECB 2019-13 Methods for Storage/Yield Analysis guards against the uncertainty of future drought. Water supply storage reallocation alternatives were sized and evaluated based on data from a 63-year period of record to be sufficient to maintain water supply storage during the associated 2 percent drought. The resulting drawdowns are not intended to demonstrate or communicate the effects of current or historic water supply usage.

The 63-year period of record data in support of these analyses extends from 1950 to 2012, to include the historic drought from 1955 to 1957. This drought, captured in stream gage records across the Missouri and Kansas Osage River Basins, is commonly acknowledged as the most severe drought on record.

Appendix C provides further details regarding database development consisting of daily flows at all gage locations, evaporation, and daily desired power demand as provided/coordinated by SWPA.

The base condition was modeled using current Springfield water supply contract demand/storage. The model uses daily input data to solve for flows necessary to meet any daily flood control requirements and/or desired power schedule while continuously releasing 46 cfs (daily) for Springfield. Resulting daily lake level and downstream flows are outputs.

Two with project alternatives were investigated, Alternative 5 and Alternative 7: Both add Southwest Missouri Regional Water as a water supply user to the Base Condition model. Alternative 5 (90,200 AF from multipurpose pool) and Alternative 7 (45,750 AF multipurpose pool / 49,000 AF flood pool), both yield 60.3 cfs daily for Southwest Missouri Regional Water.

The yield of 60.3 cfs would be the withdrawal necessary to achieve 39 MGD during a drought scenario. However, during normal weather years, the amount of water needed to be withdrawn will most likely be much less since this is a secondary source for the majority of the membership. Due to the uncertainty in actually required yield, a sensitivity analysis was conducted on both Alternative 5 and Alternative 7 assuming a 30 cfs withdrawal. The results more closely align with the Base Condition model with less significant changes to lake elevations than the 60.3 cfs withdrawal. Additional details and results can be found in Section 5.3.

In terms of sedimentation, if it is occurring in the lower portions of the flood control pool, which would eventually become part of the new multipurpose pool under Alternative 7, there is a slight, but low chance that it would change the calculated amount of storage needed to yield 39 MGD.

The M&I water supply users' demand forecasts utilize water billing and production data, demographic and socioeconomic data, historical agricultural data and water use, and weather data. Water demand projections for the study area were first developed for the base year, or starting point of the forecast, and then at 10-year intervals from 2020 to 2060. The base year of the forecast is 2010. Given the variability of available data, it was deemed appropriate to conduct the analysis using a custom-built Microsoft Excel-based demand forecasting model. Utilizing this modeling approach allows for flexibility in use of available data. The demand forecast is based on a medium-growth scenario. There is uncertainty with choosing this level of growth; however, the demand/supply modeling found that the gap in water supply was mostly needed during a drought scenario. Stockton Lake is a supplemental water supply source for all the municipalities and not their sole source. This uncertainty was accepted because if the reallocation is approved, the region will be less susceptible during a drought scenario.

City Utilities is a current member of Southwest Missouri Regional Water and is aware that efficiency of the first increment of storage will be reduced if there is a pool raise. To streamline the analysis, it was decided that any additional storage needed to make City Utilities whole would be taken from within the proposed reallocation amount, thereby reducing Southwest Missouri Regional Water's contingency for membership growth.

5.3. Hydrologic Analysis of Impacts to Water Elevations

The HEC-ResSim model, was used to model current reservoir operations in the Osage River Basin, which includes three Kansas lakes (Melvern, Pomona, and Hillsdale) and three Missouri lakes (Stockton, Pomme de Terre, and Truman). Stockton, Pomme de Terre, and Truman were the focus of the modeling. To ensure that the reservoirs were operating in tandem, a variety of operational goals and constraints were modeled in accordance with the Water Control Manual operations. Three water supply demand scenarios were used with the ResSim models for Alternatives 1 (Federal No Action/FWOP), 5 (Multipurpose Pool), and 7 (Combination Multipurpose/Flood Control Pools). The scenarios were run over the period of record of inflows with evaporation for the Sac River (1950 to 2012). Modeling scenarios included a pre-1993 water reallocation, a 60 cfs water supply withdrawal, and a 30 cfs water supply withdrawal. The following key assumptions were included in the modeling analyses:

- Period of Record 1950 to 2012: One input dataset was developed for all analyses. The dataset consists of daily flows at all gage locations and Stockton daily power demand.
- Pre-1993 Water Reallocation: This is a historical condition with no water supply demand. The model uses daily flow input data to solve for the flows necessary to meet any daily flood control requirements and/or power demand (developed in coordination with SWPA). Resulting daily lake level and downstream flows are outputs. This scenario identified hydrologic conditions over the period of record prior to any water supply changes and was modeled to determine cumulative effects. Results of this analysis can help identify differences between Alternatives 1, 5, and 7 absent any water supply changes; however, this scenario is not included in the graphics below.
- Base Condition (Federal No Action/FWOP Condition): Includes the current Springfield water supply contract demand/storage. The model uses daily input data to solve for flows necessary to meet any daily flood control requirements and/or power demand while continuously releasing 46 cfs (daily) for Springfield. Resulting daily lake level and downstream flows are outputs. Hydrologic conditions over the period of record were modeled based on existing Stockton Lake operations including the 1993 water reallocation. Results of this analysis can help identify differences between existing Federal No Action/FWOP conditions and proposed FWP conditions (Figure 5-1).
- Alternatives 5 and 7 (FWP Conditions): Both add Southwest Missouri Regional Water as a water supply user to the Base Condition model. Alternative 5 (90,200 AF from Multipurpose Pool) and Alternative 7 (45,750 AF Multipurpose Pool/49,000 AF Flood Control Pool) yield 60 cfs daily for Southwest Missouri Regional Water. Hydrologic conditions over the period of record were modeled based on proposed FWP operations at Stockton Lake (i.e., with new water supply reallocation in place). Results can be compared with the Base Condition to assess potential hydrologic changes and effects (Figure 5-1).
- Sensitivity Scenario: As a follow-up to one of the uncertainties developed and described in Section 5.2, a sensitivity analysis was completed to evaluate the possibility that Southwest Missouri Regional Water may only be withdrawing a portion of what is assumed during normal weather years. This scenario is used to assess differences in hydrologic conditions over the period of record at Stockton Lake for Alternatives 5 and 7. Results help determine potential hydrologic changes and effects if different water supply withdrawal amounts are considered (i.e., 30 cfs versus 60 cfs). See Figures 5-2 and 5-3.

Figures 5-1 through 5-3 show a graphical depiction of the differences between the alternatives over the period of record. In Figure 5-1, there is a noticeable difference during drought conditions (in the mid-1950s and early 1980s) and the associated pool elevations between the alternatives. During significant drought (1955 to 1965), drawdowns increase in a logical fashion: “Base Condition” experiences the least amount of drawdown; “Pool Raise” (Alternative 7) results in moderate drawdown; and Alternative 5 results in the greatest drawdown. During a moderate drought (1985 to 1995), Pool Raise (Alternative 7) results in drawdowns less severe than the base condition, while reallocating only from the multipurpose pool (Alternative 5) continues to result in the greatest drawdown.

Figure 5-2 displays the results of the sensitivity analysis for Alternative 5. Water supply storage is sized to yield the necessary demand during drought. Figure 5-2 shows that if the user withdraws approximately half of the yield from the existing multipurpose pool, then the period of record lake elevations carefully follow, although during some time periods, are lower than the base condition.

Figure 5-3 displays the results of the sensitivity analysis for Alternative 7. As explained in the previous paragraph, water supply storage is sized to yield the necessary demand during drought. Given that Alternative 7 includes raising the pool 1.8 feet, an evaluation was performed to evaluate lake levels if the user was withdrawing 30 cfs versus 60 cfs, possibly inducing additional flooding by not withdrawing what was originally assumed. The results are similar to the sensitivity analysis conducted for Alternative

5. There is not a significant difference, in fact the withdrawal of 30 cfs in conjunction with a 1.8-foot pool raise follows very closely with the base condition. During some periods the lake level is negligibly higher.

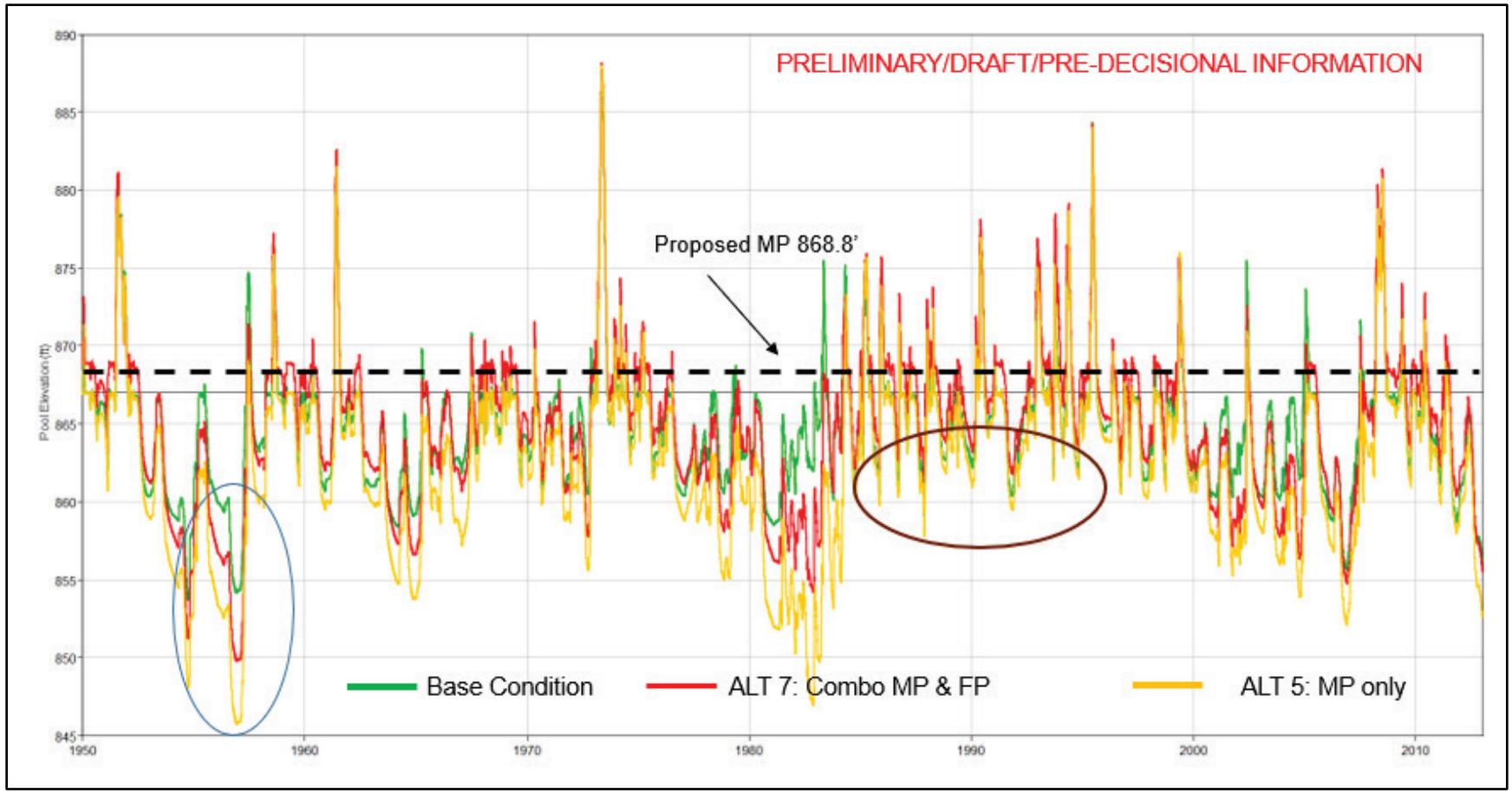


Figure 5-1. HEC-ResSim Output for Alternatives 1, 5 and 7.

Note 1: During significant drought (1955–1965, blue circle), lake drawdowns increase with decreased inflows, continued evaporation, hydropower use, and water supply needs; "Base Condition" experiences the least amount of drawdown. "Pool Raise" (Alternative 7) results in moderate drawdown. Reallocating only from multipurpose (Alternative 5) results in the greatest drawdown.

Note 2: During moderate drought (1985–1995, red circle), "Pool Raise" (Alternative 7) results in drawdowns less severe than the "Base Condition", while reallocating only from multipurpose (Alternative 5), intuitively, continues to result in the greatest drawdown.

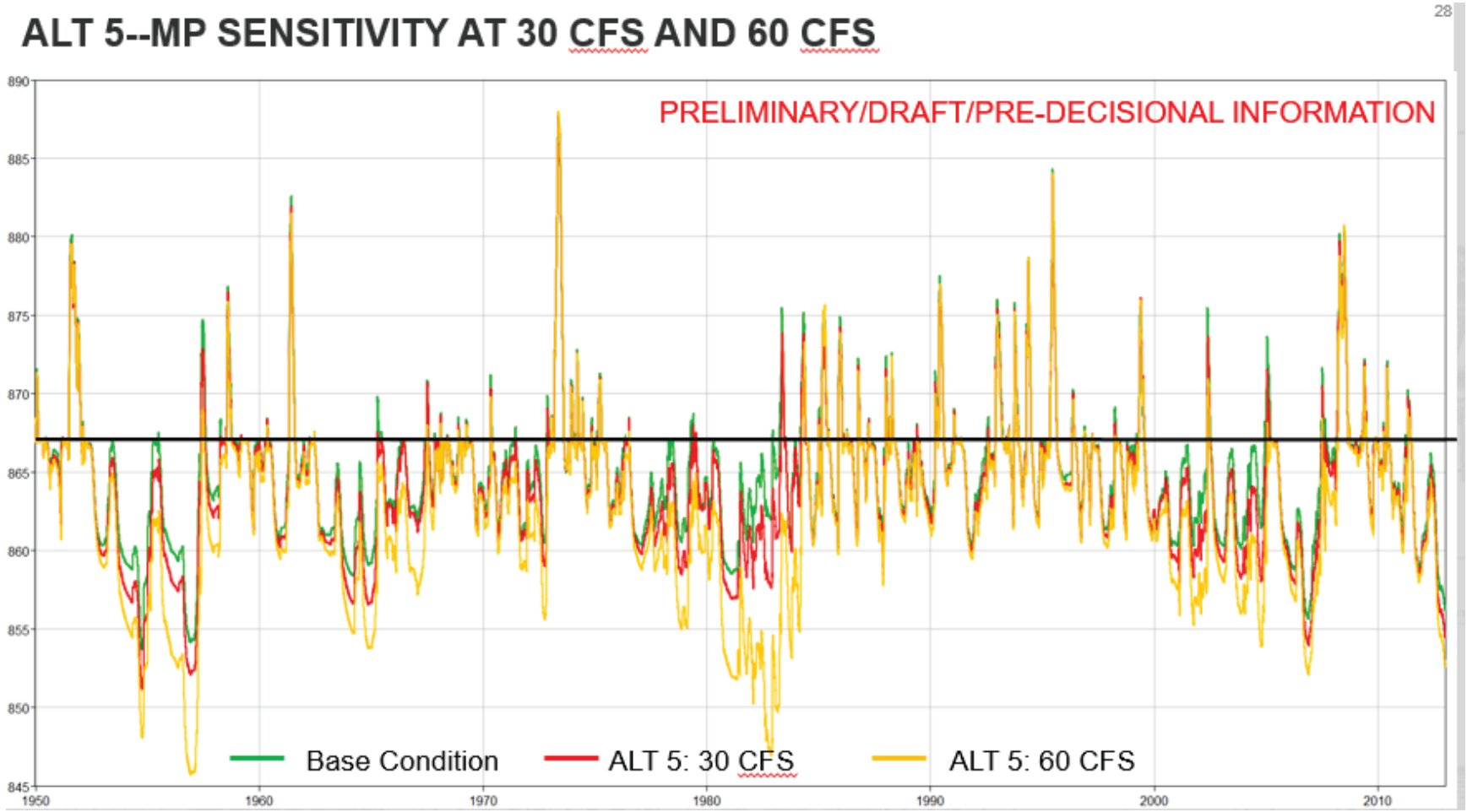


Figure 5-2. ResSim Output Sensitivity Analysis Alternative 5 with the Base Condition (Alternative 1).

Note: During drought, if 30 cfs is withdrawn instead of 60 cfs, the drawdown effect will be reduced. During normal weather years, the 30 cfs withdrawal (red) line follows closely in sync with the Base Condition.

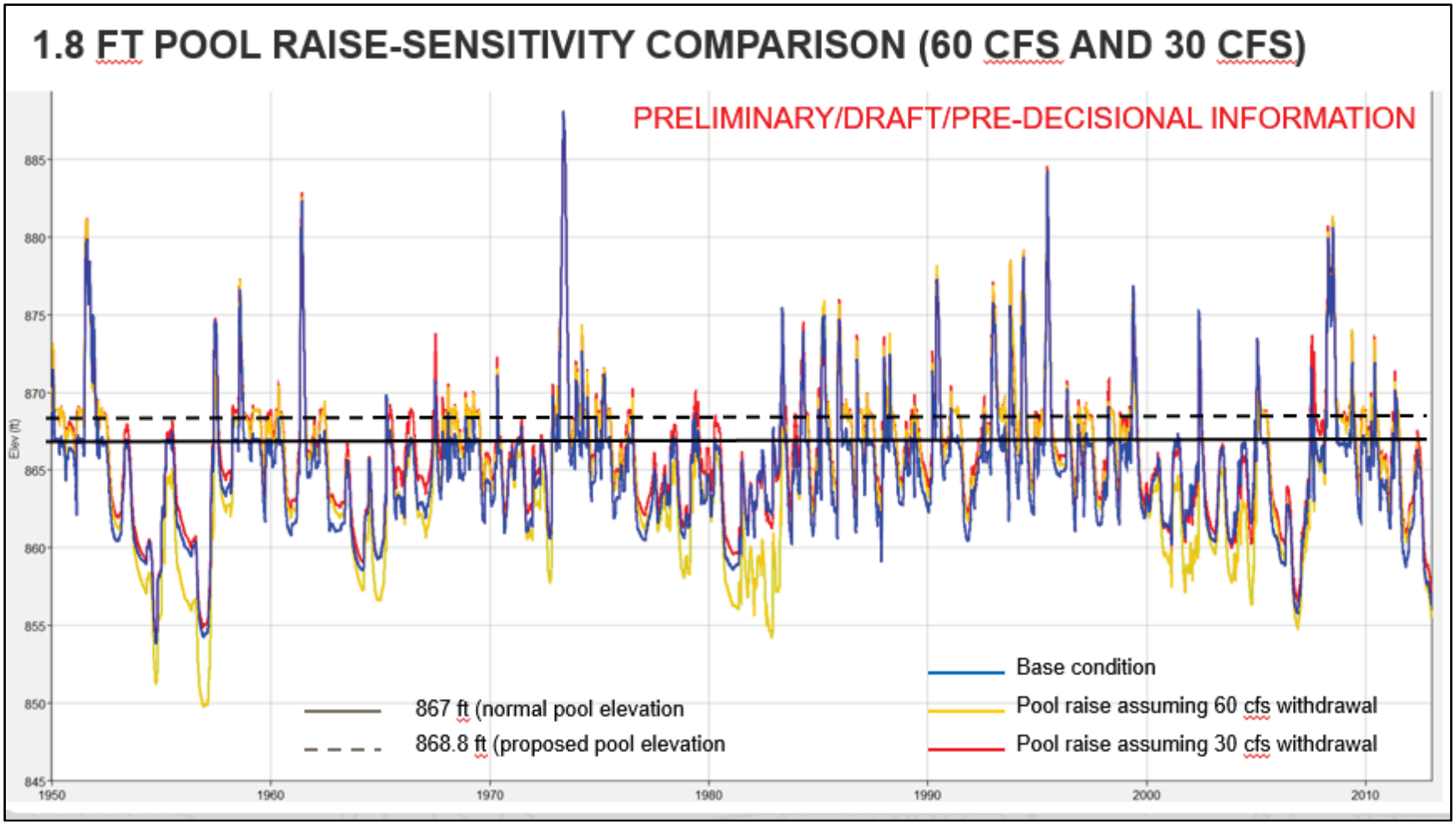


Figure 5-3. HEC-ResSim Output Sensitivity Analysis Alternative 7.

Note: During drought, if 30 cfs is withdrawn instead of 60 cfs, there is almost no noticeable drawdown effect. The red line representing a withdrawal of 30 cfs follows or is almost imposed on the blue line representing the Base Condition. During normal weather years, the 30 cfs withdrawal (red) line follows closely with the blue line representing the Base Condition.

5.4. Flood Risk Management Evaluation

A flood risk management evaluation was only conducted as it relates to Alternative 7 since Alternative 5 is not changing the normal pool elevation and therefore not reducing flood control storage or changing downstream flood risk management. As described in Appendix C, the surcharge operation criteria are understood to remain as documented post-reallocation. Assuming that remains true, any time that the elevation and inflow thresholds are met on the surcharge operation table in the Water Control Manual, the corresponding release is to be made as indicated. The reservoir modeling assumes that these phased thresholds will remain at the same elevations post-reallocation.

Below surcharge operation criteria, Water Control has discretion in the operation of the dam to make non-damaging releases. Considerations include (1) downstream conditions (i.e., flooding) and considering the (2) available storage volume within Stockton and the (3) tandem operation criteria with Truman Reservoir which is downstream of Stockton. The Phase II maximum release (or in excess of) represents the approximate threshold at which consequences to out-of-channel property occur or channel capacity is exceeded. Therefore, the same releases that occur at or below Phase III criteria today would be understood to occur after the reallocation (if surcharge operation criteria are not revised).

With a focus on Alternative 7, since it includes a pool raise, Tables 5-1 and 5-2 describe the gage location at Caplinger Mills, which is approximately 22 miles downstream of Stockton Dam. Table 5-1 includes information from the National Weather Service (NWS) flood stage data, and Table 5-2 describes the water control manual discharges at different phases. For the NWS data in Table 5-1, at 16 feet (flood stage), the percentage of time that flows are above 16 feet is 1.23 percent under the base condition and 1.25 percent under Alternative 7, which is only a 0.02 percent increase in time over the 63-year period of record. As stages increase to 19 feet (moderate flood stage) and 28 feet (major flood stage), the percentage of time flows are above those levels does not change between the Base Condition and Alternative 7. Table 5-2 displays the various stages of discharges during high water or flood events. Phase III releases begin to exceed downstream channel capacity or when incipient damages occur. Since there is not an increase in the percentage of time the gage spends above 19 feet or Phase III releases under either alternative, there is not an impact to flood risk management.

Table 5-1. National Weather Service Percent Time at Various Flood Stages at the Caplinger Mills USGS Gage.

Model Simulation	Action Stage (14')	Flood Stage (16')	Moderate Flood Stage (19')	Major Flood Stage (28')
Base/Existing Condition	2.51%	1.23%	0.47%	0.04%
Alternative 5 (90.2 kMP)	2.23%	1.18%	0.46%	0.04%
Alternative 7 (45.75 kMP 49.0 kFP)	2.64%	1.25%	0.47%	0.04%

At Caplinger Mills: Percent time that the water surface elevation is above noted stage over the period of record.

Table 5-2. Stockton Lake Water Control Manual Percent Time Discharges at the Caplinger Mills USGS Gage.

Model Simulation	Action Stage Phase I (14')	Flood Stage Phase II (16')	Moderate Flood Stage Phase III (19')
Base/Existing Condition	3.94%	1.23%	0.47%
Alternative 5 (90.2 kMP)	3.49%	1.18%	0.46%
Alternative 7 (45.75 kMP/49.0 kFP)	4.14%	1.25%	0.47%

At Caplinger Mills: Percent time that the water surface elevation is above noted stage over the period of record.

With no change to any operational criteria that currently exist and with the 1.8-foot pool raise from the combination pool reallocation scenario, Phase I, II, and III (elevation and release discretion) thresholds would occur earlier than under current base conditions. While Stockton Lake may reach higher pools slightly more frequently post-reallocation (with a higher multipurpose pool elevation), the district's water management staff would have discretion to make releases sooner and more frequently because elevation thresholds would be reached sooner.

Upon completion of this evaluation and review of the results, it was determine that a more detailed analysis of more frequent flooding events using HEC-River Analysis System (RAS), which is a USACE developed computer program that models hydraulics of water flow through rivers and other channels and HEC-Flood Impact Analysis (FIA) was not necessary since the proposed Alternative 7 is not changing the duration of flows above moderate flood stage or Phase III releases where channel capacity is exceeded. There are not any expected additional or induced flood damages due to Alternative 7.

5.5. Hydropower Evaluation

This section presents an abbreviated summary of the full analysis of the effects on hydropower and the monetary value of hydropower that are expected to result from the two proposed water reallocation alternatives. The hydropower values for energy and capacity were computed for the base condition, representing current water control operations, and for water reallocation alternatives. The full detailed hydropower analysis can be found in Appendix E.

The procedures for computing the cost of reallocating water from hydropower to water supply use are outlined in ER 1105-2-100, Planning Guidance Notebook, Appendix E, paragraph E-57, d(2). These procedures require that the reallocated storage cost charged to water supply customers be the highest of the following:

- Power benefits forgone
- Power revenues forgone
- Replacement cost of power
- Updated cost of storage

Power benefits forgone, power revenue forgone, and the replacement cost of power are impacts to hydropower. Power benefits forgone and power revenue forgone are calculated in this report. The replacement cost of power is equal to power benefits forgone and is not calculated separately. The updated cost of storage is not power-related and is documented in Section 5.7, which will be compared to the results of the hydropower benefits forgone in order to determine the cost of storage that the user will pay.

5.5.1. Hydropower Benefits Forgone

Hydropower benefits are based on the cost of the most likely alternative source of power. When conservation storage is reallocated for water supply storage, the usual assumption is that the lost energy and capacity from hydropower will be replaced with power generated from other regional thermal sources.

The power benefits forgone can be divided into two components: energy benefits forgone and capacity benefits forgone. Energy benefits forgone 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. Loss of dependable capacity could be a result of:

- A loss in head because of lower post withdrawal reservoir elevations

- 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)

Energy benefits forgone are computed by multiplying the expected average monthly loss in MWh of on-peak and off-peak generation by the average monthly prices of o-peak and off-peak energy in dollars per MWh over the peiod of analysis. These energy prices are based on the marginal cost of energy from regional generation resources 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. The product of the annualized monthly energy price and the energy loss due to water withdrawals represents the annual energy benefits forgone for that alternative.

Capacity benefits forgone are computed by first determining a composite cost per MW representing the annualized fixed cost of the combination of thermal power plants most likely to replace the capacity lost to the Osage system as a result of the reallocation alternatives. Next, the loss of dependable capacity for each alternative is calculated using the average availability method. Capacity benefits forgone are the product of the loss of dependable capacity and the composite fixed cost of the most likely mix of replacement thermal power plants.

5.5.1.1. Energy Benefits Forgone

Table 5-3 below summarizes the overall annual energy losses under each alternative compared to the Pre-reallocation condition and the current condition at the Stockton and Truman projects. The change from the Pre-reallocation/Original Condition to the Base Condition resulted in an average annual energy loss of 4,880 MWh or a 1.38 percent decrease in average annual generation. Considering the existing condition as the baseline, the largest change in generation occurs under Alternative 5, the reallocation of 90,200 AF from Stockton's multipurpose pool.

Table 5-3. Estimated Average Annual Generation Total Changes for Stockton and Truman.

Alternative	Annual Total Energy (MWh)	Annual Energy Change from Pre-reallocation Condition (MWh)	Change from Pre-reallocation Condition (%)	Annual Current Change from Existing Condition (MWh)	Change from Current Condition (%)
Pre-reallocation/ Original Condition	353,938	--	--	4,880	1.40%
Base Condition	349,058	-4,880	-1.38%	--	--
Alternative 5	343,473	-10,465	-2.96%	-5,585	-1.60%
Alternative 7	343,930	-10,008	-2.83%	-5,128	-1.47%

The final step in computing energy benefits forgone is to multiply the total average monthly generation of on-peak contract, on-peak off-contract, off-peak weekday, and off-peak weekend energy losses for each alternative by the average annual energy prices by month to obtain annual energy benefits forgone by month.

The bottom portion of Table 5-4 shows benefits forgone.

Table 5-4. Combined Annual Energy Benefits Forgone at Stockton and Truman Lakes.

Alternatives	Stockton (STN)	Harry S Truman (HST)	STN+HST Federal
Energy (MWh)			
Pre-reallocation	57,903	296,035	**353,938**
Base Condition	54,874	294,185	**349,058**
Alternative 5	50,353	293,120	**343,473**
Alternative 7	51,425	292,505	**343,930**
Energy Value ($)			
Pre-reallocation	$1,642,500	$7,501,484	**$9,143,984**
Base Condition	$1,576,572	$7,464,185	**$9,040,757**
Alternative 5	$1,467,527	$7,440,913	**$8,908,440**
Alternative 7	$1,489,626	$7,424,363	**$8,913,988**
Change in Energy (MWh)			
Pre-reallocation	0	0	**0**
Base Condition[1]	-3,029	-1,850	**-4,880**
Alternative 5[2]	-4,520	-1,065	**-5,585**
Alternative 7[2]	-3,449	-1,679	**-5,128**
Energy Benefits ($)			
Pre-reallocation	$0	$0	**$0**
Base Condition[1]	($65,928)	($37,299)	**($103,227)**
Alternative 5[2]	($109,045)	($23,272)	**($132,317)**
Alternative 7[2]	($86,946)	($39,822)	**($126,769)**

Notes: Costs are FY2019 price level.
1: Change in base condition from the pre-reallocation.
2: Change in Alternatives 5 and 7 from the base condition.

5.5.1.2. Capacity Benefits Forgone

Capacity benefits forgone are defined as the product of the loss in power plant dependable capacity and a capacity unit value, which represents the capital cost of constructing replacement thermal capacity. Table 5-5 displays the capacity benefits forgone.

Table 5-5. Capacity Benefits Forgone by Alternative.

Alternatives	Stockton (STN)	Harry S Truman (HST)	STN+HST Federal
Capacity (MW)			
Pre-reallocation	45.177	155.982	**201.160**
Base Condition	45.177	154.366	**199.544**
Alternative 5	45.177	153.837	**199.014**
Alternative 7	45.177	153.467	**198.644**
Capacity Value ($)			
Pre-reallocation	$5,782,720	$19,965,723	**$25,748,443**
Base Condition	$5,782,720	$19,758,904	**$25,541,624**
Alternative 5	$5,782,720	$19,691,115	**$25,473,834**
Alternative 7	$5,782,720	$19,643,721	**$25,426,441**

Alternatives	Stockton (STN)	Harry S Truman (HST)	STN+HST Federal
Change in Capacity (MW)			
Pre-reallocation	0.000	0.000	**0.000**
Base Condition[1]	0.000	-1.616	**-1.616**
Alternative 5[2]	0.000	-0.530	**-0.530**
Alternative 7[2]	0.000	-0.900	**-0.900**
Capacity Benefits ($)			
Pre-reallocation	$0	$0	**$0**
Base Condition[1]	$0	-$206,819	**-$206,819**
Alternative 5[2]	$0	-$67,790	**-$67,790**
Alternative 7[2]	$0	-$115,183	**-$115,183**

Notes; Costs are FY2019 price level.
Note 1: Change in base condition from the pre-reallocation.
Note 2: Change in Alternatives 5 and 7 from the base condition.

5.5.2. Hydropower Revenues Forgone

Revenue forgone is to be based on the current SWPA contract rates applicable to power generation by the White River plants. The current rates are:

Firm Energy, Supplemental Energy, and Excess Energy Rate: $9.40/MWh

Power Purchase Adder: $5.90/MWh

Energy Rate Total: $15.30/MWh

Monthly Capacity Charge: $4,500/MW

Ancillary Services:

Monthly Regulation and Frequency Response: $70.00/MW

Monthly Spinning Operating Reserve: $14.60/MW

Monthly Supplemental Operating Reserve: $14.60/MW

Annual Capacity Rate Total: $55,190.40/MW-year

To compute energy revenues forgone, 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 noncontract energy losses and off-peak energy losses. Supportable capacity in the critical year of 1954, which is used in the revenue forgone calculation, was unaffected by any of the reallocation conditions, so there is no capacity revenue forgone. The tables below show the power revenues forgone for each of the alternatives.

Table 5-6. Revenue Forgone Summary by Alternative.

Alternative	STN & HST Annual Energy (MWh)	Energy Revenue ($15.30/MWh)	Critical Year Capacity (MW)[3]	Capacity Revenue ($55,190.40/MW-year)	Total Revenue	Total Revenue Forgone
Pre-reallocation	353,938	$5,415,251	204.169	$11,268,153.80	$16,683,405	$0
Base Condition[1]	349,058	$5,340,592	205.200	$11,325,070.08	$16,665,662	**-$17,743**
Alternative 5[2]	343,473	$5,255,142	205.200	$11,325,070.08	$16,580,212	**-$85,450**
Alternative 7[2]	343,930	$5,262,129	205.200	$11,325,070.08	$16,587,199	**-$78,463**

Notes: Costs are FY2019 price level.
1: Change in base condition from the pre-reallocation.
2: Change in Alternatives 5 and 7 from the base condition.
3: Supportable capacity in the SWPA critical year of 1954.

5.5.3. Hydropower Replacement Cost

Because energy benefits forgone are based on the costs of the equivalent costs of thermal generating energy, the replacement costs of power are identical to energy benefits forgone and do not require separate calculation.

5.5.4. Summary of Hydropower Benefits Forgone

Annual hydropower benefits forgone are described in the above sections and in detail in Appendix E. Current energy market values for energy and capital costs for capacity were applied to the energy and capacity losses to estimate the NED hydropower value. Total average annual power benefits accrue from the value of both energy and capacity. Benefits forgone for each alternative have been annualized over the 50-year period and the FY2019 discount rate of 2.875 percent are shown below.

Under the Current/Existing Condition (reallocation of 50,000 AF) hydropower benefits are estimated to have been reduced by $310,046 annually. With a pool raise and reallocation of an additional 94,750 AF an additional $241,952 in annual hydropower benefits would be lost. Reallocating 90,200 AF without a pool raise annual hydropower benefits would be reduced by $200,107. Table 5-7 summarizes the total hydropower benefits forgone.

Table 5-7. Average Annual Combined Hydropower Benefits Forgone

Alternatives	Stockton (STN)	Harry S Truman (HST)	STN+HST Federal
Energy Value (Table 5-4)			
Pre-reallocation	$1,642,500	$7,501,484	**$9,143,984**
Base Condition	$1,576,572	$7,464,185	**$9,040,757**
Alternative 5	$1,467,527	$7,440,913	**$8,908,440**
Alternative 7	$1,489,626	$7,424,363	**$8,913,988**
Capacity Value (Table 5-5)			
Pre-reallocation	$5,782,720	$19,965,723	**$25,748,443**

Alternatives	Stockton (STN)	Harry S Truman (HST)	STN+HST Federal
Base Condition	$5,782,720	$19,758,904	**$25,541,624**
Alternative 5	$5,782,720	$19,691,115	**$25,473,834**
Alternative 7	$5,782,720	$19,643,721	**$25,426,441**
Hydropower Value (energy + capacity)			
Pre-reallocation	$7,425,220	$27,467,208	**$34,892,427**
Base Condition	$7,359,292	$27,223,089	**$34,582,381**
Alternative 5	$7,250,246	$27,132,028	**$34,382,274**
Alternative 7	$7,272,345	$27,068,084	**$34,340,429**
Hydropower Benefits (energy + capacity)			
Pre-reallocation	$0	$0	**$0**
Base Condition[1]	-$65,928	-$244,118	**-$310,046**
Alternative 5[2]	-$109,045	-$91,061	**-$200,107**
Alternative 7[2]	-$86,946	-$155,006	**-$241,952**

Notes: Costs are FY2019 price level.
1: Change in base condition from the pre-reallocation.
2: Change in Alternatives 5 and 7 from the base condition.

5.5.5. Hydropower Credit to the Power Marketing Agency

As a result of the 1993 Reallocation Study, a unique and nonstandard calculation was conducted for the hydropower credit. The assessment assumed that every year was a critical year (i.e., a drought year rather than an average year). As a result of the calculation, SWPA was granted a $600,000 credit per year to recoup revenues lost as a result of the 50,000 AF reallocation. For this analysis the standard methodology to calculate the hydropower credit is applied.

Stockton Lake project costs originally allocated to hydropower are being repaid though power revenues, which are based on rates designed by the federal power marketing agency (PMA), in this case, SWPA, to recover allocated costs plus interest within 50 years of the date of commercial power operation. If a portion of the storage is reallocated from hydropower to water supply, then the PMA's repayment obligation may be reduced in proportion to the lost energy and marketable capacity through a system of financial credits.

The estimate of the annual SWPA credit listed in Table 5-6 for Alternative 5 is $85,450 and for Alternative 7 it is $78,463, at 2019 price levels. HAC's estimate of credit to the PMA is based on revenue forgone as described in Appendix E, Hydropower Analysis Report. Credit values need to be based on the actual water storage agreement execution dates and amount of storage reallocated.

A letter will be sent to the PMA following execution of the water storage agreement at Stockton Lake documenting the date of agreement execution and the average annual energy and capacity losses due to the reallocation action. The PMA may use this information to apply the hydropower revenues forgone credit annually, based on the in-effect PMA rates for energy and capacity. The credit will become

effective per each water supply agreement enacted date as provided by the Kansas City District. The annual energy in MWh and capacity losses in MW for Alternatives 5 and 7 are presented in Table 5-3.

5.6. Recreation Evaluation

A recreation evaluation was conducted to evaluate the potential impacts of Alternative 5 and 7. A detailed analysis can be found in Appendix B, Economics Appendix. Table 5-8 summarizes the effects of both alternatives as compared to the base case condition. Based upon the evaluation, boat ramps could be closed more than the base condition during drought and non-recreation season under both Alternatives. There are three boat ramps that are prone to closure in the base case. Under Alternative 5, the boat ramps are estimated to be slightly more impacted than under Alternative 7. Swim beaches could expose more debris due to the drawdown effects during drought for Alternative 5. For Alternative 7, there would be a slight reduction of swim beach area and a one-time cost of $25,000 to re-anchor the buoys, but overall, the lake elevations are expected to spend more time around the normal lake elevation of 867 feet NGVD 29. For other recreation features such as campsites, picnic tables and roads, a pool raise may close the site one or two additional days.

Table 5-8. Summary of Impacts to Stockton Lake Recreation Features by Alternative.

Alternative	Campsites	Boat Ramps	Picnic Tables	Roads	Swim Beaches
1	174 sites total, of which 166 sites experience 1–13 days of closure from high water during the recreation season	15 boat ramps total; three are prone to closure and may be closed 12–30 days on average per year from low elevations	90 picnic tables and grills total, of which 87 may experience inundation 1–10 days on average during the recreation season during high water	19 roads in the park area, of which all experience 1–19 days of closure on average per year during high water	6 swim beaches, of which all experience 12 days of closure on average during the recreation season during high water when lake elevations are >873
5	No additional days of closure; 20 of the campsites may be closed one or two fewer days on average during the recreation season compared to the base condition	Three boat ramps prone to closure could be closed up to an additional 76 days on average per year compared to the base condition	No additional days of inundation; 7 picnic tables and 6 grills may be inundated 1 or 2 fewer days on average during the recreation season compared to the base condition	No additional days of closure; 5 of the roads may be closed 1–3 fewer days on average per year compared to the base condition	Lower water elevations during drought could expose debris (wood); the 6 swim beaches are expected to be closed two fewer days during recreation season compared to the base condition
7	Approx. 28 sites are closed one additional day on average during the recreation season as compared to the base condition.	Three boat ramps prone to closure could be closed up to an additional 30 days on average per year compared to the base condition	Approx. 8 picnic tables and 4 grills are inundated 1 additional day on average during the recreation season as compared to the base condition	Approx. 8 roads are closed one to 2 additional days on average per year during high water as compared to the base condition	All 6 swim beaches may experience an additional 4 days of closure on average during the recreation season as compared to the base condition; Stockton Lake project staff, don't believe swim beaches will be significantly impacted, even if some beach sizes are slightly reduced. There will be an additional one-time O&M cost ($25,000) to move the swim buoys.

Note: Considers campsites, boat ramps, picnic tables, roads and swim beaches for Alternatives 1, 5, and 7.

5.7. Updated Cost of Storage for Reallocation Alternatives

ER 1105-2-100 outlines that the nonfederal sponsor will pay for the cost of water supply storage. The cost of storage is established by calculating the highest of the benefits or revenue foregone, the replacement cost, or the updated cost of storage in the federal project. The nonfederal entity shall also be responsible for an appropriate share of the annual costs that include specific and joint-use OMRR&R costs.

The benefits forgone for the Stockton Reallocation are attributed to hydropower benefits forgone, which are calculated based on long-term power rates. This includes both energy benefits and capacity benefits forgone. Hydropower benefits forgone for Alternatives 5 and 7 are approximately $200,100 and $242,000 (FY2019 price level, annualized over 50 years at federal interest rate of 2.875 percent), respectively.

The revenues forgone for the Stockton Reallocation Study are attributed to only the hydropower revenues forgone; there are not expected to be any recreation revenues or other revenues forgone because of the reallocation.

Because the reallocation is partially from the flood control pool, it is appropriate to utilize the replacement cost of equivalent protection; however, this approach is not indicated when there are no severe impacts (ER 1105-2-100 Appendix E). Because there are no changes in flood risk or flood damages anticipated under the reallocation alternatives compared to the base condition, there are no costs attributed to equivalent protection. Per guidance from ER 1005-2-100, Appendix E, the replacement costs for hydropower are typically the same as the benefits forgone.

The updated cost of storage is determined first by computing the costs at the time of construction. The joint-use construction costs (costs that are shared jointly between flood risk management, hydropower, recreation, water quality, and fish and wildlife) are the basis for determining the cost of storage. This is computed by subtracting the specific project costs (i.e., hydropower, recreation) from the total construction cost. The joint-use construction costs are then escalated to present day price levels by using the USACE Civil Works Construction Cost Index System (CWCCIS). This index is maintained in Engineer Manual (EM) 1110-2-1304. Since the CWCCIS dates back only to 1967, the Engineering News Record (ENR) Construction Cost Index (CCI) is to be used to update the cost of older projects to the 1967 time frame. This does not apply to the Stockton Lake Reallocation since the joint-use as-built costs began in November 1966 (FY1967). The updated CWCCIS index factors were less than the ENR CCI factors, so the lesser of the indices were used to calculate the updated cost of storage. Land values were updated using a weighted average index factor of the other cost accounts.

For the Stockton Lake Reallocation specifically, the total as-built construction cost of Stockton Lake, as reported in the "1991 Annual Report of the Chief of Engineers on Civil Works Activities, Extract Report of the Kansas City, Mo. District" is $79,975,357. As-built, joint-use construction costs are defined as the total construction costs minus specific costs. Costs for road betterments and cultural resources are also excluded from consideration when calculating updated cost of storage. The 1991 report noted that specific costs at Stockton Lake included $1,310,759 for specific recreation land, $10,796,186 for specific power, and $6,185,477 for specific recreation. Excluded costs were $1,825,000 for road betterments and $133,479 for cultural resources. Total specific and excluded costs were $20,250,901, resulting in as-built, joint-use costs of $59,724,456 in FY1967 dollars to be used in determining the updated cost of storage, which is the same basis that the 1993 Stockton Lake Reallocation Study used to calculate the updated cost of storage.

The mid-point of physical construction for Stockton Lake is November 1966. This data is based on the mid-point of the date construction began (October 1963) and the date that the project was first placed into operation (December 1969). Joint-use, nonspecific, as-built costs were updated from the mid-point of construction, November 1966 (FY1967) to October 2019 (FY2020) (USACE 1993). Table 5-9 displays the updated cost of construction, which is estimated to be approximately $542 million.

Table 5-9. Updated Joint-Use Construction Costs.

Permanent Features	CWCCIS Account	As-Built, Joint-Use Costs (FY1967)	Weighted Average	FY1967 CWCCIS Index (October 1966)	FY20 CWCCIS Index (October 2019)	CWCCIS Index Factor	Updated FY2020 Joint-Use Construction Costs
Lands and Damages	--	$11,235,143.20	--	100	907.55	9.0755	$101,964,600
Relocations	02	$16,186,307.90	33%	100	926.48	9.2648	$149,962,900
Reservoirs	03	$2,308,099.10	5%	100	1021.32	10.2132	$23,573,100
Dams	04	$21,687,892.40	45%	100	907.82	9.0782	$196,887,000
Power plant	07	$6,830,049.50	14%	100	820.26	8.2026	$56,024,200
Roads	08	$667,251.90	1%	100	926.48	9.2648	$6,182,000
Channels	09	$381,036.80	1%	100	948.65	9.4865	$3,614,700
Buildings, Grounds, and Utilities	19	$285,305.00	1%	100	891.37	8.9137	$2,543,100
Permanent Operating Equipment	20	$143,369.60	0%	100	891.37	8.9137	$1,278,000
Total Project Cost		**$59,724,455.40**					**$542,029,600**

Note: *Costs are displayed in FY1967 and updated to the FY2020 price level.

Based on the updated FY2020 joint-use construction cost of $542,029,600, the user's cost of storage is determined by their proportion of usable storage. Usable storage is considered the storage volumes in both the multipurpose pool and the flood control pool, which are 789,814 and 645,575 AF, respectively. Table 5-10 displays the cost to the user for each alternative. Annual OMRR&R costs are included. The OMRR&R costs represent the water supply user's portion of the annual joint-use O&M or repair, rehabilitation, and replacement (RR&R) expenditures. Under Alternative 5, the user would responsible for 6.28 percent of the annual O&M and RR&R costs and under Alternative 7, they would be responsible for 6.60 percent of the costs. The O&M costs were based on actual FY2019 joint-use expenditures. Based on current information, there have not been significant RR&R costs incurred previously and none are projected for the near future. Table 5-11 describes the associated costs. The cost of storage is $34.1 million for Alternative 5 and $35.8 million for Alternative 7.

Table 5-10. FY2020 Updated Cost of Storage to User.

FY2020 Updated Joint-Use Construction Cost	Usable Storage (AF)	Alternative	Flood Control Pool Storage (AF)	Multi-purpose Pool Storage (AF)	Percent of Usable Storage	FY2020 Updated Cost of Storage
$542,029,600	1,435,389	Alternative 5	0	90,200	6.28%	$34,100,000
		Alternative 7	49,000	45,750	6.60%	$35,800,000

Note: Price level is FY2020

Table 5-11. Annual Operations, Maintenance, Repair, Replacement and Rehabilitation Costs.

Alternative	Estimated O&M Based on Actual FY2019 Expenditures	User's O&M Responsibility Based on Percentage of Usable Storage	Estimated RR&R Based on Actual FY2019 Expenditures	User's RR&R Responsibility Based on Percentage of Usable Storage
Alternative 5	$2,860,000	$180,000	$0	$0
Alternative 7	$2,860,000	$190,000	$0	$0

Note: There are no significant RR&R costs projected into the next 5 years per Sect. 1046(b) Water Resources Development Act to develop 5-year OMRR&R projections

5.8. National Economic Development Analysis and Screening of Final Array

Per ER 1105-2-100, the NED benefits for water supply storage are calculated by the willingness to pay for additional water supply. The benefits can be measured by the resource cost of the alternative most likely to be implemented in absence of the federal plan, which in this case, is construction of a new reservoir (additional details are provided in Section 9). Table 5-12 displays the annualized cost of Alternative 2 (construction of a new reservoir) and compares it against Alternative 5 and Alternative 7. The NED evaluation includes cost impacts to other authorized purposes and or mitigation. Alternative 2 is an all-inclusive cost estimate and includes all pertinent cost accounts, such as pre-engineering and design, real estate, environmental mitigation, construction and contingency. For evaluation of Alternative 5 and Alternative 7, the costs are captured under various accounts. For instance, as described in Section 5.5, the hydropower benefits forgone are included as part of the total costs for each alternative in order to compare the plans against each other. Hydropower benefits forgone under Alternative 5 are $200,000 and slightly more under Alternative 7 at $242,000.

The report discusses other costs that are taken into consideration. It was determined that additional real estate costs will not be necessary under Alternative 5 or 7; however, a cost identified by USACE in Section 5.6 includes a one-time cost of $25,000 to move the swim buoys to ensure swimmer safety in the case of Alternative 7, the pool raise. Dam safety is discussed in Section 5.11. Since there is uncertainty regarding the outcome of the FY2024 Periodic Assessment and the associated DSAC rating, a placeholder "TBD" cost has been identified in Table 5-12.

Environment impacts were determined to be negligible and mitigation unnecessary; however, because of the cultural sensitivity and known cultural sites that were recently identified through a survey, impacts were identified under Alternative 7. The user will be responsible for cultural mitigation that is identified within the 1.8-foot pool raise. A preliminary estimate of $2,500,000 is included in Table 5-12 for comparison of plans. Further details can be found in Section 7.7. It is important to note that these impacts are occurring under the base condition as well, so mitigation is required regardless of the reallocation action.

Lastly, annual OMRR&R costs are included. The OMRR&R costs represents the water supply user's portion of the annual joint-use O&M or RR&R expenditures. Under Alternative 5, the user would responsible for 6.28 percent of the annual OMRR&R costs and under Alternative 7, they would be responsible for 6.60 percent of the costs. The O&M costs were based on actual FY2019 joint-use expenditures. Based on current information, there have not been significant RR&R costs incurred previously or are projected for the near future. The annualized total cost of constructing a new reservoir is approximately $11.5 million, while annual total costs of reallocating water supply storage under Alternative 5 and Alternative 7 costs $1.5 million and $1.6 million respectively.

Reallocation of water supply storage under either Alternative 5 or 7 provides net benefits of approximately $10 million and $9.8 million, respectively. Alternative 5 has a benefit/cost ratio of 6.9 and Alternative 7 has a benefit/cost ratio of 6.1. Alternative 5 is the least costly plan and the NED plan. While Alternative 5 does have slightly greater net benefits, Alternative 7 is the tentatively selected plan because overall it provides greater stability for lake elevations to remain on par with current base conditions. The selection is further detailed in Sections 6 and 8.

Table 5-12. National Economic Development Analysis, Screening of Alternatives 2, 5, and 7.

Cost or Forgone Benefit for Authorized Purpose	New Reservoir	90,200 AF Multipurpose Pool	1.8-foot Pool Raise (45,750 AF MP/49,000 AF Flood Control Pool)
Estimated Yield from Storage	**39**	**39**	**39**
Hydropower benefits forgone	--	$200,000	$242,000
Real Estate Costs	--	--	--
Recreation benefits forgone	--	--	--
Recreation mitigation	--	--	$25,000
Dam Safety	--	--	TBD
Flood risk management	--	--	--
Environmental (habitat)	--	--	--
Cultural Resources (Est.)	--	--	$2,500,000
Capital Costs – Cost of Storage	$296,000,000	$34,100,000	$35,800,000
Capital Costs – Transmission and Treatment*	--	--	--
TOTAL COSTS	$296,000,000	$34,300,000	$38,600,000
O&M Costs	$500,000	$180,000	$190,000
RR&R Costs	--	--	-

Cost or Forgone Benefit for Authorized Purpose	New Reservoir	90,200 AF Multipurpose Pool	1.8-foot Pool Raise (45,750 AF MP/49,000 AF Flood Control Pool)
Interest and Amortization (I&A) Factor	0.03704	0.03704	0.03704
Total Average Annual Costs	**$11,464,000**	**$1,450,000**	**$1,620,000**
Annual Benefits		**$10,014,000**	**$9,844,000**
Benefit/Cost Ratio		**6.9**	**6.1**

Note: An FY2020 price level and FY2020 federal discount rate of 2.75% were assumed for all categories except for Hydropower Benefits Forgone, which were calculated in FY2019 dollars and using an FY2019 federal discount rate of 2.875%.

5.9. Regional Economic Development, Environmental Quality and Other Social Effects

A qualitative assessment was conducted based on regional economic development (RED), environmental quality (EQ), and other social effects (OSE) planning accounts.

The *Regional Economic Development (RED)* account should include a description and assessment of the changes in regional economic activity that would occur under the alternatives, including changes in jobs, income, economic output, and population (ER 1105-2-100, page 1-3).

RED is used to evaluate changes in the distribution of regional economic activity that result from each alternative plan. Both Alternatives 5 and 7 would result in increased costs or rates for water customers in the region; however, the additional water supply storage will alleviate water shortages during drought conditions and provide a reliable water supply for customers, supporting current and continued population and economic growth in the region.

Alternative 7 would provide more stable lake elevations and benefit all authorized purposes during drought conditions compared to Alternative 5. All authorized purposes are impacted by drought, and Alternative 7 minimizes drawdown effects during less severe droughts. Alternative 5 has the potential to result in adverse impacts to lake levels and recreational visitation during drought conditions through decreased access compared to the No Action Alternative with the potential for decreased visitor spending in lake communities and decreased tourism-related jobs, income, and regional economic conditions. Alternative 7 would result in stable water surface elevations and continued recreational access at Stockton Lake, which would support visitor spending at current levels in lake communities, benefitting tourism-related jobs, income, and regional economic conditions.

The *Environmental Quality (EQ)* planning account describes the nonmonetary effects on significant ecological, aesthetic, and cultural resources. Cultural resources are anticipated to be minimally impacted compared to current conditions. Impacts to cultural resources are described in Section 7.7, Environmental Effects. In addition, Sections 7.4, 7.5, 7.6, and 7.13 describe the environmental effects of the alternatives on water resources, terrestrial resources, threatened and endangered species, and aesthetics, respectively. The environmental resources are not anticipated to be significantly affected under the alternatives.

The *Other Social Effects (OSE)* account describes plan effects on social aspects such as community impacts, health and safety factors, displacement, energy conservation and others (USACE ER 1005-2-100; IWR Report 2013-R-03, *Applying Other Social Effects in Alternatives Analysis)*. This OSE evaluation includes a description of the provision of reliable water source, risks to life loss, community well-being and social connectedness, and social benefits associated with recreational aspects associated with the alternatives. Both reallocation alternatives benefit the southwest Missouri region by providing a reliable water source for communities, supporting community well-being, economic vitality, and public services to support health and safety in the broader community.

An evaluation on the risks of life loss from flooding was not conducted for this evaluation because Alternative 5 would not result in changes to the flood pool and Alternative 7 is not changing the duration of flows above moderate flood stage or Phase III releases where channel capacity is exceeded. There are not any expected additional or induced flood damages due to Alternative 7 (see Section 5.4 for additional details). The risk to loss of life associated with the Alternative 7 compared to the No Action Alternative would be very similar, and implementation of Alternative 7 does not significantly increase or decrease the risk to loss of life compared to the No Action Alternative. Therefore, there are no adverse social effects associated with risks to life and safety under Alternatives 5 and 7.

In addition, the ability to support recreational access through stable lake levels, continued visitation, and regional economic benefits supported by visitor spending would provide social benefits under Alternative 7, such as individual and community economic vitality and growth. Recreational amenities in communities can promote individual and community health and well-being through the provision of outdoor activities and access to trails and areas to exercise. Alternative 5 may result in some adverse social effects from reduced recreational access during drought conditions.

5.10. Dependable Yield Mitigation Storage Analysis

As mentioned in Section 3.5.1.6, per ER 1105-2-100, DYMS analysis must be completed whenever the conservation pool of a reservoir project is expanded into the flood control pool because the critical period dependable yield established for the existing user (City Utilities of Springfield, Missouri) per unit of storage will be reduced. This occurs because, even though more conservation storage is available from which to draft water, the inflow into the reservoir remains the same. Since more users will be sharing the same inflow, the yield per unit of storage decreases even though the total yield of the project increases. While water storage contracts (also referred to as agreements) do not guarantee a yield, because of fairness, USACE should not make additional or discretionary storage reallocations in a project that imposes measurable negative impacts on existing water supply contracts by reducing their critical yield periods. To avoid such negative impacts, sufficient storage would be reallocated to meet the needs of the new user and to maintain the dependable yield of the existing water supply contract holders. The additional storage required to keep existing users whole is termed DYMS. The new user of the new water supply storage space (i.e., the water supply requestor) will pay for all costs associated with DYMS.

Per ECB 2019-13, Methods for Storage Yield Analysis, it was determined that to make City Utilities whole or back to a 44 cfs withdrawal rate included in the base condition, 19,000 AF of storage would be necessary. This is amount is not additive to the current request; however, it will reduce the amount of contingency that Tri-State was requesting. The complete DYMS analysis is described in Appendix C.

City Utilities is a current member of Southwest Missouri Regional Water and the contract holder on the first increment of storage. Because of their relationship and involvement with Southwest Missouri Regional Water Commission, a sub-agreement will be negotiated between the two groups to ensure that City Utilities will maintain its original critical yield in addition to its second increment of storage needed for its growing population.

5.11. Dam Safety

Per Dam Safety Program guidance, the alternative evaluation including a pool raise (raising the normal multipurpose pool elevation) triggered review of risk identified at Stockton dam. Review of potential risk driver failure modes identified in the 2014 PA study did not reveal a change in risk at Stockton dam. However, based on updated USACE risk assessment guidelines implemented in 2019 that effectively increased the estimated probable maximum flood (PMF) that USACE dams must pass, the existing conditions review considered overtopping of the embankment at PMF at a percentage higher than the PMF to account for uncertainty in the hydrologic loading. Incremental risk associated with the overtopping failure of the dam was found to exceed the societal tolerable risk guideline. Overtopping drove the total incremental risk, resulting in change to the DSAC rating from 4 to 3. The change in DSAC

rating was not related to a potential pool raise reallocation proposal causing an increase in failure likelihood of any potential failure modes; it was related to updated methodology considering hydrologic events that exceed the design event. The updated risk assessment showed that an increase in normal pool had no impact or change to the incremental risk associated with Stockton dam.

Because of the DSAC change and per Dam Safety Program guidance, USACE, Kansas City District sought an exemption waiver from Headquarters USACE (HQUSACE) to continue the reallocation study. The exemption waiver was approved on MONTH, DATE, 2020. The sponsor was notified of the initial DSAC 4 rating on July 28, 2017, and the change in DSAC rating on May 12, 2020. The sponsor understands the financial obligation associated with any dam safety modifications or RR&R that may be required and sent a response letter on May 15, 2020. Correspondence referencing these letters is included in Appendix K, Correspondence with User.

USACE, Kansas City District funded a detailed PMF study in FY2019 to better understand the hydrologic risk. This study will be completed by end of FY2020 and will be used to reassess risk at the dam during the FY2024 periodic assessment. When FY2024 is complete, the results will inform the Risk Management Center and the DSOG as to whether or not Stockton's DSAC rating should stay a 3 or be reclassified to a 4. Since there is uncertainty regarding the outcome of the study, there is a TBD placeholder cost in the NED evaluation.

5.12. System of Accounts Analysis and Screening of the Final Array

In accordance with ER 1105-2-100, Planning Guidance Notebook, the four criteria are also applied to the final array of alternatives alongside the economic accounts of NED, RED, EQ, and OSE.

The four general criteria for consideration are (1) completeness, (2) efficiency, (3) effectiveness, (4) acceptability, described as:

1) *Completeness:* Completeness is the extent to which an alternative provides and accounts for all required investments and actions to ensure the realization of the planning objectives, including actions by other federal and nonfederal entities. Completeness also includes consideration of real estate issues, O&M, monitoring, and sponsorship factors.

2) *Efficiency:* The extent to which an alternative plan is the most cost-effective means of achieving the objectives.

3) *Effectiveness:* Effectiveness is defined as the degree to which the plan will achieve the planning objective. A plan must make a significant contribution to the problem or opportunity being addressed.

4) *Acceptability:* A plan must be acceptable to federal, state, and local government in terms of applicable laws, regulation, and public policy.

The following tables summarize and compare alternatives to applicable criteria. Table 5-13 displays the National Economic Development Account using the criteria of annual net benefits and benefit/cost ratio. Table 5-14 describes the RED Account applying the qualitative criteria of regional costs and regional benefits. The specific EQ comparison table can be found in Section 7, Environmental Effects, Table 7-2: Summary of Stockton Lake Impact Assessments. Other social effects are summarized in Table 5-15. The same screening criteria for recreation, socioeconomic resources, and environmental justice are also covered in Section 7. Lastly, Table 5-16 screens the alternatives against the USACE criteria for completeness, efficiency, effectiveness, and acceptability.

Table 5-13. National Economic Development Account Screening.

Criteria	Alternative 1 – Federal No Action/FWOP	Alternative 5 – Reallocation from Multipurpose Pool	Alternative 7 – Reallocation from Combination Multipurpose Pool and Flood Control Pool
Annual Net Benefits	--	$10,014,000	$9,844,000
Benefit/Cost Ratio	--	6.9	6.1

Note: See Table 5-12 for additional details.

Table 5-14. Regional Economic Development Account Qualitative Assessment.

Criteria	Alternative 1 – Federal No Action/FWOP	Alternative 5 – Reallocation from Multipurpose Pool	Alternative 7 – Reallocation from Combination Multipurpose Pool and Flood Control Pool
Regional Costs	No additional cost to water users; no cost to communities near the reservoir.	Medium cost to water users in the southwest Missouri region;	Medium cost to water users in the southwest Missouri region;
Regional Benefits	SWMO communities will experience water shortages during drought; continued recreational access consistent with current conditions would support economic benefits to regional economic in adjacent lake communities.	Regional benefits include adequate and reliable water supply to support population and economic growth; lake levels would decrease in low water/drought conditions, with the potential for adverse effects to recreational access, visitation, and jobs and income in tourism businesses compared to FWOP.	Regional benefits include adequate and reliable water supply to support population and economic growth; stable lake levels may increase recreational access during drought conditions, supporting increased jobs and income in tourism businesses compared to FWOP.

Table 5-15. Other Social Effects Account Assessment.

Criteria	Alternative 1 – Federal No Action/FWOP	Alternative 5 – Reallocation from Multipurpose Pool	Alternative 7 – Reallocation from Combination Multipurpose Pool and Flood Control Pool
Recreation	Baseline days of above-normal (26 days), normal (152 days), and below-normal (187 days) lake elevations would continue under the FWOP condition. Some closure currently occurs in the baseline condition; however, current level of recreational supports individual and community health and well-being and economic vitality in lake communities.	Minor adverse impacts to the recreational access during low water/drought conditions could result in adverse social effects, such as to individual and community health and well-being and economic vitality compared to the FWOP	Minor positive impact to recreational access during lower water/drought conditions could result in increased other social effects, such as to individual and community health and well-being and economic vitality compared to the FWOP

Criteria	Alternative 1 – Federal No Action/FWOP	Alternative 5 – Reallocation from Multipurpose Pool	Alternative 7 – Reallocation from Combination Multipurpose Pool and Flood Control Pool
Flood Risk Management	The percent of time at flood stage (16') is 1.2; the percent of time at moderate flood stage (19') is 0.5%; and the percent of time at major flood stage (28') is 0.04%.	Minor benefits to reduced flood risk and no anticipated change in life loss.	Insignificant impact to flood risk and no anticipated change in life loss and safety.
Environmental Justice	Low-income populations in Cedar, Dade, and Polk Counties would not be disproportionately affected under the FWOP condition.	No change from FWOP.	No change from FWOP.
Transportation	Roads would remain accessible to project facilities, although during high-water years, roads may experience closure.	No change from FWOP.	Insignificant impact; only a few roads would be closed an additional day during high water.

Table 5-16. Screening Against USACE Criteria of Completeness, Efficiency, Effectiveness, and Acceptability.

Criteria	Alternative 1 – Federal No Action/FWOP	Alternative 5 – Reallocation from Multipurpose Pool	Alternative 7 – Reallocation from Combination Multipurpose Pool and Flood Control Pool
Completeness	Does not address the project objectives.	Provides a complete solution to the identified problem and project objectives	Provides a complete solution to the identified problem and project objectives.
Efficiency	No cost but does not address the project objective.	Provides an efficient use of federal and nonfederal resources, while providing a cost-effective solution the identified problem.	Provides an efficient use of federal and nonfederal resources, while providing a cost-effective solution the identified problem.
Effectiveness	Does not make a significant contribution to the problem or opportunity being addressed.	Less effective at addressing the project objective of maintaining lake levels similar to the base condition.	More effective at addressing the project objective of maintaining lake levels similar to the base condition.
Acceptability	Less acceptable to the user requesting water storage; Acceptable in regard to federal laws, regulations, and guidelines.	Less acceptable to some users and SWPA due to more severe drawdown effects. Acceptable in regard to federal laws, regulations, and guidelines.	More acceptable to some users and SWPA due to less drawdown effects during drought and more stable lake levels. Acceptable in regard to federal laws, regulations, and guidelines.

6.0 Tentatively Selected Plan

Based on the economic and environmental evaluations, the PDT, including the proposed water user, Southwest Missouri Regional Water, puts forward Alternative 7 as the Tentatively Selected Plan (TSP). Alternative 7 consists of reallocating 45,750 AF from the multipurpose pool and 49,000 AF from the flood pool, resulting in a 1.8-foot increase to the normal pool elevation. Under the TSP, the normal pool elevation would be changed from 867.0 to 868.8 feet NGVD 29. Even though Alternative 7 is not the least costly alternative, it still provides approximately $9.8 million in net benefits, and the alternative better meets the study objectives outlined in the main report by minimizing impacts to other authorized purposes. By recommending Alternative 7, the reservoir is projected to maintain elevation ranges that closely align with the current base condition.

Tables 6-1 and 6-2 summarize the changes in the number of days the reservoir is projected to be within specified elevation ranges, and further breaks out the normal pool elevation range, which spans approximately 6 feet. Table 6-1 presents data for the entire year and Table 6-2 presents data specific to the recreation season, which spans from April through September. It is important to note that lake levels fluctuate on a daily basis. Overall, on an average annual basis, the lake is between elevations 865 and 870.9 feet NGVD 29 approximately 43 percent of the time. Under Alternative 5, it is within that range approximately 30 percent of the time, and under Alternative 7, within that range 45 percent of the time. The normal operating range was broken into a mid-normal operating range (elevations 867 to 868.9 feet NGVD 29), and low-normal operating range (elevations 865 to 866.9 feet NGVD 29). Alternative 7 reduces the number of days that the lake elevation is at low-normal elevations by 57 days and is projected to result in 60 additional days within the mid-normal range.

The results are similar for the recreation season in that the lake is projected to be at a mid-normal elevation range, rather than a low-normal range. In addition to the lake spending more time at a normal elevation, the biggest benefit to Alternative 7 is discussed in Section 5.3, Hydrologic Analysis of Impacts to Water Elevations. By implementing a 1.8-foot pool raise and reallocating storage from both the flood control pool and the multipurpose pool, the lake elevations are less prone to severe draw-down effects during drought while on the other hand making changes during high water conditions insignificant based on the period of record. In addition, it was concluded that the pool raise did not impact dam safety or change its incremental risk. There are no additional flood risk management impacts or increased inundation downstream. While it is acknowledged that hydropower benefits forgone are slightly more under Alterative 7, there will be efficiencies gained by having a higher pool elevation to generate power. In terms of recreation, Alternative 7 projects only a day less or more under the very low, low, normal, and high elevation categories during the recreation season.

Although cultural resources mitigation has been identified, the impact is expected to be minimal as compared to the current condition when comparing the below tables as well as the graphs presented in Section 5.3. Southwest Missouri Regional Water is in agreement, that even though Alternative 7 is slightly more expensive, the outcome will be less impactful to all authorized purposes while still reducing the risk of water shortages during drought.

The TSP also meets the study's primary and secondary objectives and does not violate any of the identified constraints. Compared to Alternative 5, Alternative 7 performs better at maintaining lake levels and mitigates drawdown effects during drought.

Table 6-1. Elevation Comparisons – Average Annual Days and Percentage of Time Lake Levels are within Various Lake Conditions.

Lake Condition	Elevation (feet NGVD 29)	Base Condition (Percentage of Year)	Base Condition (Days per Year)	Alternative 5 (Percentage of Year)	Alternative 5 (Days per Year)	Alternative 5 Difference from Base Condition (No. of days)	Alternative 7 (Percentage of Year)	Alternative 7 (Days per Year)	Alternative 7 Difference from Base Condition (No. of days)
High	≥871	6%	22	5%	18	-4	6%	22	0
Normal	865–870.9	43%	157	30%	109	-48	45%	164	8
High-Normal	*869–870.9*	*3%*	*10*	*2%*	*7*	*-2*	*4%*	*14*	*4*
Mid-Normal	*867–868.9*	*9%*	*31*	*5%*	*20*	*-11*	*25%*	*91*	*60*
Low-Normal	*865–866.9*	*32%*	*116*	*23%*	*82*	*-34*	*16%*	*59*	*-57*
Low	863–864.9	19%	70	14%	52	-18	15%	56	-14
Very Low	<863	32%	117	51%	186	69	34%	123	7

Note: Percentages and number of days for high-normal, mid-normal, and low-normal do not add to what is shown under the Normal category in some columns because of rounding.

Table 6-2. Elevation Comparisons – Recreation Season.

Lake Condition	Elevation (feet NGVD 29)	Base Condition (% of Time)	Base Condition (Days per Year)	Alternative 5 (% of Time)	Alternative 5 (Days per Year)	Alternative 5 Difference from Base Condition (No. of days)	Alternative 7 (% of Time)	Alternative 7 (Days per Year)	Alternative 7 Difference from Base Condition (No. of days)
High	≥871	7%	16	7%	13	-3	8%	15	-1
Normal	865-870.9	51%	93	34%	62	-31	51%	94	1
High Normal	*869-870.9*	*3%*	*6*	*2%*	*4*	*-2*	*4%*	*8*	*2*
Mid Normal	*867-868.9*	*9%*	*17*	*6%*	*11*	*-6*	*29%*	*53*	*36*
Low Normal	*865-866.9*	*39%*	*71*	*26%*	*47*	*-23*	*18%*	*33*	*-37*
Low	863-864.9	18%	33	16%	29	-4	17%	32	-1
Very Low	<863	23%	41	43%	79	38	23%	43	1

Note: Percentages and number of days for high-normal, mid-normal, and low-normal do not add to what is shown under the Normal category in some columns because of rounding.
Average Annual Days and Percentage of Time Lake Levels are within Various Lake Conditions.

7.0 Environmental Effects

This chapter discusses the probable consequences or impacts of a water supply storage reallocation on Stockton Lake resources. USACE is considering three alternatives including No Action, Multipurpose Pool Reallocation, and a Combination Flood and Multipurpose Pool Reallocation at Stockton Lake. The effects discussed can be either beneficial or adverse and were considered over a 50-year period of analysis (2019 to 2069). FWOP and FWP conditions over the 50-year period of analysis are used to assess and compare the resource categories between No Action and proposed action alternatives.

The Federal No Action/FWOP alternative is required under NEPA. The Federal No Action/FWOP alternative is the most likely condition expected to occur in the future in the absence of a nonfederal action or any of the federal action alternatives. The Federal No Action/FWOP alternative assumes no reallocation of water storage would occur from Stockton Lake. The federal fee/flowage easement property around Stockton Lake is the effects analysis area for NEPA purposes. City Utilities of Springfield, Missouri has a pipeline built from Stockton Lake to Fellows Lake north of Springfield, Missouri. Tri-State Water Resources Coalition plans to construct the new pipeline within City Utilities existing easement because there is sufficient room for another pipeline. Impacts from the original City Utilities pipeline was evaluated under the Environmental Macro-Corridor Study Proposed City Utilities of Springfield, Stockton Water Supply Project, November 1991.

Table 7-1 compares lake elevations for each of the alternatives based on outputs from the HEC-ResSim model, as described in Section 5.3.

Table 7-1. Full Year Stockton Lake Elevations for Alternatives 1, 5, and 7.

Elevation (feet)	Alternative 1 Federal No Action/FWOP		Alternative 5 Multipurpose Pool			Alternative 7 Combination Multipurpose Pool and Flood Control Pool		
	% of Year	Days/year	% of Year	Days/year	Net Change (No. of Days)	% of Year	Days/year	Net Change (No. of Days)
Above Normal (≥870)	7	26	6	21	-5	8	27	1
Normal (869.9–865)	42	152	29	106	-47	44	159	7
Below Normal (<=864.9–845.1)	51	187	65	239	52	49	179	-8
Skimming Weir (<=845)	0	0	0	0	0	0	0	0

Notes:
Values are based on average annual days over the period of record from 1950 to 2012.
Normal pool elevations represent surface water level conditions that are considered optimal for operation and management of existing authorized purposes at Stockton Lake.
Net Change = change in the number of average annual days between the Federal No Action/FWOP alternative and action alternatives.

The CEQ defines direct effects as those which are caused by the action and occur at the same time and place, whereas indirect effects are caused by the action and occur later in time or farther removed in distance but are still reasonably foreseeable (40 CFR §1508.8). CEQ guidelines indicate that significance of an impact is determined by the context and intensity of the impact (40 CFR §1508.27). Intensity refers to the severity or extent of an impact, and context relates to the environmental conditions at the location of the impact. Impacts are characterized as short-term or long-term. Short-term impacts typically are those that would be temporary (e.g., lasting only during a construction period). Long-term impacts would be permanent or would persist for a majority of the operational life of the action or activity.

Impacts are characterized in this EA as:

Beneficial Impact – A minor to major positive impact to the human or natural environment that is perceptible, readily apparent, and would be expected to occur from implementation of the proposed project. The impact could be direct, indirect, short-term, or long-term in nature. Examples could include increased habitat quality, increased recreational opportunities, a reduction in air pollution, or a reduction in flooding potential under FWP conditions.

No Impact – No measurable beneficial or adverse impact to the human or natural environment would be expected to occur with implementation of the proposed project. Impacts would be considered as negligible, not perceptible, or not readily apparent. FWP resource conditions would be the same as those under FWOP conditions.

Less-than-Significant Impact – A minor to moderate adverse impact to the human or natural environment that is perceptible, readily apparent, and would be expected to occur from implementation of the proposed project. The impact could be direct, indirect, short-term, or long-term in nature. However, the impact would typically not exceed defined regulatory, policy, or permit thresholds. The impact would likely be within historical amounts, normal operating conditions, or what would be expected to occur naturally. Examples could include fluctuations in water levels that are within the normally observed range, shifts in habitat locations, or changes to boat ramp use under FWP conditions. Additional care in following standard procedures or applying precautionary measures to minimize adverse impacts may be required. Best management practices (BMPs) are typically used to help reduce potential minor to moderate adverse effects.

Significant but Mitigatable – A major adverse impact to the human or natural environment that would be perceptible, readily apparent, and would be expected to occur with implementation of the proposed project. The impact could be direct, indirect, short-term or long-term in nature. The impact would typically exceed defined regulatory, policy, or permit thresholds. Measurable changes in resource magnitude, duration, or extent that are outside of historical amounts, normal operating conditions, or natural occurrences. However, management actions or other mitigation measures can be put in place to reduce impacts to less-than-significant. Examples of impacts and associated mitigation include loss of forest habitat and plantings to restore acreages, use of a mitigation bank to restore lost wetland habitat, or construction of a levee to mitigate increased flood potential.

Significant – A major adverse impact to the human or natural environment with implementation of the proposed project actions, which may be direct, indirect, short-term, or long-term in nature. Given the context and intensity, the impact violates or exceeds regulatory or policy standards or otherwise exceeds an identified threshold. The significant impact cannot be mitigated with practical means to a level below significant. Projects with non-mitigatable significant impacts are more likely to require evaluation in an environmental impact statement.

Assessing the potential impact to most resources was completed based on the number of days lake elevation changes would occur under each alternative compared to Alternative 1 Federal No Action/FWOP. Some resources used measurable quantitative metrics such as acres, and other resources used qualitative assessments of the potential impacts. The metrics and a summary of the impacts for each resource are shown in Table 7-2.

Table 7-2. Summary of Stockton Lake Impact Assessments.

Resource	Metric	Alternative 1: Federal No Action/FWOP	Alternative 5: Multipurpose Pool	Alternative 7: Combination Multipurpose Pool and Flood Control Pool
Plan of Regulation (Section 7.2.1)	Stockton Lake Operations	No change.	90,200 AF from Multipurpose Pool to water supply storage.	45,700 AF from Multipurpose Pool/49,000 AF from Flood Control Pool to water supply storage.
Downstream Releases (Section 7.2.2)	Change in downstream flows, HEC-ResSim data	No change to downstream releases under the FWOP condition.	The magnitude, timing, and durations of downstream releases would result in minor changes under the FWP condition.	The magnitude, timing, and durations of downstream releases would result in minor changes under the FWP condition.
Physiography, Geology, and Topography (Section 7.3)	Change in Days of above normal, normal, and below normal lake elevations, HEC-ResSim data (Table 7-1)	No change to existing lake surface elevations or nonfederal easements.	Temporary, minor soil disturbance of soil and potential erosion during construction of a water intake structure. The new structure would be within an existing nonfederal easement. Impacts would be insignificant.	Possible increase in shoreline erosion from 1.8-feet rise in surface water elevation due to 7 additional days of inundation within 869.9 to 865 shoreline elevations. Temporary, minor soil disturbance of soil and potential erosion during construction of a water intake structure. The new structure would be within an existing nonfederal easement. Impacts would be insignificant.
Surface Water (Section 7.4.1)	Change in Days of above normal, normal, and below-normal lake elevations, HEC-ResSim data (Table 7-1)	No significant changes to above normal (26 days), normal (152 days), and below normal (187 days) surface water elevations are expected under the FWOP condition. Surface water covers 25,000 acres.	Minor benefits to flood risk (Section 5.4), increase in 52 days during below-normal conditions compared to the Federal No Action/FWOP Alternative. No change to the surface water coverage.	Pool level rise to an elevation of 868.8 feet remains within the normal lake elevations. Minor changes to the number of days above normal (1 day) and below normal (8 fewer days) would be insignificant. Surface water cover increases to 25,835 acres.
Groundwater / Aquifer (Section 7.4.2)	Qualitative	Under the FWOP condition, aquifer withdrawals may increase, resulting in reduced groundwater supplies.	No impacts or minor positive effects to groundwater by not relying on water from aquifers.	No impacts or minor positive effects to groundwater by not relying on water from aquifers.
Water Quality (Section 7.4.3)	Qualitative, data from seasonal water quality sampling	No significant changes to water quality are anticipated under the FWOP condition. Seasonally high levels of phosphorus, nitrogen, and lake chlorophyll will likely continue.	No significant changes to Stockton Lake water quality are anticipated under the FWP condition.	No significant changes to Stockton Lake water quality are anticipated under the FWP condition.
Aquatic Habitat (Section 7.4.4)	Change in days of above normal, normal, and below-normal lake elevations, HEC-ResSim data (Table 7-1)	Approximately 25,000 acres of aquatic habitat would naturally fluctuate under the FWOP condition.	Availability of year-round aquatic habitat along the shoreline may be reduced due to additional 52 below normal surface water elevation days. This is expected to be a very minor impact to available aquatic habitat.	A pool level raise could increase the availability of shoreline aquatic habitat by approximately 835 acres. One additional day of above normal surface water elevation would be an insignificant impact.
Wetlands (Section 7.4.6)	Acres of wetlands, USFWS NWI data	Approximately 375 acres of wetland habitat were identified around Stockton Lake. Natural fluctuations of quantity and quality will likely occur under the FWOP condition.	The addition of 52 more below-normal surface water elevation days a year has the potential to negatively impact wetlands; however, some impacts are expected to be beneficial while others may be adverse.	A 1.8-foot pool level raise would result in 1 additional above normal day and 8 fewer below-normal days, which would result in some beneficial impacts while others may be adverse.

Resource	Metric	Alternative 1: Federal No Action/FWOP	Alternative 5: Multipurpose Pool	Alternative 7: Combination Multipurpose Pool and Flood Control Pool
Wildlife Management Area (Section 7.4.5)	Change in days of above normal, normal, and below normal lake elevations; HEC-ResSim data (Table 7-1)	No significant changes to management conditions, waterfowl habitat, or shorebird habitat at the Aldrich Refuge are anticipated under the FWOP condition.	Minor effect. Fifteen additional days when the mudflat is dry and not at least partially inundated because of the extended period of below-normal surface water elevations, resulting in less feeding and habitat area for migratory waterfowl. During shorebird season, 21 more dry days of water, resulting in decreased quality and quantity of habitat for migratory shorebird species.	Minor effect. Reduce the number of dry mudflat days by 12 and increase the number of days with at least partial inundation for the waterfowl species. During the shorebird season, Alternative 7 would reduce the low-level inundation by 36 days and increase the deeper inundation by the same 36 days.
Floodplains (Section 7.4.7)	EO 11988 eight step decision process	No significant change to floodplains under the FWOP condition.	The future pipeline alignment from Stockton Lake to the sponsor's water treatment facility would likely occur within existing easements; potential floodplain effects would be mitigated through the regulatory permitting process.	The future pipeline alignment from Stockton Lake to the sponsor's water treatment facility would likely occur within existing easements; potential floodplain effects would be mitigated through the regulatory permitting process.
Land Use (Section 7.5.1)	Acres of land use types National Land Cover Database	No significant change to existing land acreages and uses would occur under the FWOP condition. Some future land development is anticipated around the lake over the next 50 years.	No significant change to existing land acreages and uses would occur under this FWP condition.	No significant change to existing land acreages and uses would occur under this FWP condition. Approximately 835 acres of additional shoreline area would be inundated more frequently with the pool raise alternative.
Terrestrial Habitat (Section 7.5.2)	Change in Days of above normal, normal, and below-normal lake elevations, HEC-ResSim data (Table 7-1)	No change to terrestrial habitat management under the FWOP condition.	No Significant effect. Temporary, minor impacts to grassland habitat at an existing utility easement would occur during construction of the intake structure.	No significant effect. Approximately 835 acres of shoreline area would be inundated 8 additional days per year. Temporary, minor impacts to grassland habitat at an existing utility easement would occur during construction of the intake structure.
Fish and Wildlife (Section 7.5.3)	Change in Days of above normal, normal, and below-normal lake elevations, HEC-ResSim data (Table 7-1)	No significant change to existing quality or quantity of fish and wildlife habitat would occur under the FWOP condition.	No significant effect. Temporary, minor impacts to grassland habitat and shoreline turbidity would occur during construction of the intake structure.	No significant effect. Approximately 835 acres of terrestrial shoreline would be inundated 8 additional days per year. Temporary, minor impacts to grassland habitat and shoreline turbidity would occur during construction of the intake structure.
Invasive Species (Section 7.5.4)	Qualitative	No significant changes to invasive species management would occur under the FWOP condition.	No significant change or effect to invasive species under the FWP condition.	No significant change or effect to invasive species under the FWP condition. Temporary, minor impacts would occur during construction of the intake structure would be avoided by using best management practices (BMPs) such as reseeding with native vegetation.
Threatened and Endangered Species (Section 7.6)	Change in days of above normal, normal, and below normal lake elevations, HEC-ResSim data (Table 7-1)	No change to T&E species or critical habitat would occur under the FWOP condition.	Minor changes to above normal (5 fewer) and below normal (52 more) inundation days may affect but are not likely to adversely impact T&E species or critical habitat.	Minor changes to above normal (1 day) and below normal (8 fewer) inundation days may affect but not likely to adversely impact T&E species or critical habitat.

Resource	Metric	Alternative 1: Federal No Action/FWOP	Alternative 5: Multipurpose Pool	Alternative 7: Combination Multipurpose Pool and Flood Control Pool
Cultural Resources (Section 7.7)	Change in days of above normal, normal, and below normal lake elevations, HEC-ResSim data (Table 7-1)	549 identified sites at Stockton Lake. Baseline above (26 days) and below (187 days) normal water days. No change to known and unknown cultural resources under the FWOP condition.	An increase in 52 below-normal water level days could increase exposure of cultural sites that are usually inundated or difficult to access to increased wave action, erosion, and looting potential.	An increase in 1 above-normal water day and 8 fewer below-normal days will have negligible impact compared to Alternative 1 Federal No Action/FWOP.
Air Quality (Section 7.8)	Qualitative, based on NAQS standards	No change to regional air quality would occur under the FWOP condition.	Possible minor increases in pollutants if lost energy production from hydropower is replaced by coal or gas fired plants.	Possible minor increases in pollutants if lost energy production from hydropower is replaced by coal or gas fired plants.
Recreation (Section 7.9)	Change in days of above normal, normal, and below normal lake elevations, HEC-ResSim data (Table 7-1)	Baseline days of above normal (26 days), normal (152 days), and below-normal (187 days) lake elevations would continue under the FWOP condition. Some closure currently occurs in the baseline condition.	Minor adverse impacts to the Greenfield, Cedar Ridge (east ramp), and High Point boat ramps and docks due to 52 additional days of below-normal lake elevations.	Minor positive impact to recreational use from 7 more days at normal lake elevation and 8 fewer days at below-normal elevation.
Socioeconomic Conditions (Section 7.10)	Qualitative, See Section 4.9 for baseline demographics	Normal changes in regional population demographics and income are expected under the FWOP condition.	Minor benefits to reduced flood risk; possible minor adverse impact to revenue if hydropower is reduced. See recreation Section 7.9 for additional impacts.	Insignificant impact to flood risk from 1 additional day above normal lake elevations. Possible minor adverse impact to revenue if hydropower is reduced. See recreation Section 7.9 for additional impacts.
Environmental Justice (Section 7.11)	See Section 4.10 for baseline data	Low-income populations in Cedar, Dade, and Polk Counties would not be disproportionately affected under the FWOP condition.	Minor changes to Stockton Lake surface water elevations would not disproportionately affect low-income populations in Cedar, Dade, and Polk Counties.	Minor changes to Stockton Lake surface water elevations would not disproportionately affect low-income populations in Cedar, Dade, and Polk Counties.
Hazardous, Toxic, and Radioactive Waste (Section 7.12)	EDR background database search (Appendix J)	No significant changes to existing hazardous, toxic, and radioactive waste (HTRW) sites would occur under the FWOP condition.	No adverse impacts to existing HTRW sites would occur with minor changes to Stockton Lake surface water elevations under the FWP condition.	No HTRW sites were identified within the proposed 1.8-foot pool raise contours. Therefore, no effects to HTRW.
Aesthetics (Section 7.13)	Change in days of above-normal, normal, and below-normal lake elevations, HEC-ResSim data (Table 7-1)	Baseline surface water elevations and water releases would occur under the FWOP condition.	Minor adverse impacts to lake aesthetics could occur due to 52 additional days below-normal lake elevations. Exposure of mudflats, woody debris, and additional shoreline may not be aesthetically appealing.	Minor benefit to lake aesthetics due to 7 additional days at normal lake elevation and 8 fewer days at below-normal lake elevation.
Noise (Section 7.14)	Qualitative - temporary construction	No Effect	Minor adverse. Temporary, minor impacts from additional noise during construction of intake.	Minor adverse. Temporary, minor impacts from additional noise during construction of intake.
Climate Change (Section 7.15)	Qualitative Climate Change Study (Appendix D)	Climate changes studies for the region indicate the likelihood for more intense droughts and floods in the future.	Possible temporary, minor inputs of hydrocarbons s from construction-related equipment associated the proposed water intake structure.	Possible temporary, minor inputs of hydrocarbons from construction related equipment associated the proposed water intake structure.

Resource	Metric	Alternative 1: Federal No Action/FWOP	Alternative 5: Multipurpose Pool	Alternative 7: Combination Multipurpose Pool and Flood Control Pool
Flood Risk Management (Section 7.16)	Qualitative	Baseline flood risk management would continue	Minor beneficial impact due to lower lake elevations, leaving additional storage space for flood control.	No change in the percent of time the downstream gage is at or above moderate flood stage, which is 19 feet at the Caplinger Mills gage.
Hydropower Generation (Section 7.17)	Quantitative	Hydropower generation would occur as typical under the base condition.	Hydropower Benefits Forgone $200,000 average annual over the 50-year period of analysis using the FY2019 federal interest rate of 2.875%	Hydropower Benefits Forgone $242,000 average annual over the 50-year period of analysis using the FY2019 federal interest rate of 2.875%
Real Estate (Section 7.18)	Qualitative	No change to existing federal fee parcels or flowage easements.	No change to existing federal fee parcels or flowage easements.	No change to existing federal fee parcels or flowage easements because pool raise is still within the confines of federal fee parcels.

7.1. Project Setting

The project setting is described in Section 4.1, which includes Figure 4-1 showing Stockton Lake and project area. None of the proposed alternatives would impact the project setting of Stockton Lake.

7.2. Lake Operations

7.2.1. Plan of Regulation

The plan of regulation is described in Section 4.2.1.

Alternative 1 Federal No Action/FWOP

Under the Federal No Action/FWOP alternative, no changes to existing water management operations would occur, resulting in no change to the plan of regulation over the FWOP condition.

Alternative 5 Multipurpose Pool Reallocation

The reallocation from the multipurpose pool is expected to have no impact on the plan of regulation because the plan does not include increasing the normal pool elevation from 867 feet NGVD 29.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

Multipurpose operations currently defined by the lake at or below elevation 867 NGVD 29 would be increased 1.8 feet to elevation 868.8 feet NGVD 29. As indicated in Section 5.3, this would increase the gross volume of storage available to water supply while mitigating against the effects of mild and severe droughts to other authorized purposes, with no significant negative impacts to flood control operations.

Other than working to this new, elevated multipurpose elevation, the pool raise would not alter how SWPA administers power operations within the multipurpose pool. The pool raise would not alter operations that provide minimum water quality releases during periods when Stockton Dam is not generating hydropower.

Water supply withdrawals would continue to occur on an as-needed basis from construction of a new water intake structure on the lake and would not affect hydropower or water quality operations. The existing water intake operated by City Utilities would be operated in parallel with the new water intake to accommodate withdrawals by Tri-State.

The pool raise would require that the projects' water control manual be updated to reflect the changes in multipurpose and flood pool elevations and allocations.

Flood control operations will now go into effect as the lake rises above elevation 868.8 feet NGVD 29. The upper limit of flood control storage remains unchanged at elevation 892 feet NGVD 29. As analyzed in Section 5.3, the flood control allocation remains divided into three horizontal zones/phases, unchanged from what is presented in Figure 4-2 of Section 4.2.1. The results presented in Section 5.3 demonstrate that the current demarcation lines remain a viable means to manage flood control storage even after incorporating the pool raise.

Other than reducing the total volume of available flood storage, the pool raise would not impact district water management daily coordination with SWPA would be conducted to manage flood storage. The projects' water control manual would need to be updated, as mentioned above.

Surcharge storage and operations are unaffected by the proposed pool raise.

7.2.2. Downstream Releases

Existing downstream releases are described in Section 4.2.2.

Alternative 1 Federal No Action/FWOP

Under the Federal No Action/FWOP alternative, there would be no changes to downstream releases over the FWOP condition.

Alternative 5 Multipurpose Pool Reallocation

The reallocation from the multipurpose pool is expected to have little to no impact on the downstream releases because the project will operate for hydropower generation and maintaining low flow releases for downstream benefits.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

Following the pool raise, when the lake is at or below multipurpose, elevation 868.8 feet NGVD 29, releases from Stockton Dam will be attributable either to hydropower generation or to water quality minimum releases. Results presented in Section 5.3 demonstrate no significant change in downstream releases or the impacts to flow and stage downstream, indicating no significant environmental consequences.

When the lake rises into flood storage, above elevation 868.8 feet NGVD 29, water releases cannot exceed the maximum limit based upon the Phase I, II, and III operations occupied. Water releases are further constrained and cannot exceed flow criteria limits at downstream gage locations. The results presented in Section 5.3 indicate no significant change in downstream releases or human and environmental resources.

7.3. Physiography, Geology, and Topography

The physiography, geology, and topography affected environment is described in Section 4.3.

Alternative 1 Federal No Action/FWOP

No significant effects to physiography, geology, and topography would occur as a result of implementing the Federal No Action/FWOP alternative. Varying levels of soil erosion would likely persist at Stockton Lake because of future development of campgrounds and marinas under the FWOP condition. Future development would require soil disturbance, vegetation removal, and transformation of pervious surfaces into impervious areas. This promotes erosion during construction activities and increased surface water runoff after development is completed. In addition, remaining pervious surfaces around developed areas would likely become more impervious because of increased foot traffic from recreational activity. This type of potential future development would likely occur under all FWOP and FWP conditions. Low-density public use activities, such as primitive camping, fishing, hunting, trails, and wildlife viewing, would continue with all alternatives. Additional shoreline use permits for docks, trails, and other similar amenities that could result in vegetation removal, topographic changes, increased impervious substrates, or soil disturbances would continue to be assessed and permitted on a case-by-case basis. Existing land and vegetation regulations would remain unchanged under all alternatives.

Alternative 5 Multipurpose Pool Water Reallocation

Water reallocation from the multipurpose pool would result in no change to the normal lake surface elevation under the FWP condition; however, 5 fewer days of above-normal and 52 additional days of below-normal surface water elevations would be expected. Water reallocation from the multipurpose pool would be the same as the FWOP condition. This alternative would have an insignificant impact on the physiography, geology, and topography compared to the Federal No Action/FWOP alternative.

Minor increases in soil disturbances would occur under this alternative during construction of the new water intake structure. The soil impacts would be considered minor during construction. There would be no direct long-term changes to soil around the lake with implementation of Alternative 5.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

Water reallocation from a combination of flood and multipurpose pools would result in an approximate 1.8 feet rise to the normal surface water elevation at Stockton Lake. Alternative 7 would be similar to the FWOP condition, with only 1 additional day above-normal lake surface water elevation and 8 fewer days below-normal lake surface water elevation. This alternative would have an insignificant impact on the physiography, geology, and topography as compared to the Federal No Action/FWOP alternative.

Minor increases in soil disturbances would occur under this alternative during construction of the new water intake structure. The soil impact would be minor during construction. There would be no direct long-term changes to soil around the lake with implementation of Alternative 7.

7.4. Water Resources

7.4.1. Surface Water

The surface water affected environment is described in Section 4.4.1.

Alternative 1 Federal No Action/FWOP

Under the Federal No Action/FWOP alternative, no changes to existing water management operations would occur, resulting in no change to variability of surface water levels at Stockton Lake over the FWOP condition. The pool elevations for the Federal No Action/FWOP and the action alternatives are shown in Table 7-1.

Alternative 5 Multipurpose Pool Water Reallocation

Water reallocation from the multipurpose pool would result in 5 fewer days of above-normal surface water elevations (Table 7-1), indicating that there could be minor benefits associated with flood risk management (i.e., less total days of above-normal lake conditions). There would be 47 fewer normal lake surface water elevation days (Table 7-1) under the FWP condition, indicating that there could be minor impacts to lake infrastructure because of lower lake elevations (see Section 7.9 for recreation/infrastructure discussion). There would be 52 more below-normal surface water elevation days, indicating that this alternative would increase the number of low water days during drought conditions.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

Water reallocation from a combination of flood and multipurpose pools would result in an approximate 1.8-foot pool raise to the normal lake surface elevation, which is within the normal pool elevations shown in Table 7-1. This alternative would stabilize the pool levels to closely match the water level fluctuations experienced in the FWOP condition and cause the lake levels to be within the normal range 7 additional days. HEC-ResSim modeling indicates that the tributary stream flows would not be significantly changed from the FWOP condition. Lake operations and downstream releases and flows are discussed in Section 4.2.

7.4.2. Groundwater/Aquifer

The groundwater/aquifer affected environment is described in Section 4.4.2.

Alternative 1 Federal No Action/FWOP

Aquifer recharge occurs as precipitation infiltrates the ground in upland areas and percolates to the water table. Groundwater flow paths are defined by small-scale topographic features where flow occurs from elevated areas to valley floors terminating in small stream systems. Groundwater storage in these aquifers is influenced by fractures and faults.

The FWOP groundwater conditions at Stockton Lake are not expected to significantly change with implementation of the Federal No Action/FWOP alternative. Lake operations would remain the same, resulting in no change to current groundwater seepage amounts, flows, and aquifer recharge rates. It is

assumed that without additional water supply, groundwater withdrawals may increase to meet future needs under the FWOP condition, which could reduce existing aquifer levels.

Alternative 5 Multipurpose Pool Water Reallocation

The reallocation from the multipurpose pool is expected to have a beneficial impact on groundwater levels since the additional water supply would be pulled from the Stockton Lake pool as opposed to the aquifers.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

Similar to Alternative 5, reallocation from the combination of multipurpose and flood control pools is expected to have a beneficial impact on groundwater levels by avoiding potential additional water supply from aquifers. The 1.8 feet of pool level rise at Stockton Lake is not expected to impact current seepage amounts, groundwater flows, or aquifer recharge rates.

7.4.3. Water Quality

The water quality affected environment is described in Section 4.4.3.

Alternative 1 Federal No Action/FWOP

Stockton Lake pool fluctuations associated with precipitation events, tributary inflows, power production, water supply, and flood control procedures result in variable surface water elevations and shoreline inundation levels. Changes in water elevation along with prevailing winds, surface water runoff, and wave action result in variable shoreline erosional zones, which can increase sedimentation and turbidity at Stockton Lake. Turbidity and sedimentation can also increase at Stockton Lake for short periods from heavy upstream precipitation events. During these periods, surface water runoff and tributary inputs can also contribute additional phosphorous, nitrogen, and other constituents to the lake. Implementation of the Federal No Action/FWOP alternative would not result in changes to the existing watershed drainage patterns or subsequent effects to existing lake water quality. Seasonally high levels of phosphorous, nitrogen, and lake chlorophyll that are above MoDNR nutrient screening thresholds would likely continue in the future. Impaired water body status from exceeding MoDNR Nutrient Criteria for chlorophyll-a concentration could eventually occur from the eutrophication process.

The potential for residential development around Stockton Lake under the FWOP condition would likely have short- and long-term negative impacts to Stockton Lake water quality because of the potential for increased erosion, localized increases in turbidity and sedimentation, and additional inputs of chemicals associated with residential and recreational-related properties. However, there are no known plans for additional residential development currently.

As discussed in Section 7.9, it is likely that modifications and development to existing campgrounds, marinas, and similar infrastructure would continue in the future, resulting in project-specific erosion during construction, increased impermeable surfaces, and increased surface water runoff. Low-density public use activities, such as primitive camping, fishing, hunting, trails, and wildlife viewing, would continue with all alternatives. Additional shoreline use permits for docks, trails, and other similar amenities that could result in vegetation removal, topographic changes, increased impervious substrates, or soil disturbances would continue to be assessed and permitted on a case-by-case basis.

Alternative 5 Multipurpose Pool Water Reallocation

There would be no effect to water quality by reallocation of water storage from the multipurpose pool.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

There would be no effect to water quality from a 1.8-foot pool raise and reallocation of water storage from the combined multipurpose pool and flood control pool.

7.4.4. Aquatic Habitat

The existing aquatic habitat potential affected environment is described in Section 4.4.4.

Alternative 1 Federal No Action/FWOP

The aquatic resources associated with Stockton Lake would not undergo a significant change under the FWOP condition due to implementation of the Federal No Action/FWOP alternative. No changes to the current operation of Stockton Lake would occur that could impact the existing quality and quantity of aquatic habitat within Stockton Lake, in associated upstream tributaries, and downstream of the lake. The quality and quantity of aquatic habitat within the study area would continue to vary over time with seasonal changes, watershed development, and habitat management objectives.

Alternative 5 Multipurpose Pool Water Reallocation

Water reallocation from the multipurpose pool would result in 5 fewer above-normal, 47 fewer normal, and 52 additional days below-normal lake surface water elevation days (Table 7-1). The total amount of available shoreline or littoral habitat available at Stockton Lake would be less under the Alternative 5 FWP condition compared to the FWOP condition. A minor negative impact to aquatic shoreline habitat would be expected from the 52 additional days of below-normal surface water levels during drought conditions. Although the shoreline would be drier more often, the loss of habitat at the shoreline is within the normal fluctuations of the lake. However, no significant impacts to aquatic species that rely on shoreline/littoral habitat are anticipated upstream, downstream, or within Stockton Lake.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

The 1.8 feet rise in water surface elevation associated with the combination multipurpose and flood control pool reallocation would result in lake elevations with 7 additional days in the normal range, thus providing a permanent and beneficial effect to aquatic habitat. The total amount of available shoreline or littoral habitat available at Stockton Lake would increase under the Alternative 7 FWP condition compared to the FWOP condition. The variability in surface water elevations would be within the range of normal lake operations that have occurred over the 62-year period of record. A minor positive impact to aquatic shoreline habitat would be expected from the 1.8 feet rise in surface water levels during normal conditions. Although the shoreline would be wet more often, the beneficial impacts are within the normal fluctuations of the lake. No significant impacts to aquatic species that rely on shoreline/littoral habitat are anticipated upstream, downstream, or within Stockton Lake.

7.4.5. Wildlife Management Area

Alternative 1 Federal No Action/FWOP

Semipalmated Sandpiper.

The Aldrich Refuge is unique in that it provides large shallow water mudflats that are attractive to migratory shorebird species during the spring and summer months. Numerous shoreline birds feed on naturally occurring plankton and bloodworms in the mudflats. Inundated mudflats during the fall and winter months also provide habitat for migratory waterfowl species. The focus is on waterfowl species, such as dabbling ducks, that prefer feeding on moist soil plants. The Aldrich Refuge is operated by MDC. No changes to the current operations and management of the Aldrich Refuge are anticipated under the FWOP condition. The Aldrich Refuge location is shown in Figure 7-1. Table 7-3 shows the lake elevations when the Aldrich Refuge is too deep, optimal, and dry for the effective use of the refuge.

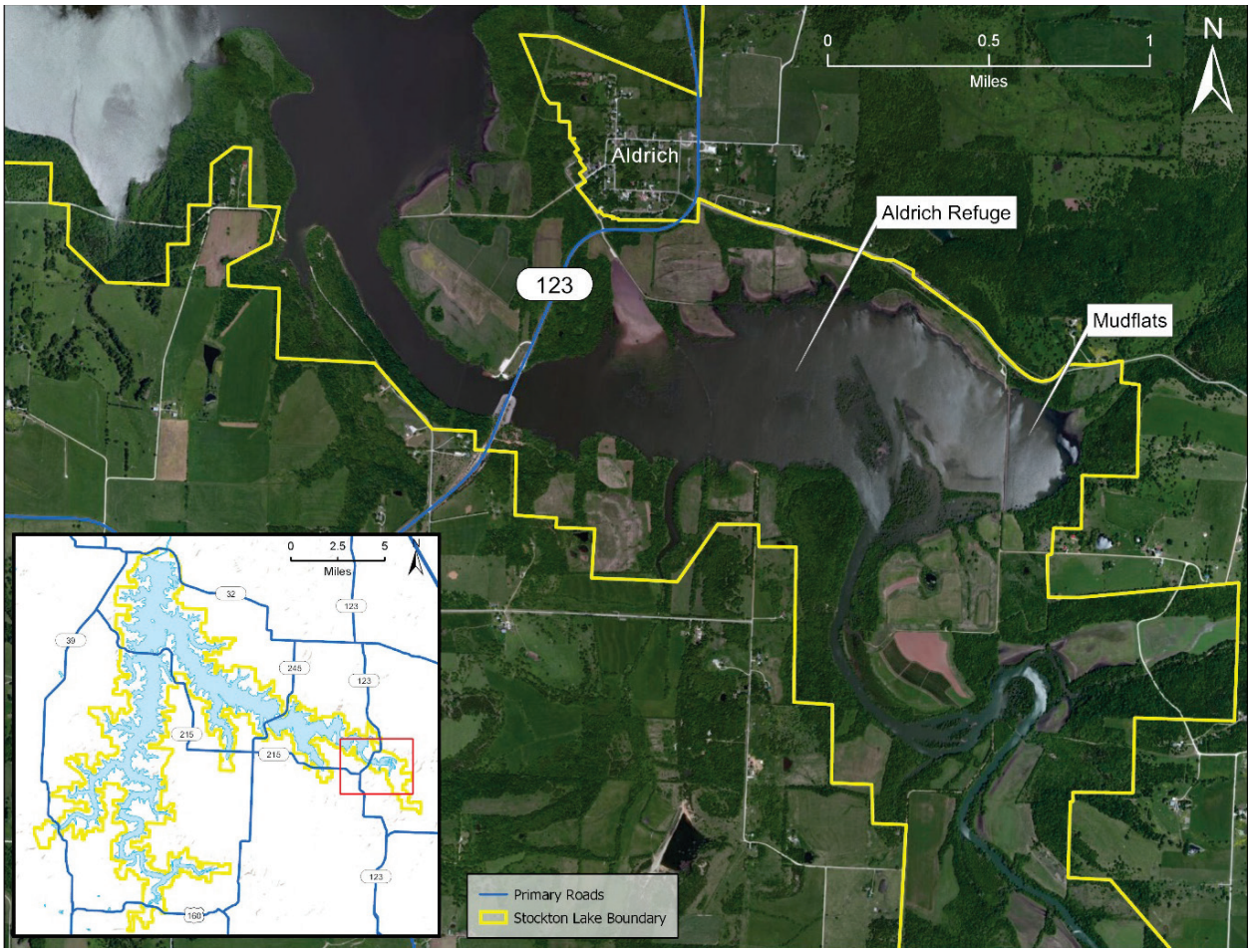


Figure 7-1. Location of Aldrich Refuge and Associated Wetlands/Mudflats at Stockton Lake.

Table 7-3. Comparison of Wetland and Mudflat Elevations at Aldrich Refuge.

Elevation	Management Impact	Alternative 1 Federal No Action/FWOP		Alternative 5 Multipurpose Pool			Alternative 7 Combination Multipurpose Pool and Flood Control Pool		
Feet	N/A	% Time of Year	Days/yr	% Time of Year	Days/yr	Net Change (No. of Days)	% Time of Year	Days/yr	Net Change (No. of Days)
Management Season (April thru September)									
>=869	Fully inundated, no management can occur	*12%*	*21*	*9%*	*17*	*-4*	*12%*	*22*	*1*
866-868	Partially inundated, portion can be managed	*34%*	*63*	*22%*	*41*	*-22*	*17%*	*32*	*-31*
866-867	Partially inundated, portion can be managed	*27%*	*50*	*18%*	*33*	*-17*	*9%*	*17*	*-33*
<=866.0	Not inundated, all of refuge can be managed	*52%*	*95*	*67%*	*122*	*28*	*50%*	*91*	*-4*
Waterfowl Season (October thru March)									
>872	No habitat, depths > 3 ft	3%	5	2%	4	-1	3%	6	2
866-872	Partial habitat at 3 ft	26%	49	19%	34	-14	32%	59	11
866-871	Partial habitat at 2-3 ft	25%	47	18%	33	-13	31%	58	11
866-870	Partial habitat at 1-3 ft	24%	45	17%	31	-14	30%	55	10
866-869	Max habitat at 1-3 ft	23%	43	16%	30	-13	27%	51	8
866-868	Partial habitat at 1-2 ft	21%	39	15%	28	-12	15%	27	-12
866-867	Partial habitat at 1 ft	15%	28	11%	20	-8	7%	12	-16
<=866.0	No habitat, dry	71%	133	80%	148	15	65%	121	-12
Shorebird Season (April thru September)									
866-870.5	No habitat, depths > 1ft	39%	71	26%	47	-24	42%	76	5
866-870	Partial habitat at 1 ft	38%	70	25%	46	-24	41%	75	5
866-869.5	Partial habitat at 0.5-1 ft	37%	68	25%	45	-23	40%	73	4
866-869	Max habitat at 0.1-1 ft	36%	67	24%	44	-23	38%	70	3
866-868.5	Max habitat at 0.1-1 ft	36%	65	23%	42	-23	25%	45	-20
866-868	Max habitat at 0.1-1 ft	34%	63	22%	41	-22	17%	32	-31
866-867.5	Max habitat at 0.1-1 ft	33%	60	21%	39	-21	13%	24	-36
866-867	Max habitat at 0.1-1 ft	27%	50	18%	33	-17	9%	17	-33
866-866.5	Partial habitat at 0.1-0.5 ft	8%	15	6%	11	-4	4%	8	-7
<=866.0	No habitat, dry	52%	95	67%	122	28	50%	91	-4

Values are based on average annual days over the period of record from 1950 to 2012.

During the operational management season, dry mudflat conditions are preferred for seeding, planting, and other wetland maintenance activities.

During the October-March migratory season, the refuge provides optimal waterfowl habitat when elevations from 866-869 are inundated at 1-3 feet depths. During higher water pools above 869, optimal habitat is reduced due to depths greater than 3 feet; likewise, at lower water pools below 866, no habitat is inundated.

During the April-September migratory season, the refuge provides optimal shorebird habitat when water elevations are inundated at 0.1 to 1.0 ft depths between elevations 866-869. As water elevations increase or decrease, the amount of optimal habitat also changes. Water depths above 1.0 feet reduces habitat availability because the water is too deep; and water depths below 866 do not provide habitat because the refuge is dry.

Net Change equals the change in the number of average annual days between the No Action alternative and action alternatives.

Alternative 5 Multipurpose Pool Water Reallocation

During management season months when the lake elevations are naturally lower, 27 additional days at below-normal lake elevations would help provide MDC the ability to sow moist soil plants in the Aldrich Refuge flats. However, during the waterfowl migratory season when 3-foot inundation is ideal, this alternative would have 14 less days when the mudflat is dry and not at least partially inundated due to the extended period of below-normal surface water elevations resulting in less feeding and habitat area for migratory waterfowl.

During the shorebird season a half foot inundation is preferred. Alternative 5 has 28 more dry days and loses a like amount of days from when the lake elevations would have 0.5 to 1.5 feet of water (elevations 866 to 867.5 feet NGVD 29) resulting in decreased quality and quantity of habitat for migratory shorebird species.

Minor impacts are expected to the management season of the Aldrich Refuge flats and the waterfowl and shorebird seasons within the wildlife management area within Stockton Lake.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

Wetter and higher summer lake levels reduce the opportunity for MDC to sow moist soil plants across the Aldrich Refuge mudflats by 4 days when MDC would not be able to manage the quality vegetation as a food source for migratory birds. However, Alternative 7 would reduce the number of dry mudflat days by 12 and increase the number of days with at least partial inundation for the waterfowl species.

During the shorebird season, Alternative 7 would reduce the low-level inundation of 0.5 to 1.5 feet (elevations 866 to 867.5 feet NGVD 29) by 36 days and increase the deeper inundation by the same 36 days. This will result in some areas of the Aldrich Refuge mudflats and moist soil vegetation being too deep for shorebirds to utilize them as a food source. When the lake levels are too deep for the shorebirds to feed from the beneficial, high-quality plantings at the bottom of the mudflats, the shoreline would be available for the shorebirds to feed, but they would forage from a lower-quality food source.

Minor impacts are expected to the management season of the Aldrich Refuge flats and the waterfowl and shorebird seasons within the wildlife management area within Stockton Lake.

7.4.6. Wetlands

The existing wetlands affected environment is described in Section 4.4.6.

Alternative 1 Federal No Action/FWOP

The USFWS NWI indicates there are approximately 375 acres of wetlands, while the NLCD indicates there are 895 acres occurring throughout the adjacent federal property surrounding Stockton Lake. The NWI indicates the majority of this wetland acreage is classified as palustrine forested, either seasonally or temporarily flooded. The NLCD has emergent and woody wetlands evenly split. For this analysis, the NWI data set was slightly more reliable relative to accuracy of actual wetlands around Stockton Lake, but both acreages are presented and discussed. The location of NWI wetland areas are relatively limited throughout the adjacent federal property surrounding the lake and would not undergo any significant change under FWOP conditions because of implementation of the Federal No Action/FWOP alternative. Normal seasonal and yearly lake surface water elevation fluctuations would continue to influence the quality and quantity of existing wetlands around the lake.

Alternative 5 Multipurpose Pool Water Reallocation

Under Alternative 5, Stockton Lake water surface elevations would continue to fluctuate by season and year with variations in precipitation, surface runoff, and tributary inflows as seen in Figure 7-1. Identified wetland sites would generally receive 5 fewer days at flood water elevations, 47 fewer days at normal pool elevations, and 52 additional days at below-normal elevations (Table 7-1) over the period of record

compared to the FWOP condition. The wetlands would face minor adverse impacts as the drier conditions and soils along the shoreline are less conducive for wetlands. The wetlands would also have minor beneficial impacts as the periods of lower lake levels would provide opportunities for wetlands to expand into areas that were previously too deep for wetlands. Minor beneficial and adverse effects to approximately 12.52 acres of existing wetlands would be expected according to the NWI data, and 34.79 acres of existing wetlands would be expected using the NLCD data, with the implementation of the Alternative 5, which would vary by year, season, and month under the FWP condition. The actual impacted areas are likely somewhere between these two data sources and as noted, some impacts are expected to be beneficial while others may be adverse.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

Under Alternative 7, Stockton Lake water surface elevations would continue to fluctuate by season and year with variations in precipitation, surface runoff, and tributary inflows as seen in Table 6-1. Alternative 7 would result in 1 additional day above normal, 7 additional days at normal, and 8 fewer days below normal pool elevations.

Between the Federal No Action/FWOP alternative and Alternative 7, FWP contour elevations 867 to 868.8 feet NGVD 29, an initial estimate of approximately 26.6 acres (NWI data) and 129.59 acres (NLCD data) of emergent/forested wetland habitat was identified through review of NWI/NLCD land use classifications. The study team compared the U.S. Department of Agriculture Soil Surveys versus the impacted wetland areas to confirm the presence or absence of soils suitable for wetland sites at Stockton Lake to refine the estimated acreage of wetlands impacted. Figures 7-2 through 7-9 show the locations of identified wetland habitat within contour elevations 867 and 868.8 feet NGVD 29 having suitable wetland soils. Following the detailed assessments, NWI/NLCD land use estimated acreages were adjusted to approximately 12.52 acres (NWI data) and 34.79 acres (NLCD data). Many of the wetland areas that were originally identified through NWI/NLCD land use mapping consist of rocky shorelines, within-lake islands, and littoral areas of Stockton Lake. Detailed descriptions of confirmed wetland areas are provided below. This evaluation does not include potential effects to wetlands and mudflats at the Aldrich Refuge, which was analyzed separately (Section 7.4.5).

Wetland Area 1 – Wetland Area 1 is located along Turnback Creek as it enters Stockton Lake (Figure 7-2). This wetland area consists of 5.38 acres of woody wetlands and 13.70 acres of emergent herbaceous wetlands, according to NLCD data, totaling 19.08 acres. The NWI database identifies a total of 6.92 acres entirely of freshwater forested/shrub wetlands in Wetland Area 1.

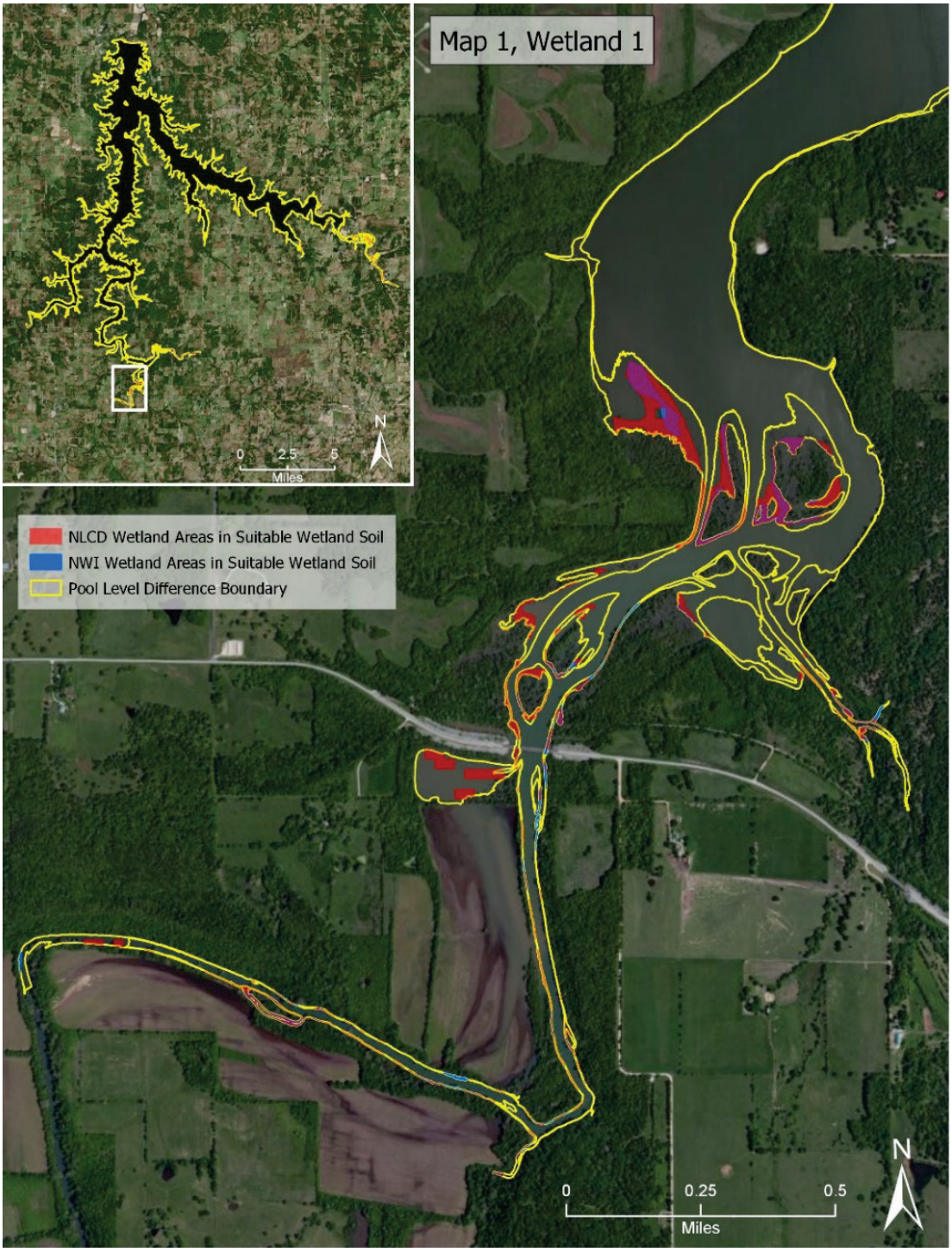


Figure 7-2. Wetland Area 1 along Turnback Creek.

Wetland Area 2 – Wetland Area 2 is located along the Sac River as it enters Stockton Lake (Figure 7-3). This wetland area consists of 4.10 acres of woody wetlands and 2.46 acres of emergent herbaceous wetlands, according to NLCD data, totaling 6.56 acres. The NWI database identifies a total of 3.46 acres consisting of 3.42 acres of freshwater forested/shrub wetlands and 0.04 acres of freshwater emergent wetlands in Wetland Area 2.

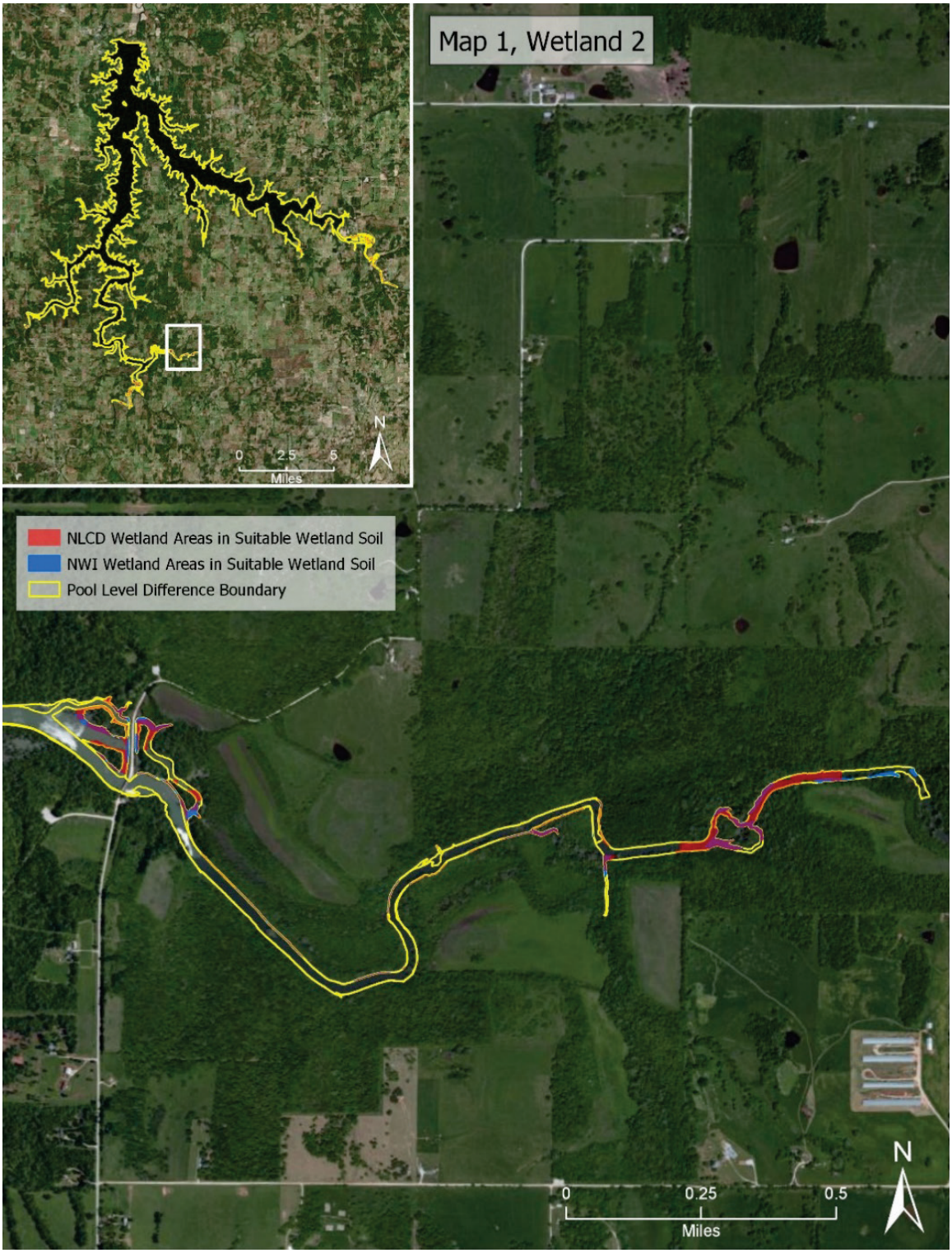


Figure 7-3. Wetland Area 2 along the Sac River.

Wetland Area 3 – Wetland Area 3 is located along the Sons Creek as it enters Stockton Lake (Figure 7-4). This wetland area consists of 0.56 acres of woody wetlands and less than 0.01 acres of emergent herbaceous wetlands, according to NLCD data, totaling 0.56 acres. The NWI database identifies a total of 0.79 acres consisting entirely of freshwater forested/shrub wetlands in Wetland Area 3.

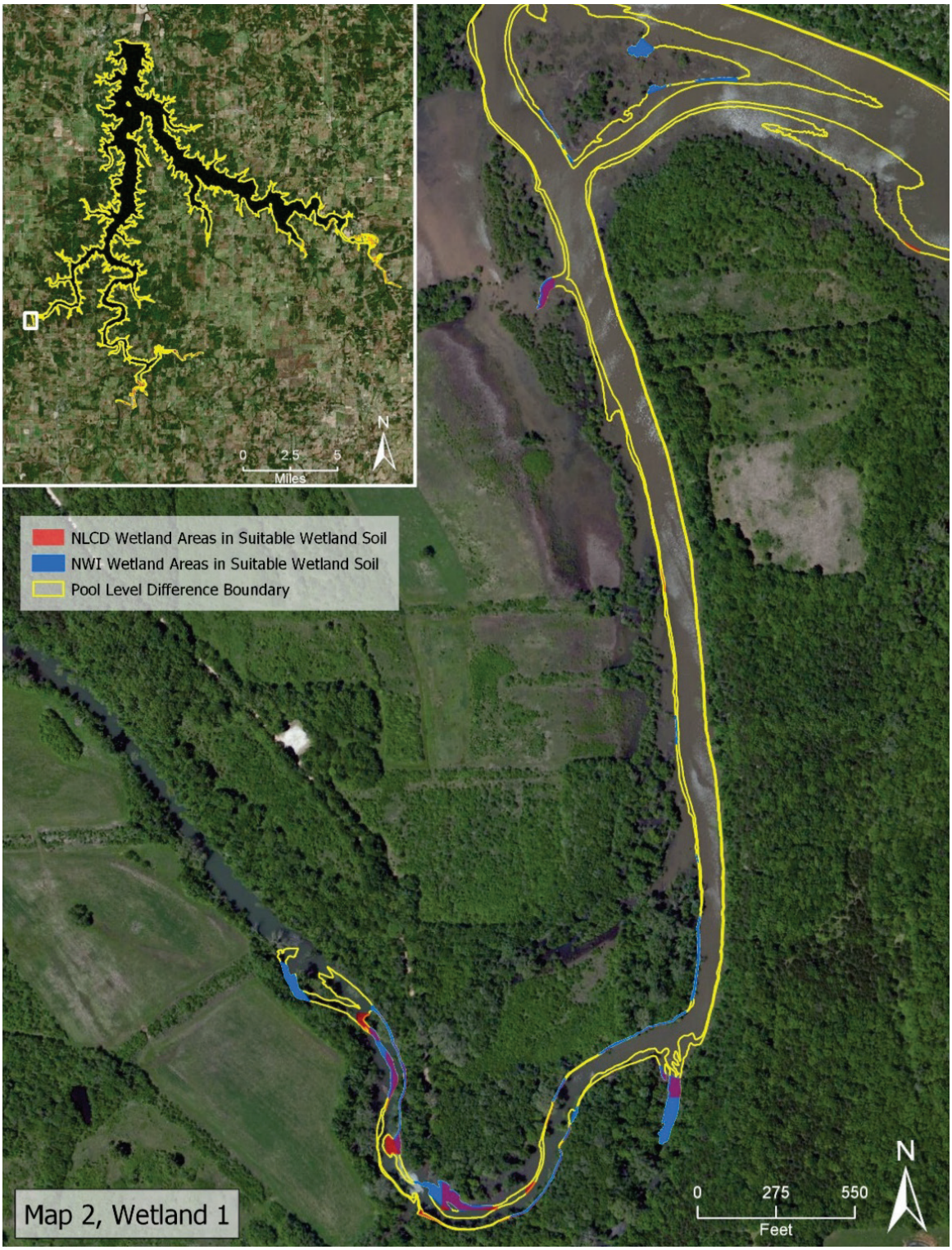


Figure 7-4. Wetland Area 3 along Sons Creek.

Wetland Area 4 – Wetland Area 4 is located along the Little Sac River as it enters Stockton Lake (Figure 7-5). This wetland area consists of 4.89 acres of woody wetlands and 0.97 acres of emergent herbaceous wetlands, according to NLCD data, totaling 5.86 acres. The NWI database identifies a total of 1.35 acres consisting of 1.29 acres of freshwater forested/shrub wetlands and 0.06 acres of freshwater emergent wetlands in Wetland Area 4.

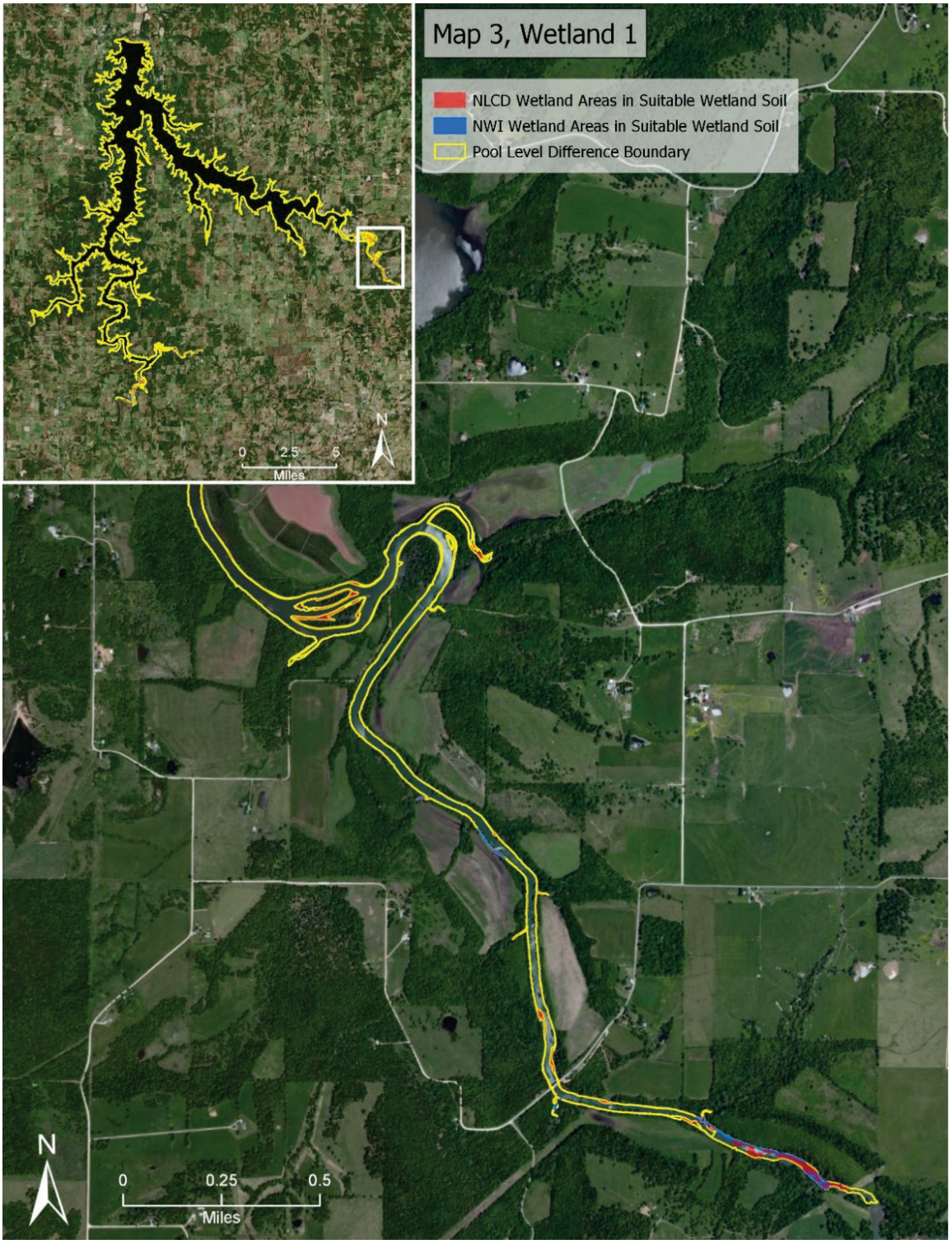


Figure 7-5. Wetland Area 4 along the Little Sac River.

Wetland Area 5 – Wetland Area 5 is located along the northwestward-facing shoreline west of Highway 123 (Figure 7-6). This wetland area consists of 0.12 acres of woody wetlands and 0.88 acres of emergent herbaceous wetlands, according to NLCD data, totaling 1.00 acre. The NWI database does not identify any wetlands in Wetland Area 5.

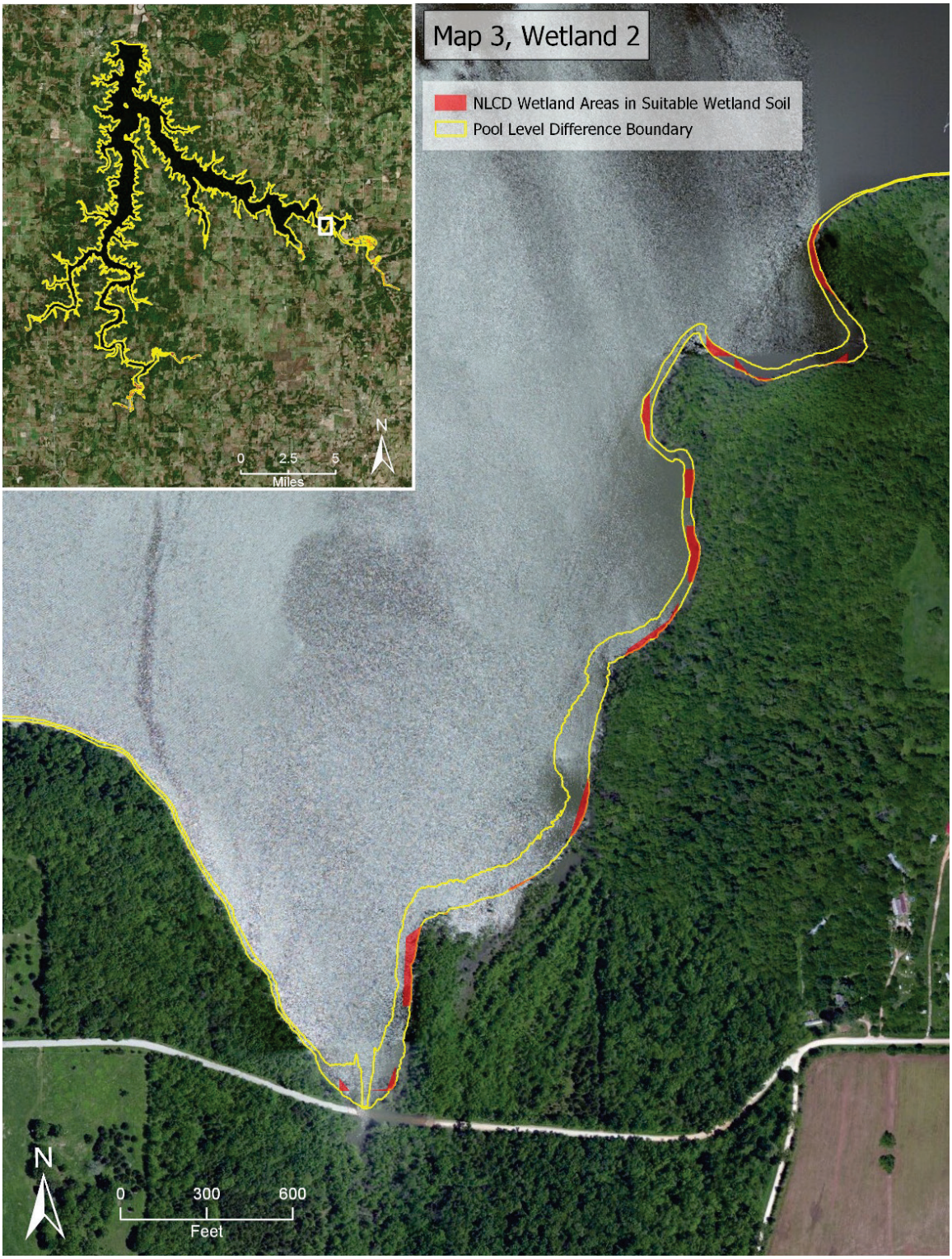


Figure 7-6. Wetland Area 5 along Stockton Lake Shoreline West of Highway 123.

Wetland Area 6 – Wetland Area 6 is located along Turkey Creek as it enters Stockton Lake and includes the northwestward-facing shoreline (north of the Highway 215 bridge) and the northward-facing shoreline about 1.25 miles northwest of the Highway 215 bridge by direct-line distance (Figure 7-7). This wetland area consists of 0.45 acres of woody wetlands and 0.92 acres of emergent herbaceous wetlands, according to NLCD data, totaling 1.37 acres. The NWI database does not identify any wetlands in Wetland Area 6.

Figure 7-7. Wetland Area 6 along Turkey Creek.

Wetland Area 7 – Wetland Area 7 is located along the Hawker Branch as it enters Stockton Lake. (Figure 7-8). This wetland area consists of 0.13 acres of woody wetlands and 0.14 acres of emergent herbaceous wetlands, according to NLCD data, totaling 0.27 acres. The NWI database does not identify any wetlands in Wetland Area 7.

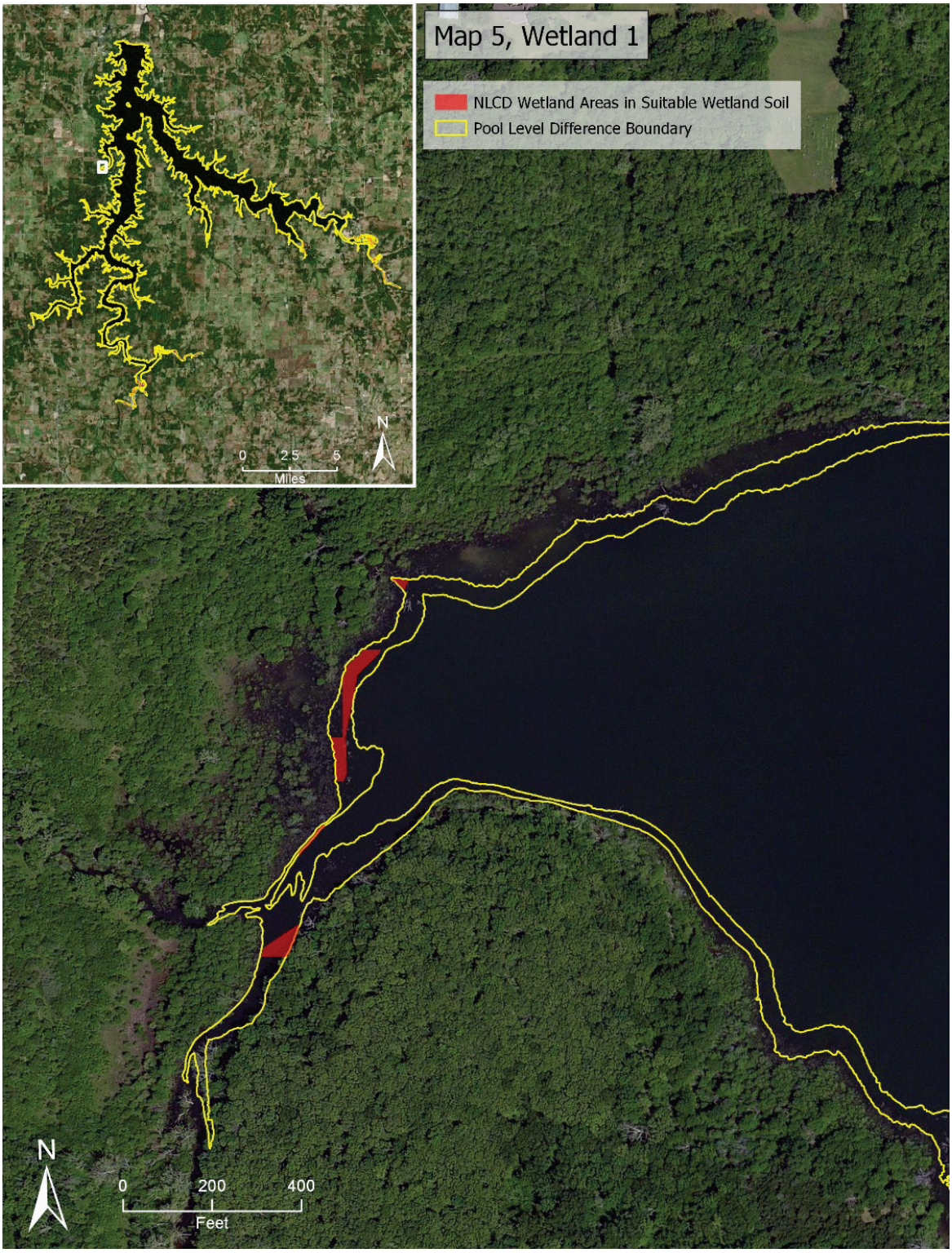


Figure 7-8. Wetland Area 7 along the Hawker Branch.

Wetland Area 8 – Wetland Area 8 is located along the Maze Creek as it enters Stockton Lake. (Figure 7-9). This wetland area consists of 0.01 acres of only emergent herbaceous wetlands, according to NLCD. The NWI database does not identify any wetlands in Wetland Area 8.

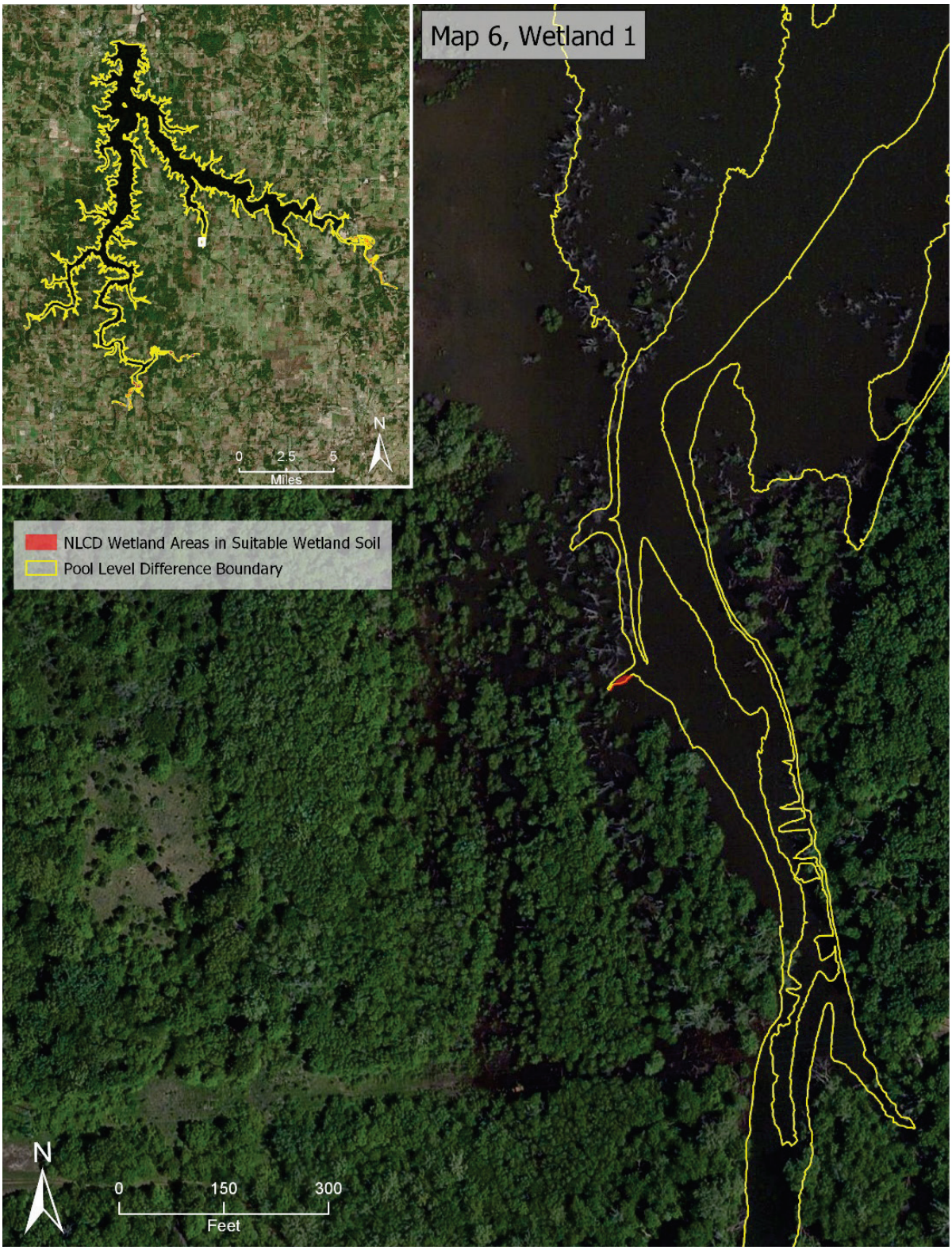


Figure 7-9. Wetland Area 8 along Maze Creek.

Table 7-4 summarizes the potential wetland impacts from Alternative 7. The NLCD data result in impacts to 34.71 acres of wetlands, and the NWI data result in impacts to 12.52 acres of wetlands.

Table 7-4.. Summary of Potential Wetland Impacts.

Map	Wetland Area	Woody Wetlands Acres (NLCD)	Emergent Herbaceous Wetlands Acres (NLCD)	Freshwater Forested/Shrub Wetland Acres (NWI)	Freshwater Emergent Wetland Acres (NWI)
Figure 7-2	1	5.38	13.70	6.92	0.00
Figure 7-3	2	4.10	2.46	3.42	0.04
Figure 7-4	3	0.56	< 0.01	0.79	0.00
Figure 7-5	4	4.89	0.97	1.29	0.06
Figure 7-6	5	0.12	0.88	0.00	0.00
Figure 7-7	6	0.45	0.92	0.00	0.00
Figure 7-8	7	0.13	0.14	0.00	0.00
Figure 7-9	8	0.00	0.01	0.00	0.00
Total Wetlands Acreage (excluding Aldrich Refuge)		15.63	19.08	12.42	0.10

The NWI data set is slightly more reliable relative to accuracy of actual wetlands around Stockton Lake. The wetlands would face minor adverse impacts with the 1.8-foot pool raise as areas become too deep for the wetlands. The wetlands would also have minor beneficial impacts as the pool raise would provide opportunities for wetlands to expand into areas that were previously dry shoreline. Alternative 7 would have some similar beneficial impacts and detrimental impacts to the 12.52 acres of NWI wetlands because of the differing surface water elevations.

7.4.7. Floodplains

The EO 11988 eight-step decision process was reviewed to identify potential effects of the proposed project on floodplains (Table 7-5). As noted in Section 5.3, there are no significant impacts either to reservoir elevations or to downstream flows, and consequently, there are no anticipated environmental effects.

Table 7-5. EO 11988 Eight-Step Decision Process for Stockton Lake.

Step Process	Decision
1) Determine if a proposed action is in the base floodplain.	Yes, portions of the proposed project would occur within a regulatory floodplain. Base flood elevations (BFEs) have been computed and in effect since 2011 for Stockton Lake (elevation 887.13 feet NAVD 1988), whereas the Sac River below Stockton Dam through Cedar County and St. Clair County is designated Zone A, no BFE determined. Proposed Stockton Lake pool raise alternatives could result in modified lake surface water elevations. Construction of a new water intake structure would occur along the existing Stockton Lake shoreline within USACE property and an existing sponsor easement. A future pipeline alignment from the water intake structure to the sponsor water treatment facility would likely transect regulatory floodplains. This construction would be underground and because it is not vertical construction, there would be no impact to the floodplain. Southwest Missouri Regional Water will conduct a separate NEPA analysis through the USACE Regulatory office.
2) Conduct early public review, including public notice.	A 30-day public review period will be conducted for the Stockton Lake reallocation project to comply with NEPA compliance requirements for actions on USACE property (pool modifications and water intake structure). Additional regulatory compliance and associated public review would occur in the future for the sponsor-related water pipeline alignment.
3) Identify and evaluate practicable alternatives to locating in the base floodplain, including alternative sites outside the floodplain.	USACE has evaluated practicable alternatives to achieve project objectives (see Section 3.5). Proposed pool raise/modifications will not result in any direct construction activities within a floodplain. Other practical alternatives that also meet water supply objectives would likely occur in floodplains and would require new facilities and infrastructure.
4) Identify impacts of the proposed action.	The proposed 1.8-foot pool raise and water intake structure would not result in direct construction-related impacts to floodplains. Minor changes to average annual surface water elevations at Stockton Lake would occur. The magnitude, timing, and durations of downstream releases would result in minor changes with the proposed action. The future pipeline alignment from Stockton Lake to the sponsor's water treatment facility would likely occur within existing easements; potential floodplain effects would be mitigated through the regulatory permitting process. No flood-related damages or impacts to human health, safety, or welfare are anticipated with implementation of proposed project features. The proposed action complies with applicable state and local laws on floodplains. The proposed action will affect the natural and beneficial values of the floodplain due to changes in the lake level. "Natural and Beneficial Values" include but are not limited to water resources values (natural moderation of floods, water quality maintenance, and ground water recharge), living resource values (fish, wildlife and plant resources), cultural resource values (open space, natural beauty, scientific study, outdoor education and recreation) and cultivated resource values (agriculture, aquaculture and forestry).
5) If impacts cannot be avoided, develop measures to minimize the impacts and restore and preserve the floodplain, as appropriate.	The Stockton Lake water reallocation project would not require measures to avoid, minimize, or mitigate for adverse impacts to a floodplain. Impacts from future pipeline alignments would be mitigated through the regulatory permitting process. The proposed action complies with applicable state and local laws on floodplains.

Step Process	Decision
6) Re-evaluate alternatives.	This project evaluated a full range of potential water supply alternatives. The proposed alternative was identified as the most practical and least damaging option relative to EO 11988. All potential impacts to the human and natural environment were considered and evaluated in this report. Other potential impacts were avoided, minimized, or mitigated, as detailed in this report.
7) Present the findings and a public explanation.	The feasibility report and integrated environmental assessment will be provided to the resource agencies and public for review and comment.
8) Implement the action.	It is anticipated that the proposed action would be initiated in 2022.

No new structures would be constructed within streams, existing floodplains, or other waterways with implementation of the 1.8-foot pool raise in Alternative 7. Future pipeline alignments constructed by Southwest Missouri Regional Water that may occur in floodplain areas would have a separate public review process and would be constructed in compliance with federal and state regulations under the CWA and EO 11988.

7.5. Terrestrial Resources and Land Use

7.5.1. Land Use

The existing land use affected environment is described in Section 4.5.1.

Alternative 1 Federal No Action/FWOP

The land surrounding Stockton Lake is primarily undeveloped with very few residences or docks. There are 10 campgrounds and 3 marinas around the lake (see Section 4.11, Figure 4-14). Almost 50 percent of the area surrounding Stockton Lake is forest and woodland, 45 percent split fairly evenly between grasslands (non-prairie), crop lands, old fields, and savannas, and approximately 3.5 percent in glades and wetlands. No changes to existing lake operations are anticipated with this alternative. Any future land use changes at Stockton Lake would likely occur due to development of future recreational opportunities such as new marinas and campsites. Future residential development may also occur as existing land use agreements change under the FWOP condition. Due to the existing undeveloped nature of the study area, any future land use developments would result in less natural habitat at Stockton Lake.

Alternative 5 Multipurpose Pool Water Reallocation

Water reallocation from the multipurpose pool would result in 5 fewer above-normal days, 47 fewer normal days, and 52 additional days below-normal surface water elevation. With a projected 52 additional days of below-normal water elevations, this alternative would expose additional shoreline for a longer period under drought conditions. Existing land use would not be expected to change under this FWP condition from additional days of below-normal surface water levels. Minor negative impacts to land uses may occur, primarily to recreational uses, quantity of aquatic habitat, and shoreline-related activities.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

Reallocation from the combination flood and multipurpose pool would result in a 1.8-foot surface water elevation increase across the lake. The pool raise to 868.8 feet NGVD 29 would remain within normal lake operational elevations, which have experienced water elevations at this elevation on a seasonal and annual basis. With a projected 1 additional above-normal day, 7 additional normal days, and 8 fewer days of below-normal water elevations, this alternative would expose additional shoreline for a shorter period under drought conditions. Existing land use would not be expected to change under this FWP condition from additional days of above-normal and normal surface water levels. Minor positive impacts to land uses may occur, primarily to recreational uses, quantity of aquatic habitat, and shoreline-related activities.

7.5.2. Terrestrial Habitat

The terrestrial habitat affected environment is described in Section 4.5.2.

Alternative 1 Federal No Action/FWOP

The terrestrial habitat would not undergo a significant change from the FWOP conditions due to implementation of the Federal No Action/FWOP alternative.

Alternative 5 Multipurpose Pool Water Reallocation

Water reallocation from the multipurpose pool would result in in 5 fewer above-normal days, 47 fewer normal days, and 52 additional days below-normal surface water elevation. With a projected 52 additional days of below-normal water elevations, this alternative is not expected to have a significant impact on the terrestrial habitat around the lake under this FWP condition. With up to 52 additional days of below-normal water elevations, lost aquatic and littoral habitat would be temporarily replaced with dry terrestrial habitat during extended droughts. Newly exposed shorelines may result in the growth of additional shoreline vegetation such as cocklebur, water willow, buttonbush, smartweed, cottonwood, silver maple, and black willow. If later inundated, this submerged vegetation may result in higher quality littoral and aquatic habitat for fish shelter, reproduction, and feeding.

Minor increases in habitat disturbances to existing grassland habitat would occur under this alternative during construction of the new water intake structure. The terrestrial habitat impact would be minor during construction. There would be no direct long-term changes to terrestrial habitat around the lake with implementation of Alternative 5.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

Water reallocation from the combination flood control and multipurpose pools would result in a 1.8-foot surface water elevation increase across the lake. The pool raise elevation would remain in the normal pool operational range. Natural lake level fluctuations occur seasonally and annually at this elevation. This alternative is not expected to have a significant impact on the terrestrial habitat around the lake under this FWP condition. Fluctuations in the existing aquatic and terrestrial habitat boundary and interface may result in some minor long-term shifts in aquatic, littoral, and terrestrial habitat elevations and boundaries.

Minor increases in habitat disturbances to existing grassland habitat would occur under this alternative during construction of the new water intake structure. The terrestrial habitat impact would be minor during construction.

7.5.3. Fish and Wildlife

The fish and wildlife affected environment is described in Section 4.5.3.

Alternative 1 Federal No Action/FWOP

Fish and wildlife would not undergo a significant change from under the FWOP condition due to implementation of the Federal No Action/FWOP alternative. Natural variability by season, with lake operations and future watershed development, are anticipated for fish and wildlife species and their habitats under the FWOP condition above, below, and within Stockton Lake. This variability would occur under all alternatives.

Alternative 5 Multipurpose Pool Water Reallocation

Water reallocation from the multipurpose pool would result in 5 fewer above-normal days, 47 fewer normal days, and 52 additional below-normal days for surface water elevations. With a projected 52 additional days of below-normal water elevations, this alternative would result in similar effects as described in Section 7.5.2 for habitat effects. Minor short-term shifts from aquatic habitat to terrestrial habitat may provide benefits to terrestrial species, especially those that receive benefits from exposed shorelines, such as shorebirds. Long-term aquatic benefits may occur as additional littoral habitat is

inundated following droughts, providing increased quality and quantity of habitat for aquatic fish, birds, and macroinvertebrates.

Minor increases in grassland habitat disturbances would occur under this alternative during construction of the new water intake structure. The terrestrial habitat impact would be minor during construction. Some minor increases to water turbidity may occur during construction. There would be no direct long-term changes terrestrial habitat around the lake with implementation of Alternative 5.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

Water reallocation from the combination flood control and multipurpose pool would result in a 1.8-foot surface water elevation increase across the lake. This pool raise elevation remains in the normal pool elevation range. Overall, this would result in 1 additional day above normal, 7 additional days at normal, and 8 fewer days below-normal pool elevations. Natural lake level fluctuations elevations are often at this level throughout the year. This alternative is not expected to have a significant impact on the fish and wildlife around the lake under this FWP condition.

Minor increases in habitat disturbances would occur under this alternative during construction of the intake structure. The terrestrial habitat impact would be minor during construction. There would be no direct long-term changes terrestrial habitat around the lake with implementation of Alternative 7.

7.5.4. Invasive Species

The invasive species affected environment is described in Section 4.5.4.

Alternative 1 Federal No Action/FWOP

Stockton Lake and the area surrounding it are not protected from the spread of invasive species. The most common and problematic invasive species currently found in and near Stockton Lake are Lespedeza, Johnson grass, and musk thistle. Stockton Lake personnel are also taking measures to prevent the introduction of zebra mussel, hydrilla, and emerald ash borer. Future residential and industrial growth adjacent to the shoreline would have the potential to introduce invasive species. Stockton Lake personnel would continue to manage and prevent invasive species over the FWOP condition on a case-by-case basis.

Musk Thistle.

Alternative 5 Multipurpose Pool Water Reallocation

Water reallocation of storage from the multipurpose pool would not in itself import or propagate invasive species around the lake. Stockton Lake personnel would continue efforts to manage and prevent invasive species as needed. This alternative would not result in significant impacts from invasive species.

Minor increases in soil disturbances would occur under this alternative during construction of the new water intake structure. Construction of the water intake structure would use BMPs such as native grass seeding to limit the potential spread of invasive species. There would be no direct long-term changes invasive species around the lake with implementation of Alternative 5.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

Water reallocation of storage from the combination flood control and multipurpose pool either pool would not in itself import or propagate invasive species around the lake. Stockton Lake personnel would continue efforts to manage and prevent invasive species as needed. This alternative would not result in significant impacts from invasive species.

Minor increases in soil disturbances would occur under this alternative during construction of the intake structure. Construction of the water intake structure would use BMPs such as native grass seeding to limit

the potential spread of invasive species. There would be no direct long-term changes invasive species around the lake with implementation of Alternative 7.

7.6. Threatened and Endangered Species

There are eight threatened or endangered species identified in Section 4 and shown in Table 4-4.

Alternative 1 Federal No Action/FWOP

Threatened and endangered species would not experience a significant change due to implementation of the No Action alternative under FWOP conditions. However, natural shifts in aquatic, littoral, and terrestrial vegetation would continue over the FWOP condition with existing Stockton Lake operations because of changes from precipitation, flows, hydropower needs, and climate change. These natural changes may affect but are not likely to adversely affect feeding habitat and associated insect populations that the gray bat (*Myotis grisescens*), Indiana bat (*Myotis sodalis*), and northern long-eared bat (*Myotis septentroinalis*) use as a food source.

Alternative 5 Multipurpose Pool Water Reallocation

Water reallocation from the multipurpose pool would result in fewer high-, normal-, and low-lake water surface elevation days (Table 7-1). Alternative 5 would decrease the number of above normal lake elevations by 5 days and decrease the number of normal lake elevations days by 47 days. An increase of 52 below-normal water surface elevation days is also expected with implementation of Alternative 5. Table 4-4 lists the threatened and endangered species within the federal property boundaries and describes their habitat.

- Gray bat, Indiana bat, and northern long-eared bat – Alternative 5 may result in minor shifts in the extent and location of aquatic, littoral, and terrestrial vegetation along the shorelines of Stockton Lake, which may increase or decrease associated insects that bats use as a food source. Inundated littoral vegetation following a drought or during flood elevations may provide feeding benefits. Water fluctuations that result in reduced insect levels could reduce feeding benefits. Therefore, Alternative 5 may affect but is not likely to adversely affect the gray bat, Indiana bat, or northern long-eared bat.
- Niangua darter (*Etheostoma nianguae*) – Niangua darters live in clear upland creeks and small- to medium-sized rivers with slight to moderate currents. They require continuously flowing streams with silt-free gravel and rock bottoms. These streams typically drain hilly areas with chert or dolomite bedrock. This type of habitat would not be impacted by proposed FWP actions. Therefore Alternative 5 would have no impact on known Niangua darter or its habitat.
- Ozark cavefish (*Amblyopsis rosae*) – Ozark cavefish occur in caves, sinkholes, and underground springs untouched by light. This type of habitat would not be impacted by proposed FWP actions. Therefore, Alternative 5 would have no impact on the Ozark cavefish or its habitat
- Geocarpon (*Geocarpon minimum*) and Missouri bladderpods (*Lesquerella filiformis*) – Geocarpon and Missouri bladderpods occur in glade habitat. There are six sites on federal property of Stockton Lake with good-quality sandstone glades and known populations of Geocarpon and Missouri bladderpods (Bona Glade, Maze Creek Glade, Corry Branch Glade, and Tara Glade). These sites are in upland areas that would not be impacted by FWP actions. Therefore, Alternative 5 would have no impact on known Geocarpon, Missouri bladderpods or their glade habitat.
- Mead's milkweed (*Asclepias meadii*) – Mead's milkweed occurs in native tallgrass prairie habitat that is outside the study area. Therefore, Alternative 5 would have no impact on Mead's milkweed or its tallgrass prairie habitat.

The changes to water elevations and flows within the Stockton Lake study area due to implementation of Alternative 5 may affect, but is not likely to adversely affect, currently listed species under Section 7 of ESA.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

A geographic information system evaluation of the 1.8-foot pool raise would result in 1 additional day above normal lake elevations, 7 additional days within normal lake elevations, and a decrease of 8 days below-normal lake elevations. These lake elevation changes are consistent with the Federal No Action/FWOP alternative.

- Gray bat, Indiana bat, and northern long-eared bat – Based on the results in Table 7-1, Alternative 7 would likely have similar shifts in the extent and location of aquatic, littoral, and terrestrial vegetation as the Federal No Action/FWOP alternative. These shifts may increase or decrease associated insects that bats use as a food source. Therefore, Alternative 7 may affect but is not likely to adversely affect the gray bat, Indiana bat, or northern long-eared bat.
- Niangua darter (*Etheostoma nianguae*) – Existing Niangua darter habitat is located outside of proposed FWP actions, therefore Alternative 7 would have no impact on known Niangua darter or its habitat.
- Ozark cavefish (*Amblyopsis rosae*) – Existing Ozark cavefish habitat is located outside of proposed FWP actions, therefore Alternative 7 would have no impact on the Ozark cavefish or its habitat.
- Geocarpon (*Geocarpon minimum*) and Missouri bladderpods (*Lesquerella filiformis*) – Stockton Lake glade habitat sites are located in upland areas that would not be impacted by FWP actions. Therefore, Alternative 7 would have no impact on known Geocarpon, Missouri bladderpods or their glade habitat.
- Mead's milkweed (*Asclepias meadii*) – Mead’s milkweed occurs in native tallgrass prairie habitat that is outside of FWP actions, therefore, Alternative 5 would have no impact on the Mead’s milkweed or its tallgrass prairie habitat.

The changes to water elevations and flows within the Stockton Lake study area due to implementation of Alternative 7 may affect, but is not likely to adversely affect, currently listed species under Section 7 of ESA.

Other Species of Concern

Downstream mussel populations are not expected to be affected by either FWP alternative. The hydraulic studies and details (see Section 5.3) indicate that downstream flows would remain consistent with the Federal No Action/FWOP alternative.

There are nine BCCs in the area surrounding Stockton Lake as identified in Section 4 and shown in Table 4-5. The effect on these migratory species coincides with potential impacts on the Aldrich Refuge, which provides a haven and feeding opportunities for many of the BCC species. The Aldrich Refuge impacts are discussed in Section 7.4.5.

Bald eagles around Stockton Lake would not be affected by either FWP alternative. Neither alternative is expected to affect bald eagles, which nest in the treetops of the wooded areas surrounding Stockton Lake.

7.7. Cultural Resources

The cultural resources affected environment is described in Section 4.7.

Effects on cultural resources are assessed based on the extent to which a proposed project alternative increases the potential for erosion and other processes leading to cultural resource site damage. Previous studies (Dunn 1996, Dunn et al. 1996) indicate that cultural resources sites are sensitive to changes in

water surface elevations. Impacts to cultural resources are closely linked to increased risk of erosion due to wave action on the resources, and increased risk of looting and vandalism due to increased shoreline access. The analysis presented below will look at the frequency that cultural resource sites would be subject to increased or decreased lake elevation frequencies in days for the considered alternatives.

Area of Analysis

The Stockton Lake reallocation study area of analysis is the elevation range in which lake fluctuation levels have the potential to impact cultural resource sites. For the Stockton Lake analysis, these elevations were divided into three zones that include an above-normal, a normal, and a below-normal lake elevation. Table 7-6 summarizes the numbers of recorded sites within these elevations. Cultural resource sites can extend into more than one elevation range. As such, the left column in Table 7-6 represents site counts for each site's lowest elevation range and the total number of sites for each elevation range.

Cultural Resource Sites within the Study Area

As noted, 549 cultural resource sites have been formally recorded within the study area. However, as large portions of the study area have not been surveyed, additional sites are almost certainly present within all lake elevations mentioned above. Below is a synopsis of the known sites.

The above-normal elevations have 301 recorded sites mapped entirely above 871 feet. Of these sites, 92 represent historic sites (mostly farmsteads) and 188 are recorded as prehistoric sites, which consist mostly of small, low-density artifact scatters. The prehistoric sites also include 28 burial mound/cairns and 16 rock shelters with prehistoric occupations. Twenty of these sites have both prehistoric and historic components, such as a farmstead site with prehistoric artifacts. One site has no data. Of these 301 sites, 156 have been determined not eligible for the NRHP and 145 remain unevaluated.

Seventy-four sites are recorded within the normal lake elevations. Sixty-five of these sites are prehistoric campsites and rock shelters. None of these sites are listed on or determined eligible for the NRHP; however, 53 sites have no NRHP eligibility determination. Twenty-one sites have been determined not eligible for the NRHP. There are five historic sites and four sites with both prehistoric and historic components.

The below-normal elevations contain 165 recorded sites; all but 8 are prehistoric or multicomponent historic and prehistoric sites. Sixty of the sites are noted as "inundated," meaning they are situated on landforms below 863-foot elevation and are inundated except during periods of extreme low water. Twenty-six of the sites have been determined not eligible for the NRHP. Of the remainder, one rock art site (ranging in elevation from 862 to 879 feet NGVD 29) has been recommended eligible and the rest (76 sites) have undetermined NRHP eligibility. Table 7-6 shows the recorded sites within lake level elevations from above normal to below normal. Elevations in the left column represent the minimum site elevation.

Table 7-6. Recorded Sites Within Lake Elevations.

Minimum Site Elevation (feet NGVD 29)	Total
>871	
Eligible	0
Unevaluated	144
Not Eligible	156
No Data	1
Subtotal	**301**
865–870.9	
Eligible	0
Unevaluated	53
Not Eligible	21
Subtotal	**74**

Minimum Site Elevation (feet NGVD 29)	Total
863–864.9	
Eligible	0
Unevaluated	16
Not Eligible	2
Subtotal	**18**
<863 feet	
Eligible	1
Unevaluated	60
Not Eligible	26
Inundated/partially inundated	60
Subtotal	**147**
No Data	9
Grand Total	**549**

Note: Some sites are on steep slopes and can range over more than one elevation band. For presentation purposes, the sites are characterized by their minimum elevation.

Below is a discussion and comparison of the lake fluctuation conditions of the three considered alternatives: the Federal No Action/FWOP alternative, Alternative 5, and Alternative 7.

Alternative 1 Federal No Action/FWOP

In the Federal No Action/FWOP alternative, Stockton Lake operations would be kept as present levels with no reallocation of water. In 2018, a partial survey of the shoreline identified some sites that require further testing for eligibility and potential mitigation. A final survey of the remaining shoreline will be required to identify other sites. Alternative 5 would take water from the existing multipurpose pool with no lake raise. Alternative 7 would raise the normal multipurpose pool 1.8 feet, from elevation 867 to 868.8 feet NGVD 29. Table 7-7 below presents a comparison of the annual average number of days that the lake would have spent at each elevation band over a full year for each of the three alternatives. This information is an output of the reservoir simulation model and is based on a 63-year period of analysis. For example, the lake elevation is in a normal elevation range 157 days under the base condition, 109 days under Alternative 5 (a decrease of 48 days), and 164 days under Alternative 7 (an increase in 8 days). The table includes the net change of days spent at various elevation ranges to allow comparison between alternatives. The elevation range bands were originally developed to characterize recreation impacts; however, cultural resource PDT members felt that the elevation ranges were also applicable and a reasonable methodology to evaluate potential impacts to cultural resource sites. This same information is presented in graphical form in Section 5.3, Hydraulic Analysis of Impacts to Water Elevations, Figure 5-1, HEC-ResSim Output for Alternatives 1, 5, and 7.

Table 7-7. Hydraulic Models for the Three Alternatives Based on Data from 1962 to 2012, Full Year, with Archeological Sites.

Lake Condition	Elevation (feet NGVD 29)	Federal No Action/FWOP		Alternative 5 - Multipurpose Pool			Alternative 7 Combination Multipurpose Pool and Flood Control Pool			Number of sites within the elevation zone
		% of Year	Days/yr	% of Year	Days/yr	Net Change (No. of Days)	% of Year	Days/yr	Net Change (No. of Days)	
Above Normal	>871	6	22	4	18	-4	6	22	0	301
Normal	865–870.9	43	157	30	109	-48	45	164	+8	74
Below Normal	863–864.9	19	70	14	52	-18	15	56	-14	18
Low	<863	32	117	51	186	+69	34	123	+7	147

Notes:
Values are based on average annual days over the period of record from 1950 to 2012.
Normal pool elevations represent surface water level conditions that are considered optimal for recreation and were determined to be a reasonable basis for the cultural resources evaluation.
Net Change = change in the number of average annual days between the Federal No Action/FWOP alternative and action alternatives.
Total Days/yr or % of Year may not exactly equal 365 days or 100% because of rounding.

Alternative 5 Multipurpose Pool Water Reallocation

Based on hydraulic modeling, Alternative 5 would result in a decrease in high water days (>871 feet NGVD 29) of 4 days from the current operating condition. Normal operating pool level levels would see a decrease of 48 days in the normal pool operating zone (elevations 865 to 870.9 feet NGVD 29). The decrease in inundation days at above-normal elevations would benefit cultural resource sites by subjecting them to less erosive wave action. However, the decrease in days in the normal operating pool would subject the sites to additional exposure and potentially more looting activity. Alternative 5 would greatly increase exposure for sites in low-lake elevations (<863 feet NGVD 29), with an increase of 69 days of exposure a year compared to current operating conditions. Based on the 63 years of modeling data, water levels should spend no appreciable time below elevation 850 feet NGVD 29 for any of the alternatives. However, any amount at low elevations would expose many high-potential landforms in the lower reaches of the lake that may never have been surveyed.

At above-normal elevations, there is a negligible difference of 4 less days of inundation between Alternative 5 and Alternative 1 on cultural resource sites. For sites in the normal pool fluctuation zone, Alternative 5 would result in potentially fewer impacts from erosion but may allow for more site exposure than Alternative 1. The biggest difference is at below normal or lower water levels where Alternative 5 would potentially put more sites at risk from exposure for considerably longer periods than Alternative 1. However, based on known information under the Federal No Action/FWOP alternative, there isn't expected to be significant impacts. If Alternative 5 becomes the recommended plan at any point in the future, the Programmatic Agreement (Appendix M) would cover the process for further testing and any potential mitigation.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

Alternative 7 would result in no change during the entire year for above-normal lake levels. Lake elevations would increase to 8 days above the current operating conditions for the normal pool operation zone. Below normal lake elevations to 863 feet NGVD 29 would decrease from the current operation by 14 days under Alternative 7. Low-lake elevations below 863 feet NGVD 29 would see a small increase of 7 days. In summary, in comparison to the base condition, Alternative 7 would result in no change in days above 871 feet NGVD 29, a negligible increase in days within the normal operating band, a decrease in

exposure to sites at low elevations, which may protect against looting activity and possible erosion, and a small increase in exposure for 7 days at low lake levels. As the tentatively selected plan, the Programmatic Agreement will cover the process for further testing and any necessary mitigation.

Alternative 7 would have little difference in inundation days on cultural resource sites at above-normal lake levels compared to the base condition. However, all the sites are currently being impacted by current lake operations. Also, the degree in change in water level impacts for a relatively short period (i.e., 1 to 8 days with Alternative 7), over the course of a year on cultural resource impacts is impossible to differentiate from the current conditions.

7.8. Air Quality

The existing air quality affected environment is described in Section 4.8.

Alternative 1 Federal No Action/FWOP

Under the Federal No Action/FWOP alternative, air quality around the lake would remain relatively the same. This alternative does not add new air emission sources or changes to the existing emission sources, which are likely as development continues over the next 50 years. No violations of the National Ambient Air Quality Standards (NAAQS) as established by EPA are expected as a result of the implementation of this alternative. Any new or increased emissions in the future would be permitted and regulated based on current and future NAAQS criteria and thresholds.

Alternative 5 Multipurpose Pool Water Reallocation

The additional water supply from the multipurpose pool is unlikely to result in a reduction in the amount of hydropower produced. If additional regional power supply is needed, supplemental power could come from existing oil or gas-based energy sources or other alternative energy sources such as wind or solar. There would be slight beneficial or slight negative air quality impacts depending on the replacement power source. No violations of the NAAQS would be expected as a result of implementation of this alternative.

Minor increases in heavy machinery use and exhaust would occur under this alternative during construction of the new water intake structure. The air quality impact would be minor and temporary during construction. There would be no direct long-term changes in air quality around the lake with implementation of Alternative 5.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

The additional water supply from the flood and multipurpose pools is unlikely to result in a reduction in the amount of hydropower produced. If additional regional power supply is needed, supplemental power could come from oil or gas-based energy sources or other alternative energy sources such as wind or solar alternatives. There would be slight beneficial or slight negative air quality impacts depending on the replacement power source. No violations of the current NAAQS are expected as a result of the implementation of this alternative.

Minor increases in heavy machinery use and exhaust would occur under this alternative during construction of the new water intake structure. The air quality impact would be minor and temporary during construction. There would be no direct long-term changes in air quality around the lake with implementation of Alternative 7.

7.9. Recreation Resources

The recreation resources potential affected environment is described in Section 4.11.

Table 7-8 provides a summary of recreational features impacted by each of the alternatives. Additional detail is provided in Appendix B, Economics Appendix. Appendix B also shows the quality of recreation rating for the various pool levels. Data are based on interviews of Stockton Lake park and operations

managers on September 16, 2016. The higher the value, the higher the reported quality/value of recreation at Stockton Lake. At normal levels, the recreation rating is at 64. When the pool levels rise or fall into above-normal or below-normal pool levels, the recreational rating drops into the low 40s, indicating a decline in the patron's recreational enjoyment. At below-normal lake elevations, the recreational rating is 28. Because of the increase in days the lake is at below-normal elevation, this alternative would have an adverse impact to the recreational opportunities at Stockton Lake.

Table 7-8. Summary of Impact to the Recreation Features at Stockton Lake for Campsites, Boat Ramps, Picnic Tables, Roads, and Swim Beaches.

Alternative	Campsites	Boat Ramps	Picnic Tables	Roads	Swim Beaches
Alternative 1 Federal No Action/FWOP	174 Sites total, of which 166 sites experience between 1 – 13 days of closure from high water during the recreation season	15 boat ramps total; three are prone to closure and may be closed between 12 – 30 days on average per year from low elevations	90 picnic tables and grills total, of which 87 may experience inundation between 1 – 10 days on average during the recreation season during high water	19 roads in the park area, of which all experience between 1 – 19 days of closure on average per year during high water	6 swim beaches, of which all experience 12 days of closure on average during the recreation season during high water when lake elevations are >873 feet NGVD 29
Alternative 5 Multipurpose Pool Water Reallocation	No additional days of closure; 20 of the campsites may be closed one or two fewer days on average during the recreation season compared to the base condition	Three boat ramps prone to closure could be closed up to an additional 76 days on average per year compared to the base condition	No additional days of inundation; 7 picnic tables and 6 grills may be inundated one or two fewer days on average during the recreation season compared to the base condition	No additional days of closure; 5 of the roads may be closed one to three fewer days on average per year compared to the base condition	Lower water elevations during drought could expose debris (wood); the 6 swim beaches are expected to be closed two fewer days during recreation season compared to the base condition
Alternative 7 Combination Flood Control and Multipurpose Pool Water Reallocation	Approx. 28 sites are closed one additional day on average during the recreation season as compared to the base condition.	Three boat ramps prone to closure could be closed up to an additional 30 days on average per year compared to the base condition	Approx. 8 picnic tables and 4 grills are inundated one additional day on average during the recreation season as compared to the base condition	Approx. 8 roads are closed one to two additional days on average per year during high water as compared to the base condition	All 6 swim beaches may experience an additional 4 days of closure on average during the recreation season as compared to the base condition; Stockton Lake project staff, don't believe swim beaches will be significantly impacted, even if some beach sizes are slightly reduced. There will be an additional one-time O&M cost ($25,000) to move the swim buoys.

Alternative 1 Federal No Action/FWOP

Fishing and sailing are a major recreation component at Stockton Lake, having regional and nationwide popularity. Low-water levels during the FWOP condition would continue to impact Greenfield, Cedar Ridge (east ramp), and High Point ramps approximately 12 to 30 days per year on average, as shown in Table 7-8. Above-normal water levels would continue to impact all boat ramps an average of 22 days per year, except Masters boat ramp, which would be closed approximately 26 days per year on average (Appendix B).

Beaches around the lake would continue to have occasional closures during high-water levels. The Federal No Action/FWOP alternative would result in six beach closures for an average of 12 days per year when lake levels exceed 873 feet.

Campsites around the lake, like the beaches, are only impacted by high-water levels. Table 7-8 shows the 166 campsites are closed between 1 and 13 days per year due to high water elevations. In addition, 87 of the 90 picnic tables may experience inundation between 1 and 10 days annually on average, when lake levels exceed 873 feet. There are 19 roads in the park area that currently experience 1 to 19 days of closure when lake levels are above normal.

Alternative 5 Multipurpose Pool Water Reallocation

Compared to the Federal No Action/FWOP alternative, Alternative 5 would result in up to 60 additional days of closure at three boat ramps that are prone to closures during below-normal water elevation days. The three boat ramps prone to below-normal closure are at Greenfield, Cedar Ridge (east ramp), and High Point boat ramps. This alternative would also reduce the number of ramp closures during high-water levels by approximately 8 average annual days at each boat ramp, except at Masters, where 9 fewer average annual days of closure would be anticipated.

Alternative 5 would reduce beach closures by an average of 2 days every year at the six swim beaches. Below-normal water levels increase the exposure to the lake bottom which may contain sticks and other debris.

Campsites would also experience beneficial effects with this alternative, resulting in 1 to 2 fewer days 20 campsites would be closed per year. There are 13 picnic tables that will be inundated 1 to 2 fewer days and access to the recreational areas would also be beneficially impacted. Road closures would occur 1 to 2 fewer days on five roads surrounding the lake under this alternative.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

The combination flood and multipurpose pool water reallocation would result in surface water elevations that are more consistent with Alternative 1 Federal No Action/FWOP. As compared to the Federal No Action/FWOP alternative, Alternative 7 would result in an additional 30 days during drought at the three boat ramps (Greenfield, Cedar Ridge-East, High Point) prone to below-normal lake level closures. The boat ramp impact from this alternative during above-normal water elevations would be the same as the Federal No Action/FWOP alternative, except at Masters boat ramp, where approximately 4 fewer average annual days of ramp closure would be expected (Appendix B).

Alternative 7 would increase beach closures by an average of four days every year at all six swim beaches compared to the base condition; however, Stockton Lake project staff do not believe swim beaches will be significantly impacted, even if some beach sizes are slightly reduced. There would be an additional one-time O&M cost ($25,000) to move the swim buoys.

Campsites would also experience minor effects as 28 of the 166 campsites with closures in the Federal No Action/FWOP alternative would experience an additional closure day. Picnic areas would have 13 tables with 1 additional day of inundation. Road closures would occur one to two days more often on 8 roads surrounding the lake. The other 10 roads around the lake would remain the same as closures in the Federal No Action/FWOP alternative.

As a result of the stable pool levels compared to the FWOP condition, Alternative 7 would have some minor positive and negative effects to the quality of recreational opportunities at Stockton Lake.

7.10. Socioeconomic Conditions

The existing socioeconomic conditions potential affected environment is described in Section 4.9.

Alternative 1 Federal No Action/FWOP

The No Action alternative has minor positive and negative effects to the socioeconomic FWOP condition in the counties surrounding Stockton Lake because of seasonal, annual variability in lake levels and associated effects to water supply, hydropower, recreation, and flood risk management. Alternative 1 would have a negative effect on socioeconomic conditions over time as population growth is expected to outpace the current water supply, eventually resulting in a water shortage in southwest Missouri. Hydropower would continue to provide a positive socioeconomic impact through the production of clean, efficient power for the regional community. Recreational activities would continue as they do now, as a positive impact to the area economy through the purchase of recreational supplies and fees. Flood protection to downstream populations would remain unaffected.

Population growth and the demographic makeup of the local population would most likely remain similar to the current rates and percentages the area experiences now. Future residential and recreational development around Stockton Lake would likely benefit local economies through short-term construction activities and long-term recreational use.

Alternative 5 Multipurpose Pool Water Reallocation

Water reallocation from the multipurpose pool would result in fewer above-normal and normal lake elevation days and more days at below-normal lake elevations (Table 7-1). Approximately 52 additional average annual days of below-normal lake elevations are anticipated with Alternative 5 during drought periods. This FWP alternative would provide an additional 39 MGD to Southwest Missouri Regional Water for water supply, providing a positive effect on socioeconomic conditions to support the expected population growth in the region. Hydropower would continue to produce clean, efficient power for the regional community. Alternative 5 would have a minor adverse effect on recreation activities as additional low-water days could create less pleasing recreational experiences and may impact the purchase of recreational supplies and fees if there are fewer recreational users (Section 7.9). Flood protection to downstream populations would remain unaffected (Section 7.16).

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

Water reallocation from the combination flood and multipurpose pool would result in 7 additional days at normal lake elevations and 8 fewer days of below-normal elevations over the calendar year (Table 7-1). This FWP alternative would provide an additional 39 MGD for Southwest Missouri Regional Water, providing a positive effect on socioeconomic conditions to support the expected population growth in the region. Hydropower would continue to produce clean, efficient power for the regional community. Alternative 7 would have a minor beneficial impact to local socioeconomic conditions through potentially increased recreation activities. Additional days at normal lake elevations would create a more pleasing recreational experience and may increase the purchase of recreational supplies and fees (Section 7.9). Flood protection to downstream populations would remain unaffected (Section 7.16).

7.11. Environmental Justice

The existing environmental justice affected environment is described in Section 4.10.

Alternative 1 Federal No Action/FWOP

There are substantial low-income populations within the three-county study area. Section 7.10 discusses the adverse and positive impacts associated with Alternative 1. These impacts would be felt by all populations and would not disproportionately impact Environmental Justice populations. The Federal No Action/FWOP alternative would not have disproportionate adverse effects to low-income populations.

Alternative 5 Multipurpose Pool Water Reallocation

Implementation of the multipurpose pool reallocation alternative would ensure that southwest Missouri service members would have adequate water supply to meet the future demands of its customers. The

increased water supply would be accessible to all southwest Missouri customers without regard to race or income. Any rate increases resulting from increased cost of water storage would be spread across all southwest Missouri service areas and customers in an equitable manner, thus this alternative would not have disproportionate adverse effects to low-income populations.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

Implementation of the combination flood and multipurpose pool reallocation alternative would ensure that southwest Missouri service members would have adequate water supply to meet the future demands of its customers. The increased water supply would be accessible to all southwest Missouri customers without regard to race or income. Any rate increases resulting from increased cost of water storage would be spread across all southwest Missouri service areas and customers in an equitable manner, thus this alternative would not have disproportionate adverse effects to low-income populations.

7.12. Hazardous, Toxic, and Radioactive Waste

The existing HTRW potentially affected environment is described in Section 4.12.

Alternative 1 Federal No Action/FWOP

A review of the EDR area/corridor report for the area surrounding Stockton Lake revealed two potential sites of concern. The Stockton Lake dam and power plant are listed as an active RCRA CESQG with no violations. The second site, the Stockton State Park, is listed as a RCRA inactive site with no violations. Both sites have been issued NPDES permits. The Federal No Action/FWOP alternative would not result in any impact to HTRW sites.

Alternative 5 Multipurpose Pool Reallocation

The proposed multipurpose pool water storage reallocation alternative would not disturb either of the HTRW sites identified through the EDR database, and thus there would be no impact to or release of hazardous waste into the environment.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

The proposed combination flood and multipurpose pool water storage reallocation alternative would not disturb either of the HTRW sites identified through the EDR database, and thus there would be no impact to or release of hazardous waste into the environment.

7.13. Aesthetics

The aesthetics affected environment is described in Section 4.13.

Alternative 1 Federal No Action/FWOP

Aesthetics is an important environmental resource consideration for areas that are centered around outdoor recreational activities and require natural conditions to promote a positive recreational experience. Lands around Stockton Lake generally provide a natural setting that are aesthetically pleasing to recreational users. Fluctuations in lake levels are one of the main contributors to changes in lake aesthetics. Increases in lake elevation could submerge vegetation and trees surrounding the lake, causing aesthetic changes including deteriorating and dead trees and vegetation. Decreases in elevation could expose rocky shorelines to a greater extent. These potential changes in the shoreline of Stockton Lake are typically short-term in nature but could be considered aesthetically unappealing and may discourage boaters and other recreational users from visiting the lake. Over the long-term, changes in vegetation type and extent could occur based on the dynamics of long-term changes in surface water elevation. The natural setting also serves as a buffer from surrounding developed and agricultural lands. One of USACE's goals is to ensure that the lake retains desired viewscapes while also providing recreational amenities and opportunities to a broad group of outdoor enthusiasts.

Alternative 5 Multipurpose Pool Water Reallocation

During below-normal lake elevation conditions, the multipurpose pool reallocation alternative would result in approximately 52 additional days of below-normal lake water levels compared to the Federal No Action/FWOP alternative (Table 7-1). During below-normal lake elevation days, additional shoreline area (primarily rocky cobble and gravel substrate) would be exposed between the vegetation line and water line. Submerged logs, trees, debris, and old foundations may be exposed for longer periods. Below-normal lake elevations would also provide minor positive effects to future fisheries habitat by allowing shoreline vegetation such as buttonbush, water willow, cocklebur, and other littoral species of vegetation to become established, which would become inundated as lake levels rise back to multipurpose pool. Swim areas would have larger sand beaches and less lake between the shoreline and the swim buoys. This alternative would have a minor negative effect on the lake aesthetics and recreational amenities.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

The combination flood and multipurpose pool reallocation alternative would result in a surface water level condition that is consistent with the Federal No Action/FWOP alternative (Table 7-1). This alternative would provide for additional days at normal lake levels, resulting in surface water levels that are optimal relative to existing recreational infrastructure and shoreline vegetation. This alternative would have a neutral to slightly beneficial effect on Stockton Lake aesthetics and recreational amenities.

7.14. Noise

The noise affected environment is described in Section 4.14.

Alternative 1 Federal No Action/FWOP

The noise levels in and around Stockton Lake are typical of those normally found in areas where water recreation takes place (i.e., noise from boats, jet skis, and other recreational vehicles and equipment). Recreational use and associated noise levels at Stockton Lake are not considered excessive but may increase gradually under the Federal FWOP condition as population numbers increase in the surrounding areas. There would be minor adverse effects associated with noise levels at Stockton Lake due to increased long-term recreational use with implementation of the Federal No Action/FWOP alternative. This assumption would be the same for all FWOP and FWP conditions.

Alternative 5 Multipurpose Pool Water Reallocation

Minor increases in noise levels would occur under this alternative during construction of the new water intake structure. The increased noise level would be minor and temporary during construction. There would be no direct long-term changes in noise levels around the lake with implementation of Alternative 5.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

Minor increases in noise levels would occur under this alternative during construction of the new water intake structure. The increased noise level would be minor and temporary during construction. There would be no direct long-term changes in noise levels around the lake with implementation of Alternative 7.

7.15. Climate Change

The climate-change-affected environment is described in Section 4.15. Because of climate change uncertainties, this analysis focuses on the potential impacts that the alternatives would have on climate change. Additional discussion regarding how climate change was qualitatively evaluated is described in Section 3.4.7 and Appendix D, Climate Change Assessment. The assessment concluded that the region may experience more severe rainfall and droughts and that the yield analysis had reasonably accounted for climate change.

Alternative 1 Federal No Action/FWOP

The future variability in precipitation (more high/low events) within the watershed is likely resulting in more variable Stockton Lake pool levels. However, the forecasted variability is within the existing variability that has occurred over the 62-year period of record. Any future variability would be the same for all future with and without project alternatives and conditions.

Alternative 5 Multipurpose Pool Water Reallocation

Implementation of the multipurpose pool water reallocation alternative would not have impacts to climate change since hydroelectric-generating capacity would not be changed.

Minor increases in heavy machinery use and exhaust would occur under this alternative during construction of the new water intake structure. The climate change impact would be minor and temporary during construction. There would be no direct long-term changes to climate change around the lake with implementation of Alternative 5. This alternative is expected to have no impact on climate change.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

Implementation of the combination flood control and multipurpose pool reallocation alternative would not have impacts to climate change since hydroelectric-generating capacity would not be changed.

Minor increases in heavy machinery use and exhaust would occur under this alternative during construction of the intake structure. The climate change impact would be minor and temporary during construction. There would be no direct long-term changes to climate change around the lake with implementation of Alternative 7. This alternative is expected to have no impact on climate change.

7.16. Flood Risk Management

The flood risk management affected environment is described in Section 4.16.

Alternative 1 Federal No Action/FWOP

Flood risk management would not undergo a significant change from the FWOP conditions due to implementation of the Federal No Action /FWOP alternative. There would be no change in operations.

Alternative 5 Multipurpose Pool Water Reallocation

Water reallocation from the multipurpose pool would result in no change from the current condition since the normal pool elevation of the reservoir would not be changed. It is estimated that the reservoir would spend additional time at lower elevations, essentially creating more space for flood waters; however, the change is expected to be minor.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

Water reallocation of storage from the combination flood control and multipurpose pool would result in a 1.8-foot surface water elevation increase across the lake. Because of operations and no change in the percent of time that the downstream Caplinger Mills gage spends at or above major flood stage, there is no change in flood risk management. Additional details can be found in Section 5.4.

7.17. Hydropower

The hydropower affected environment is described in Section 4.17.

Alternative 1 Federal No Action/FWOP

Hydropower generation would not undergo a change from the FWOP conditions due to implementation of the Federal No Action/FWOP alternative. There would be no change in operations.

Alternative 5 Multipurpose Pool Water Reallocation

Water reallocation of storage from the multipurpose pool would result in a change from the current condition since multipurpose pool storage would be reallocated specifically for the use of water supply storage. Therefore, hydropower would have less storage to meet their daily power demand. Hydropower benefits forgone are estimated to be $200,000 annually over a 50-year period of analysis as described in Section 5.5. It is estimated that this is a -0.58 percent change from the total capacity and energy values for the Osage River Basin System calculated under the No Action alternative. This accounts for impacts at both Stockton Lake and Truman Lake, which is downstream.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

Water reallocation from the combined multipurpose pool and flood control pool would result in a change from the current condition since storage would be reallocated specifically for the use of water supply storage. Hydropower would have less storage to generate hydropower from; however, hydropower generation would benefit from the 1.8-foot pool raise because it would provide more head and allow for hydropower to generate more efficiently. Hydropower benefits forgone are estimated to be $242,000 annually over a 50-year period of analysis as described in Section 5.5. It is estimated that this is a -0.70 percent change from the total capacity and energy values for the Osage River Basin system calculated under the Federal No Action/FWOP alternative. This accounts for impacts at both Stockton and Truman, which is downstream.

7.18. Real Estate

The real estate affected environment is described in Section 4.18.

Alternative 1 Federal No Action/FWOP

Real estate would not undergo a significant change from the FWOP conditions due to implementation of the Federal No Action/FWOP alternative. There would be no change in federal fee ownership.

Alternative 5 Multipurpose Pool Reallocation

Reallocation from the multipurpose pool would result in no change from the current condition since the normal pool elevation of the reservoir would not be changed. There would be no change in federal fee ownership.

Alternative 7 Combination Multipurpose Pool and Flood Control Pool Water Reallocation

Reallocation from the combination flood control pool and multipurpose pool would result in a 1.8-foot surface water elevation increase across the lake. Because of the original real estate acquisition when the reservoir was constructed, no additional parcels or conversion of flowage easements will be necessary. Appendix H includes the full evaluation.

7.19. Cumulative Effects

Cumulative impacts are defined in 40 CFR 1508.7 as:

> *"…the impact on the environment which results from the incremental impact of the [proposed] action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions."*

Past and present actions are actions that have occurred or are ongoing in the project area. Reasonably foreseeable future actions are actions that meet the following criteria:

- The potential impacts of the future action would occur within the same project area and during the same time as the potential impacts of the proposed action.
- The future action would affect the same environmental resources as the proposed action.

- There is a reasonable expectation the future action would occur given trends (the action is not speculative).
- There is sufficient information available to define the future actions and assess potential cumulative impacts.

The combination of these effects, and any resulting environmental degradation, is the focus of the cumulative impact analysis. The cumulative impacts of an action can be viewed as the total effects on a resource, ecosystem, or community of the proposed action and all other actions affecting that item regardless of the entity (i.e., federal, nonfederal, or private) responsible for the actions. The cumulative effects span the 50-year period of analysis in this report of the Stockton Lake reallocation study, through 2070.

7.19.1. Geographical and Temporal Boundaries

The geographical boundaries for this discussion of cumulative impacts are the Sac River drainage area (**Error! Reference source not found.** and the Stockton Lake study area, which includes federal fee and flowage property (**Error! Reference source not found.**). Stockton Lake covers 24,700 surface acres at the normal operating pool elevation of 867 feet NGVD 29. Temporal boundaries span the Stockton Lake impoundment (1968) to the 50-year period of analysis in this report (through 2070). This time frame includes the past 1993 water supply storage reallocation action. The existing conditions are described in Section 4 of this report. City Utilities of Springfield, Missouri has a pipeline built from Stockton Lake to Fellows Lake north of Springfield, Missouri. Tri-State Water Resources Coalition plans to construct the new pipeline within City Utilities existing easement because there is sufficient room for another pipeline. Impacts from the original City Utilities pipeline was evaluated under the Environmental Macro-Corridor Study Proposed City Utilities of Springfield, Stockton Water Supply Project, November 1991.

7.19.2. Past Actions

The Flood Control Act (approved in 1954) authorized Stockton Lake as a multipurpose project with water storage allocated for flood control (or flood risk management), hydroelectric power, water quality, recreation, and fish and wildlife management. Congress specifically authorized Stockton Lake construction for the purposes of flood control, recreation, and hydropower. Stockton Lake is also operated for water quality and fish and wildlife conservation under general congressional authorities.

USACE initiated construction in June 1964, and impoundment was initiated on December 12, 1969 (USACE 1977). The lake first filled to the top of the multipurpose zone (867 feet (NGVD 29) on December 18, 1971. In 1993, a water supply agreement for 50,000 AF of storage from the multipurpose pool was reallocated for water supply storage and contracted by City Utilities of Springfield, Missouri.

The dam consists of an earth/rock embankment, concrete spillway, and a hydroelectric power plant. Water released through the power plant produces electric energy which is marketed by SWPA. Four large spillway gates can be used during flood release operations to supplement discharges made through the power plant. The design of the gated spillway prevents overtopping of the dam and allows for the controlled release of excess flood water. SWPA has been generating power at Stockton Lake since 1971; the turbine was replaced in 2014.

There has been one water supply reallocation from Stockton Lake since the project's inception. In 1993, USACE received a request from City Utilities for water withdrawals from Stockton Lake. A USACE evaluation determined that sufficient surplus water existed in Stockton Lake to meet the request on an interim basis while still fulfilling the congressionally authorized purposes of the project. The Water Supply Act of 1958 (WSA), 43 U.S.C. § 390b, provides general authority to USACE to include municipal and industrial water supply storage in USACE lake projects provided that the state or local interests agree to pay for the cost of the storage provided (USACE 2003). Subsection (e) of the WSA requires congressional approval for modifications of a lake project if the reallocation of storage for water supply

would seriously affect the purposes for which the project was authorized, surveyed, planned, or constructed, or involves a major structural or operational change for the project (CRS 2012). A reallocation study at Stockton Lake resulted in a water storage contract with City Utilities in 1993. The environmental condition at Stockton Lake following the 1993 reallocation was considered as part of the Base Condition for this reallocation report.

7.19.3. Present Action

This Stockton Lake reallocation study was initiated to consider existing conditions, current requests for additional water supply storage, and the potential impacts of water storage reallocation alternatives to project purposes and natural resources.

Stockton Lake is currently managed under the 2020 Stockton Lake Lands Management Plan (MDC 2020) and the Stockton Lake Shoreline Management Plan (USACE 2018b). The lands management plan focuses on the authorized project purposes of recreation and associated natural resource management to ensure that natural resources and project facilities are being used to the greatest extent possible, but without degradation to the resource. The plan considers future uses and demands to accommodate varying recreational opportunities while avoiding potential conflict with current uses and integrates the management of diverse ecological and cultural resources at Stockton Lake while providing public recreation opportunities that contribute to the quality of the natural and human environments. The purpose of the shoreline management plan is to clarify and establish present policy; provide guidance for the management, protection, and restoration of the shoreline where degradation has occurred through private exclusive use; establish and maintain acceptable fish and wildlife habitats; maintain aesthetic quality and natural environmental conditions; and promote the safe, healthful use of the shoreline for recreational purposes by the public.

The request for additional water supply storage has created a need to carefully weigh increased water storage and withdrawals with existing withdrawal rates and what project resources can provide. Careful consideration must be given to the potential effects a reallocation of storage to water supply from current project purposes may have on aquatic and recreational resources. Under each alternative (Alternatives 5 and 7), an intake would be constructed at Stockton Lake. Any impacts from construction of the intake are considered as part of the proposed reallocation.

7.19.4. Reasonably Foreseeable Future Actions

The 2020 Stockton Lake Lands Management Plan, Stockton Lake Shoreline Management Plan, future water transmission line construction, and a water supply reallocation at Pomme de Terre Lake are the reasonably foreseeable future plans and projects in this analysis. The lands management plan and shoreline management plan are discussed above, as they are both presently utilized in the management of the lake and would continue to guide management decisions into the future.

The Southwest Missouri Regional Water transmission line construction is anticipated to occur in the southwest Missouri region to provide the infrastructure to convey water from Stockton Lake to its members. The plans for the intake and transmission line are currently conceptual in nature. Effects related to construction of the intake were evaluated as part of the current reallocation request in Section 7 of this report. The transmission line would primarily be located outside the study area for this report. A separate NEPA process would be completed relative to construction of the transmission line; therefore, it is not included in this analysis.

A separate reallocation request for Pomme de Terre Lake has been submitted by Southwest Missouri Regional Water to meet any additional water supply gap in the region. A reallocation study will be completed to assess potential impacts at Pomme de Terre Lake.

7.19.5. Cumulative Impacts Assessment

Table 7-9 summarizes the cumulative impacts resulting from the proposed action and any reasonably foreseeable future actions related to the proposed action. Cumulative impacts are assessed individually for each significant resource discussed in Sections 4 and 7 of this report.

7.19.6. Summary and Conclusion

The most significant environmental impacts, in consideration of cumulative effects, occurred at the time of construction of the Stockton Lake and Dam.

The resources surrounding Stockton Lake were thoroughly considered during the analysis of each reallocation alternative and the respective impacts. Minor, generally temporary impacts to water quality and noise may result from construction of the new intake.

An increase in availability of water for municipal and industrial use may increase development opportunities and population growth in the project areas, resulting in socioeconomic benefits. The reallocation request takes this future growth into consideration and is expected to fulfill the needs of the southwest Missouri region through 2070.

Table 7-9. Summary of Past, Present, Reasonably Foreseeable Actions and Cumulative Effects for the Proposed Stockton Lake Reallocation Project.

Resource	Past Actions Past Reallocation	Present Action Proposed Reallocation	Future Actions Reasonably Foreseeable	Cumulative Effects
Lake Operations	City Utilities of Springfield holds a contract for approximately 50,000 AF of water storage from Stockton Lake since 1993.	Alternative 5 would reallocate 90,200 AF from the Multipurpose Pool to water supply storage. Alternative 7 would reallocate 45,700 AF from the Multipurpose Pool and 49,000 AF from the Flood Control Pool to water supply storage.	There are no changes to lake operations noted in the management plans, and no changes to Stockton Lake operations would result from a reallocation of water from Pomme de Terre Lake.	Effects on lake operations would be solely attributed to the impacts resulting from operations under the selected reallocation alternative. There would be no cumulative impacts to lake operations.
Physiology, Geology, Topography	Upland riverine areas were flooded as a result of the impoundment.	Under both Alternatives 5 and 7 there may be minor, temporary soil disturbance and increased erosion potential during construction of a new intake structure. Impacts from this construction are considered to be insignificant. Under Alternative 7, there could be an increase in shoreline erosion due to additional days of inundation.	There are no impacts to physiology, geology, and topography resulting from Stockton Lake management plans or reallocation from Pomme de Terre Lake.	There are no cumulative effects to the physiology, geology, and topography of the study area.
Water Resources	Reliable water quantity was provided by Stockton Lake from the impoundment. The 1993 reallocation study determined pool level impact would be negligible in supporting a withdrawal rate of 50,000 AF by the City of Springfield. Stockton Lake has supported all its designated uses of hydropower, fish and aquatic life, recreation, wildlife, and water quality.	Under the proposed reallocation, reliance on existing groundwater and surface water supplies would be reduced, potentially increasing availability of surface and groundwater resources in the region. There would also be a minor reduction in the quantity of water available in Stockton Lake for other purposes. A reduction in the availability of aquatic habitat and wetlands is expected under Alternative 5, with increased availability of wetlands and aquatic habitat under Alternative 7. Under both alternatives, minor short-term impacts to water quality at Stockton Lake may result from intake construction.	A future reallocation from Pomme de Terre Lake may be beneficial to groundwater and surface water supplies within the study area.	Beneficial impacts to groundwater and surface water supplies are expected as a result of the proposed reallocation at Stockton Lake and a future reallocation at Pomme de Terre Lake.
Terrestrial Resources and Land Use	During Stockton Lake impoundment, agricultural, rural, and forest lands were submerged under the lake. Since this time, additional land was converted from natural habitats, rural, and agriculture to urban uses due to commercial development and population growth throughout the watershed. Impoundment of Stockton Lake converted nearly 24,700 surface acres of terrestrial habitat for wildlife aquatic habitat and use.	Temporary, minor impacts to grassland habitat at an existing utility easement would occur during construction of the intake structure. Under alternative 7, approximately 835 acres of additional shoreline area would be inundated more frequently, however, these impacts would not be significant.	There are no plans within the federal fee and flowage easement for residential or commercial development identified in the 2020 Stockton Lake Management Plan or the Stockton Lake Shoreline Plan. Additional water availability may lead to a continued increase in the local population and conversion of land from natural, rural and agriculture to residential and commercial development.	With increased water availability, there may be a continued increase in human population centers and conversion of land from natural, rural and agricultural uses to residential and commercial land use around Stockton Lake. No significant cumulative effects are anticipated because of the proposed Stockton Lake project due to occasional inundation of 835 acres around the lake; potential long-term land use changes will likely occur regardless of the Stockton Lake reallocation.

Resource	Past Actions Past Reallocation	Present Action Proposed Reallocation	Future Actions Reasonably Foreseeable	Cumulative Effects
Threatened and Endangered Species	Habitat disturbance occurred from the conversion and submersion of a riverine and terrestrial habitat to a lake aquatic ecosystem. The increase of water availability benefited fishery resources suited to a lentic environment. The 1993 reallocation study determined that the pool level change would be negligible and threatened and endangered species were not likely to be adversely affected.	Minor changes to above normal and below normal inundation days may occur but are not expected to adversely impact threatened and endangered species or critical habitat.	The 2020 Stockton Lake Management Plan outlines objectives to ensure that the biological resources and habitat remain healthy and thrive. Reallocation of water from Pomme de Terre lake would not affect threatened and endangered species within the Stockton Lake study area.	No cumulative effects to threatened and endangered species are anticipated.
Cultural Resources	Submersion of cultural resources occurred from the creation of Stockton Lake. The 1993 water reallocation study concluded minimal effect on cultural properties or resources. In 2018, a partial survey of the shoreline identified some sites that may be eligible for further testing and mitigation.	The magnitude of exposing cultural resources increases under Alternative 5 due to an increase in low water days which could increase exposure of cultural sites that are usually inundated. Impacts under Alternative 7 would be negligible given information known under the Federal No Action/FWOP.	The 2020 Stockton Lake Management Plan notes that all caves are closed or restricted to public access to reduce the risk of exposure and looting of cultural resources. Reallocation of water from Pomme de Terre lake would not affect cultural resources within the Stockton Lake study area.	Restrictions on public access to reduce exposure and looting of cultural resources are expected to reduce potential impacts on cultural resources. There would be no cumulative effects to cultural resources.
Air Quality	Hydropower generation typically provides a beneficial impact to air quality versus previous coal or gas fired generation of electricity. This is a qualitative assumption based on hydropower energy production being considered as a cleaner source of energy production.	Possible minor increases in pollutants would occur if lost energy production from hydropower is replaced with coal or gas generation of electricity. Short-term temporary impacts may occur during intake construction due to use of motorized equipment.	No impacts to air quality are expected as a result of future management plans or a possible reallocation at Pomme de Terre Lake.	No cumulative impacts to air quality are anticipated.
Socioeconomic Conditions	Creation of Stockton Lake likely provided multiple potential socioeconomics benefits to local and regional economies associated with the authorized purposes of the lake (recreation, flood risk, hydropower, and fish and wildlife resources). The reallocation of water to City Utilities of Springfield likely allowed for continued water supplies needed to continue economic growth and development. These are qualitative assumptions based on economic growth success being linked with consistent and reliable water supply.	Loss of a minor amount of hydropower benefit. Likely beneficial effect to local economic growth potential because of a long-term and adequate and safe water supply.	Likely beneficial effect to local economic growth because of a long-term reliable water supply.	Likely beneficial effects would occur to local economic growth resulting from a long-term safe and reliable water supply.
Environmental Justice	Impact to low-income populations with the creation of Stockton Lake are unknown.	Minor changes to Stockton Lake surface water elevations would not affect low-income populations.	Future lake management and a proposed water reallocation at Pomme de Terre Lake would not affect low-income populations.	No cumulative effects to low-income populations would occur.

Resource	Past Actions Past Reallocation	Present Action Proposed Reallocation	Future Actions Reasonably Foreseeable	Cumulative Effects
Recreation	The formation of Stockton Lake created significant new recreational opportunities for the area. The 1993 reallocation study determined that there would be no effect to recreation activities and facilities.	Under Alternative 5, minor adverse impacts to some boat ramps may occur. Under Alternative 7, changes in elevation would be insignificant to recreational use.	Future lake management and a water reallocation at Pomme de Terre Lake would not impact recreational uses of Stockton Lake.	No cumulative effects to recreational uses would occur.
Hazardous, Toxic, and Radioactive Waste	No adverse impacts to existing HTRW sites occurred during the construction of Stockton Lake or the 1993 reallocation.	No adverse impacts to existing HTRW sites would occur with minor changes to Stockton Lake surface water elevations under Alternatives 5 and 7.	No adverse impacts to HTRW sites.	No cumulative effects to HTRW sites are anticipated.
Aesthetics	The formation of Stockton Lake created a setting that is aesthetically pleasing to recreational users and local residents.	Minor impacts to aesthetics based on changes in lake fluctuations under the proposed reallocation alternatives.	No adverse impacts to aesthetics.	No cumulative effects to aesthetics would occur.
Noise	Temporary increases in noise emissions during past construction activities.	Possible temporary increases in noise emissions from construction activities during intake construction.	No increases in noise emissions within the study area.	No cumulative effects to noise emissions would occur.
Climate Change	Possible, minor inputs of hydrocarbons to the atmosphere from construction related equipment during impoundment.	Possible temporary, minor inputs of hydrocarbons to the atmosphere from construction-related equipment associated with the proposed water intake structure.	No impacts to climate change would occur under the future actions.	No cumulative effects to climate change would occur.
Flood Risk Management	The creation of Stockton Lake was a beneficial impact to regional flood risk management.	Under Alternative 5, a minor beneficial impact is expected due to lower lake elevations. There is no adverse impact to flood risk management from Alternative 7.	No impacts to flood risk management under the future actions.	No cumulative effects to flood risk management.
Hydropower Generation	Creation of Stockton Lake provided a significant amount of hydropower. Electrical power benefitted development and local population growth around Stockton Lake. The 1993 water reallocation study notes a loss in hydropower production would result in SWPA having to purchase power from other sources to fill power commitments.	The amount of power generated through hydropower is negatively affected by the proposed water reallocation as more storage is allocated to water supply.	No impacts to hydropower generation under the future actions.	No cumulative effects to hydropower generation.
Real Estate	Increased development following the impoundment of Stockton Lake.	No change to the existing federal fee parcels or flowage easements.	No change to the existing federal fee parcels or flowage easements.	No cumulative change to the existing federal fee parcels or flowage easements.

8.0 Recommended Plan

Based on the economic and environmental evaluations the USACE and the proposed water user, Southwest Missouri Regional Water, have selected Alternative 7 as the Recommended Plan. Alternative 7 consists of reallocating 45,750 AF from the multipurpose pool and 49,000 AF from the flood control pool, resulting in a 1.8-foot increase to the normal pool elevation (i.e., a 1.8-foot pool raise). Under this alternative, the normal pool elevation would be changed from 867 to 868.8 feet NGVD 29.

The Recommended Plan meets all of the study objectives, which are:

- Reduce, to the extent practicable, water supply shortages forecasted for M&I water users, over the 50-year period of analysis to 2070
- Improve the reliability of water supply during drought conations over the 50-year period of analysis to 2070 for the 16-county area
- Maintain current lake elevation fluctuations as much as possible

In addition to the meeting the primary objectives, the Recommended Plan also meets the project's secondary objectives:

- Provide water supply of equivalent quality as currently supplied by groundwater and surface water sources over the 50-year period of analysis to 2070
- Become less reliant on nonrenewable groundwater over the 50-year period of analysis

Based on the comparison and evaluation of the two alternatives, Alternative 7 will more effectively maintain current lake elevations without significantly harming the environment. It also takes into account and does not violate any of the project constraints. The recommended plan does not induce or increase flood risk management downstream, nor does it increase the risk of life safety. The recommended plan does not significantly affect other authorized purposes at the project based upon the study's evaluation. The recommended plan will continue to provide adequate downstream flood control and will maintain downstream flows and water quality over the 50-year period of analysis.

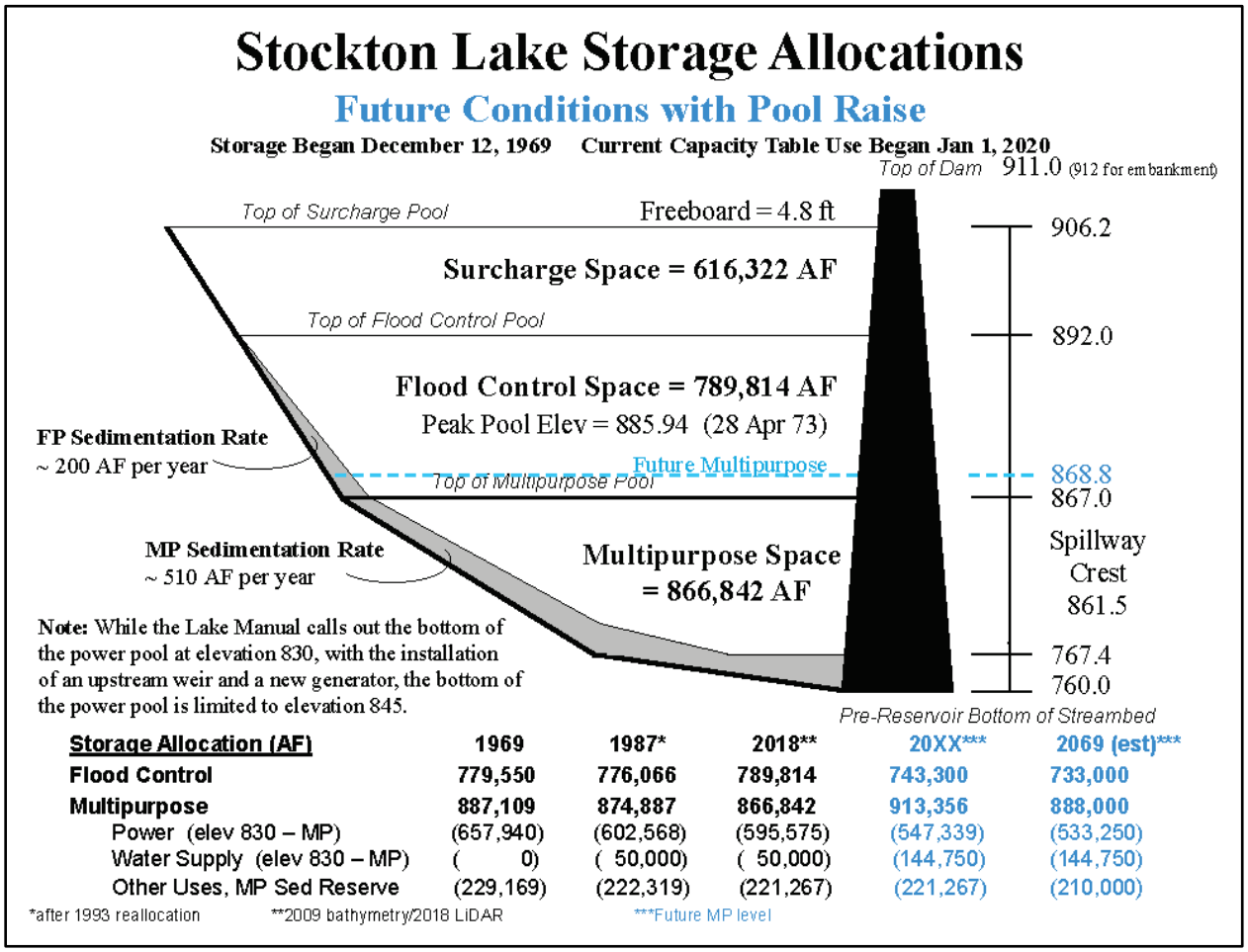
The Recommended Plan will allow SWMO Regional Water to reduce the area's vulnerability during drought and serve the current and growing needs of the region.

Figure 8-1 displays the revised storage allocations based on the recommended plan; Table 8-1 shows the same information in a different format.

Table 8-1. Recommended Plan Storage Data on Stockton Lake.

Feature	Elevation (feet NGVD 29)	Area (acres)	Storage Volume (AF)
Surcharge storage	892–906.2	48,053	616,322
Flood control storage	867–892	38,281	789,814
Multipurpose storage	765–867	24,632	866,842
Hydropower[1]	830–867	--	(547,339)
Water Supply	830–867	--	(144,750)
Other Multipurpose	Below 830	--	(221,267)
Total Useable Storage[2]	**N/A**	**N/A**	**1,435,389**

[1] SWPA is not able to generate below elevation 845 feet NGVD 29.
[2] Total useable storage = flood control storage + multipurpose storage from elevations 830–867 feet NGVD 29.



Storage Allocation (AF)	1969	1987*	2018**	20XX***	2069 (est)***
Flood Control	779,550	776,066	789,814	743,300	733,000
Multipurpose	887,109	874,887	866,842	913,356	888,000
Power (elev 830 – MP)	(657,940)	(602,568)	(595,575)	(547,339)	(533,250)
Water Supply (elev 830 – MP)	(0)	(50,000)	(50,000)	(144,750)	(144,750)
Other Uses, MP Sed Reserve	(229,169)	(222,319)	(221,267)	(221,267)	(210,000)

*after 1993 reallocation **2009 bathymetry/2018 LiDAR ***Future MP level

Figure 8-1. Recommend Plan Storage Allocation.

8.1. Risk and Assumptions

As described earlier in Section 5.2 Risk and Uncertainties, there were assumptions made for the reservoir modeling, which is an accepted risk in order to make a decision. There is a high likelihood that the water user will not continually withdrawal 60 cfs from Stockton Lake. For most of the Southwest Missouri Regional Water members, this is a supplemental or secondary source of water supply. While there is an immediate need, it will most likely take to the end of the period of analysis before withdrawals in the amount of 60 cfs are realized. In addition, the maximum withdrawals would primarily be expected to occur during periods of drought.

Assumptions were additionally made regarding future population growth, usage, available water supplies, temperatures, and rainfall for the region. If one or more of those factors or assumptions is incorrect, the study could have over or under projected the supply gap for the region. However, it is known that the two larger municipalities of Joplin and Springfield are in need of additional water supply storage. Joplin's need is most immediate, and Springfield's is projected to occur in about 10 years. Regardless, the proposed plan will help the southwest Missouri region be more resilient against drought and reduce their risk of shortages.

8.2. Repayment Cost for the User

Costs allocated to storage are set to the highest of benefits forgone, revenues forgone, replacement costs, or updated cost of storage as described in Section 5.7. Therefore, users incur updated cost of storage costs. The total annual financial payment for the recommended reallocation is $1,985,890. The cost of

storage is repaid at the FY2020 Water Supply interest rate of 2.875 percent over 30 years (Table 8-3). In accordance with Section 932 of the Water Resources Development Act of 1986, this interest rate will be adjusted at 5-year intervals throughout the repayment period. The rate is the yield rate as determined by the Secretary of the Treasury plus one-eighth percent. This is documented in the annual HQUSACE Economic Guidance Memorandum. The estimated O&M expenditures are based on actual FY2019 O&M expenses and the RR&R is based on projected RR&R costs at the project. At this time, there are no significant RR&R costs that have been identified. Table 8-2 outlines the parameters used to calculate the repayment cost to the user, and Table 8-3 displays the total repayment costs.

Table 8-2. Parameters Used to Calculate Repayment Costs for Southwest Missouri

Parameter	Item
Total water supply storage required under TSP (AF)	94,750
Water supply yield (MGD)	39
Interest rate	2.875%
Repayment period	30
Flood control storage	789,814
Multipurpose storage (830 to 867 feet NGVD 29)	645,575
Inactive storage (below 830 feet NGVD 29)	221,267
Usable storage	1,435,389
Storage required as percent of useable storage	6.60%

Note: Costs are in FY2020; annualized using the FY2020 Federal Water Supply discount rate of 2.875% over a 30-year repayment period.

Table 8-3. Updated Cost of Storage for Southwest Missouri Regional Water Annual Repayment Cost.

Costs (FY2020$)	Total Costs	Costs as a Percent of Usable Storage (6.60%)
Joint-use project cost	$542,029,600	$35,800,000
Annualized joint-use project cost	$27,208,997	$1,797,101
Estimated annual O&M (based on actual FY2019 O&M expenditures)	$2,860,000	$188,789
Estimated RR&R (based on projected RR&R expenditures)	$0	$0
Total Annual Repayment		$1,985,890

9.0 Test of Financial Feasibility

The updated cost of storage method results in the highest cost for the reallocation of storage for water supply under the Recommended Plan and will be used in testing financial feasibility and determining the first cost of storage in the water storage agreements. As a test of financial feasibility, the annual cost of the reallocated storage (estimated in Section 5.7) is compared to the annual cost of the most likely, least cost alternative that would provide an equivalent quality and quantity of water, and which Southwest Missouri Regional Water would undertake in the absence of utilizing additional reallocated storage from Stockton Lake.

According to previous studies conducted by Southwest Missouri Regional Water, the most likely, least costly alternative for a reliable water source in absence of reallocating storage at Stockton Lake would be construction of a new reservoir and associated transmission and treatment lines.

Southwest Missouri Regional Water has been investigating this issue since 2006. A study conducted by Black and Veatch (2006) concluded that rivers and streams do not have sufficient flow to meet long-term demand without the construction of an additional reservoir. It also identified alternate source options as existing surface area reservoirs. To further evaluate the issue, Freese and Nichols (2009) evaluated potential reservoir sites and associated costs. In 2010, a supplemental study was completed in which three potential reservoir sites were evaluated in more detail; however, the study concluded that seeking a reallocation from an existing surface water reservoir would be more cost effective (Freese and Nichols 2010). One of the identified sites was used as the basis for the Alternative 2 condition. Site 2 near Joplin, Missouri included one configuration to construct a 36 MGD reservoir. The 2010 cost estimated from this study was reviewed and updated by NWK Cost Estimating staff. The first part of the review updated the unit costs either by using the ENR Construction Cost Index Factor or by replacing 2010 costs with current FY2020 costs. The second part included a review of assumptions and cost accounts. Cost accounts that were not included in the 2010 estimate were added (for instance, preconstruction, engineering, and design) for completeness. Since Southwest Missouri Regional Water is seeking a reservoir large enough to supply 39 MGD, an additional 8 percent cost increase (based on a ratio of cost/MGD) was added to the cost estimate to account for the additional yield. With all of these updates applied, the cost of a new reservoir in FY2020 dollars is approximately $296 million; annual O&M is estimated to be $500,000.

O&M costs for water supply users at Stockton Lake are based on actual FY2019 joint-use expenditures and the associated percentage that the water supply user will be responsible for as described in Section 8. RR&R costs were determined in conjunction with the USACE, Kansas City District Operations Division. At this time, no RR&R projects have been identified in the next 2 budget years. As described in Section 8, original construction, joint-use costs were updated to 2020 dollars and apportioned to the new user using the water storage user percentages under the Recommended Plan. A 50-year period of economic analysis was used, and all costs were inflated accordingly. The costs were discounted using the current FY2020 discount rate of 2.75 percent to find the net present value and the average annual equivalent cost. The resulting OMRR&R costs under the Recommended Plan are estimated to be $190,000.

The capital costs for the Recommended Plan is the updated cost of storage, benefits forgone, and mitigation, which is approximately $8,600,000, annualized over 50 years at a discount rate of 2.75 percent. The resulting annualized cost of storage, including O&M, is approximately $1,620,000.

This analysis shows that the Recommended Plan is more financially feasible than the most likely, least costly alternative for Southwest Missouri Regional Water as indicated in Table 9-1.

Table 9-1. Test of Financial Feasibility.

Cost or Forgone Benefit for Authorized Purpose	Alternative 2 New Reservoir	Alternative 7 Combination Multipurpose Pool and Flood Control Pool
Estimated Yield from Storage	**39**	**39**
Hydro energy and capacity benefits forgone	--	$242,000
Real Estate Costs	--	--
Recreation benefits forgone	--	--
Recreation mitigation	--	25,000
Dam Safety	--	TBD
Flood risk management	--	--
Environmental (habitat)–TBD	--	--
Cultural Resources (EST.)		$ 2,500,000
Capital Costs–Cost of Storage	$296,000,000	$35,800,000
Capital Costs–Transmission and Treatment*	--	--
TOTAL COSTS	$296,000,000	$38,600,000
O&M Costs	$500,000	$190,000
RR&R Costs	--	--
I&A Factor	0.03704	0.03704
Total Average Annual Costs	**$11,464,000**	**$1,620,000**

Notes: FY2020 price level; average annual costs calculated over a 50-year period of analysis at the current FY2020 federal discount rate of 2.75%.
Hydropower FY2019 price level over a 50-year period of analysis at the FY2019 federal discount rate of 2.875%.
Capital costs of transmission and treatment will have to be constructed with a new reservoir or with a reallocation. To not skew the average annual costs, the costs have been removed but range from $1.6 billion to $1.7 billion.

10.0 Public Involvement, Review, and Consultation

Tri-State Water Resources Coalition and the Kansas City District have conducted various public outreach over the past years. Tri-State Water Resources Coalition originally submitted a reallocation request back in 2007, not knowing when and where funds would be allocated to begin a study, Tri-State Water Resources Coalition started communicating their mission. On February 3, 2012, a Stockton Lake Stakeholder meeting hosted by Tri-State Water Resources Coalition, with support from the Kansas City District and the Missouri Department of Natural Resources at the Stockton Lake project office. Elected officials and others from six surrounding counties were invited (Dade, Polk, Cedar, Vernon, Saint Clair, and Hickory). Another Stockton Lake Stakeholder meeting was conducted on May 7, 2015, and Tri-State attended after the initial study funding was received.

Other key stakeholder meetings are listed below:

July 24, 2017: The study project manager, Tri-State Water Resources Coalition, and Stockton lake staff met with the mayor of Stockton, Missouri to discuss the reallocation study and answer questions. Later that day, meetings were held at the three marinas operating at Stockton Lake, which included Stockton State Park, Orleans Trail Resort, and Mutton Creek Marina.

September 20, 2017: The Executive Director of Tri-State Water Resources Coalition presented at a Stockton Chamber of Commerce luncheon to discuss their mission and their request for a reallocation.

10.1. Agency and Tribal Initial Coordination

Coordination has been initiated with USFWS (on July 31, 2017) and MDC (on October 11, 2017) regarding potential impacts to threatened and endangered species in the project area resulting from potential alternatives for reallocation of water supply storage.

Letters initiating consultation under Section 106 of the NHPA with the Missouri SHPO and Native American tribes were sent on August 14, 2017. Coordination letters were mailed to the Missouri State Historic Preservation Office (SHPO), the Osage Nation, the Caddo Nation, the Iowa Tribe of Kansas and Nebraska, the Kaw Nation, the Omaha Tribe, the Ponca Tribe of Nebraska, The Ponca Tribe of Oklahoma, and the Sac and Fox Nation of Missouri in Kansas and Nebraska. Responses for additional coordination were received from the Missouri SHPO and the Osage Nation. Additional information and copies of the letters can be found in Appendix G.

SWPA was sent a coordination letter in August 2019. SWPA responded on October 25, 2019. Further coordination will take place in spring 2020.

Coordination with MoDNR and EPA was initiated on February 26, 2020, regarding potential impacts to water quality in the project area resulting from the final array of alternatives and reallocation of storage.

All agency coordination letters and responses are included in Appendix G, National Historic Preservation Act Documentation and Correspondence, and Appendix F, NEPA Correspondence.

10.1.1. Coordination with USFWS and MDC

An initial coordination meeting was held with USFWS and MDC on October 10, 2017, and again on February 11, 2020. Discussion during the first meeting included the following topics of concern to the agencies:

- Potential impacts to the thermocline because of the skimming weir at elevation 845 feet NGVD 29
- Potential impacts to Aldrich Refuge (managed by MDC)
- Downstream flow changes and potential impacts to endangered species
- Potential changes to land use, including trees for bat habitat

The February 2020 meeting focused more specifically on the final array of alternatives and Alternative 7. Discussion was again focused mainly on the same topics above. USFWS has always been and continues to be concerned with the fluctuation of Stockton Lake dam releases associated with hydropower and impacts to downstream mussels. No changes to downstream releases are anticipated with implementation of proposed alternatives, and minimum low-flow releases would remain in place. It is recommended that additional studies focusing on Stockton Lake releases and benefits/impacts to downstream mussel populations be conducted in the near future. Additional information and meeting notes can be found in Appendix G.

10.1.2. Coordination with SWPA

Southwestern Power Administration (SWPA) was sent a coordination letter in August 2019. SWPA responded on October 25, 2019. Additional coordination with SWPA occurred through Hydropower Storage Reallocation Team meetings that involved multiple Power Marketing Agencies, Headquarters USACE, the Hydropower Analysis Center from the USACE Portland District and the USACE Water Management and Reallocation Study Center of Expertise. These meetings occurred periodically from 2017 to 2018.

A coordination meeting occurred on June 11, 2020 to discuss the HEC-ResSim model and results from the Hydropower Analysis Center.

10.1.3. Coordination with SHPO and Tribes

In Missouri SHPO's response letter, it stated concerns that changes in water levels or water fluctuation could affect both known and unknown sites. The SHPO also stated that only a partial inventory had been collected previously using unreliable standards as compared to modern methodologies that are used now. They requested to continue consultation.

An initial coordination meeting with the Osage Nation was held on December 19, 2017, in Pawhuska, Oklahoma at the tribe's office. A presentation was provided to discuss the study background and initial array of alternatives. At that meeting, the Osage Nation expressed concern that cultural resource sites of importance to the tribe were being impacted by lake operations and requested further consultation on the study. Other concerns included the lack of survey data and inability of USACE to describe impacts. The tribe was also concerned about the secondary indirect effects of the reallocation because it involves constructing transmission lines, and if the city/municipalities are in charge of that, they may not follow correct process regarding cultural involvement.

A second virtual coordination was held on April 27, 2020. Attendees included Missouri SHPO, Advisory Council on Historic Preservation the Osage Nation and the Ponca Tribe.

Additional information and copies of the letters can be found in Appendix G, National Historic Preservation Act Documentation and Correspondence.

10.2. Notice of Availability

A notice of availability of the draft report and unsigned finding of no significant impact (FONSI) was released to the public on July, 08, 2020. Comments received are summarized below and included in their entirety in Appendix F. USACE's responses are shown in *italics*.

ADD TEXT AFTER PUBLIC REVIEW.

10.3. Environmental Compliance

Project compliance with environmental laws are listed in Table 10-1. Definitions of compliance are as follows:

- Full compliance: Having met all requirements of the statute for the current stage of planning (either preauthorization or post-authorization).

- In-Progress: Not having met some of the requirements that normally are met in the current stage of planning.
- Noncompliance: Violation of a requirement of the statute.
- Not applicable: No requirements for the statute required; compliance for the current stage of planning.

Table 10-1. Environmental Compliance.

Federal Policies	Compliance
Archeological Resources Protection Act, 16 U.S.C. 470, et seq.	In-Progress
Clean Air Act, as amended, 42 U.S. C. 7401–7671g, et seq.	Full Compliance
Clean Water Act (Federal Water Pollution Control Act), 33 U.S.C. 1251, et seq.	Full Compliance
Coastal Zone Management Act, 16 U.S.C. 1451, et seq.	Not Applicable
Endangered Species Act, 16 U.S.C. 1531, et seq.	In-Progress
Environmental Justice (EO 12898)	Full Compliance
Estuary Protection Act, 16 U.S.C. 1221, et seq.	Not Applicable
Farmland Protection Policy Act, 7 U.S.C. 4201, et. seq.	Not Applicable
Federal Water Project Recreation Act, 16 U.S.C. 4601–12, et seq.	Full Compliance
Fish and Wildlife Coordination Act, 16 U.S.C. 661, et seq.	In-Progress
Floodplain Management (EO 11988)	In-Progress
Invasive Species (EO 13122)	Full Compliance
Land and Water Conservation Fund Act, 16 U.S.C. 4601–4, et seq.	Not Applicable
Marine Protection Research and Sanctuary Act, 33 U.S.C. 1401, et seq.	Not Applicable
Migratory Bird Treaty Act, 16 U.S.C. 703–712, et. seq.	In Progress
National Environmental Policy Act, 42 U.S.C. 4321, et seq.	In-Progress
National Historic Preservation Act of 1966, as amended, 16 U.S.C. 470a, et seq.	In-Progress
Protection and Enhancement of the Cultural Environment (EO 11593)	In-Progress
Protection of Wetlands (EO 11990)	In Progress
Rivers and Harbors Act, 33 U.S.C. 403, et seq.	Full Compliance
Watershed Protection and Flood Prevention Act, 16 U.S.C. 1001, et seq.	Full Compliance
Wild and Scenic River Act, 16 U.S.C. 1271, et seq.	Not Applicable

11.0 Implementation

The water supply storage reallocation study proposes a phased implementation of storage reallocation. Approval of this report will enable reallocation of the entire volume of 94,750 AF for water supply storage. However, the implementation of reallocation through water supply contracts for storage will be phased, with a recommendation to execute an immediate water storage agreement for the lesser volume of 45,750 AF from the multipurpose pool upon approval of this report. In FY2024, further dam safety evaluations will be conducted as part of the cyclical Dam Safety Periodic Assessment at Stockton Dam. The results of the assessment will determine if the DSAC should be reclassified as a 4 in accordance with the risk guidelines. If the DSAC rating is reclassified as a 4 and approved by the HQUSACE Chief of Engineers, a water storage agreement for the remaining 49,000 AF of storage could be executed by Southwest Missouri Regional Water and the 1.8-foot pool raise would be implemented. Southwest Missouri Regional Water is aware of the DSAC rating and their responsibility associated with any major repairs required to restore the rating to a 4 or seek a waiver to policy if a 4 rating is not achievable.

11.1. Federal and Nonfederal Costs and Responsibilities

In accordance with Section 103(c)(2) of the WRDA of 1986 (Pub. L. No. 99-662), the cost to reallocate storage in Stockton Lake for M&I water supply is a nonfederal responsibility.

The water storage agreement documents the federal government and M&I water supply users' rights and responsibilities. It includes the cost of storage and other specific costs. The M&I water supply users could repay the cost of storage upfront or repay the cost over a 30-year period, beginning with the date of signing a new water storage agreement approved by the Assistant Secretary of the Army for Civil Works. The draft water supply agreement for Southwest Missouri Regional Water seeking additional storage is included in Appendix I. Model water storage agreements will be utilized and deviations are documented.

The cost of storage was derived using the use of facilities cost allocation procedure (Appendix E of ER 1105-2-100). This procedure selects the greatest cost among benefits forgone, revenue forgone, updated cost of storage, or replacement costs for the cost of storage. The value of the full 94,750 AF of storage necessary to accommodate the total need under Alternative 7 is estimated to cost $35,800,000 based on the updated cost of storage.

The annual OMRR&R costs of the project associated with the reallocated storage (joint-use project) is also a nonfederal responsibility. These costs would be paid at the beginning of each fiscal year. At the end of the fiscal year, final adjustments and accounting will summarize all joint-use costs associated with OMRR&R for the project. The use of facilities cost allocation procedure would be applied to the joint-use OMRR&R cost to determine the final OMRR&R costs. In addition to the OMRR&R associated with the joint-use project, increased OMRR&R costs related to the reallocation of storage are a nonfederal responsibility.

City Utilities is a current member of Southwest Missouri Regional Water and the contract holder on the first increment of storage. Because of their membership and involvement with Southwest Missouri Regional Water, a sub agreement will be negotiated between the two groups to ensure that City Utilities will maintain its original critical yield of approximately 44 cfs in addition to its second increment of storage as part of the current action needed for its growing population.

Southwest Missouri Regional Water is aware of the DSAC rating and their responsibility associated with any major repairs associated under the program.

Southwest Missouri Regional Water is also aware of the mitigation costs associated with recreation and cultural resources ($25,000 and $2,500,000, respectively) as a result of the proposed action.

11.2. Serious Effects Summary

Serious effects are summarized in Tables 11-1 and 11-2. The summary is based upon all previous evaluations presented in the report.

Table 11-1. Summary of Serious Effects Part A.

Alternative	Dam Safety	Flood Risk Management	Hydropower	Recreation
Alternative 1 Federal No Action/FWOP (includes 50,000 AF reallocation for Springfield, MO)	DSAC 4 when study started. Changed to DSAC 3 after initial potential failure mode review (new methods)	The gage is at or above major stage 0.46% of the time over the period of record	Hydropower Benefits forgone: ($310,046) or -0.89% change from the Pre-reallocation condition for the Osage Federal System; Revenue forgone: $17,743 1993 Reallocation: $600,000 credit	Campsites: On average annually, 166 campsites are closed for as many as 13 days Boat Ramps: 3 boat ramps are typically impacted each year during drought/low water Picnic Tables: On average annually, 87 picnic tables are inundated approximately 4 days Roads: All 19 roads closed on average 4 days per year Swim Beaches: All 5 beaches, on average, are closed 12 days per year Outgrants: 103 outgrants
Alternative 5	Does not change DSAC rating or incrementally increase project risk	A 0.01% decrease in the amount of time that the gage is at or above major flood stage over the period of record	Hydropower Benefits forgone: ($200,107); -0.58% change in energy and capacity values from the base condition for the Osage Federalsystem; --1.48% change in energy and capacity values for Stockton Lake.	Campsites: N/A Boat Ramps: Additional closure days during drought at the 3 ramps; there could be closures at ramps that typically are not closed during drought Picnic Tables: N/A Roads: N/A Swim Beaches: More debris (sticks, etc.) could be exposed during drought Outgrants: No impact
Recommended Plan: Alternative 7	Does not change DSAC rating or incrementally increase project risk	Does not increase the amount of time that gage is at or above major flood stage over the period of record	Hydropower Benefits forgone: ($241,952); -0.70% change in energy and capacity values from the base condition for the; for the Osage Federal system; -1.18% change in energy and capacity values for Stockton Lake.	Campsites: Approximately 28 campsites would close 1 additional day Boat Ramps: During drought, minimal amount of days of additional closures due to lower water elevations Picnic Tables: Approximately 13 tables would be inundated 1 additional day Roads: Approximately 7 roads would be inundated 1 additional day Swim Beaches: buoys would need a one-time adjustment Outgrants: No impact

Table 11-2. Summary of Serious Effects Part B.

Alternative	Environmental	Cultural	Real Estate
Alternative 1 Federal No Action/FWOP (includes 50,000 AF reallocation for Springfield, MO)	Lake elevations generally fluctuate between elevations 863 feet to 873 feet. Lake is, on average annual basis: • 43% of time in normal pool range (865–870.9 feet) • 19% (865–863 feet) at a low elevation • 32% at a below-normal elevation (863 or below) Sites are already being impacted due to current operation	Sites are already being impacted by current operations	No additional Real Estate required
Alternative 5	Land Use: N/A Minimum flows: Still at 40 cfs Water management staff plotted downstream flows; they are not expected to change significantly Pool at potentially lower lake elevations, especially during drought	During drought, pool elevations are projected to lower than base case	No additional Real Estate required
Recommended Plan: Alternative 7	Land Use: Acreage of potential inundation would be 835 acres; 12.52 acres of NWI wetlands are believed to have some beneficial impacts and disadvantageous impacts Minimum flows: Still at 40 cfs Water management staff plotted downstream flows; they are not expected to change significantly	Mitigation of sites within the band of 867.0 to 868.8 feet will be the responsibility of Southwest Missouri Regional Water. 24 potentially eligible sites identified so far; 1/3 of the shoreline still needs survey	No additional Real Estate required; No impact as determined by the takings analysis

11.3. Reallocation Approval

The Recommended Plan does not seriously affect the authorized purposes of Stockton Lake or involve major structural or operational changes to the reservoir. Therefore, this reallocation is within the Secretary of the Army's discretionary authority.

11.4. Proposed Schedule

If the proposed reallocation is approved, Southwest Missouri Regional Water will sign a water storage agreement as soon as practicable to contract for water supply storage in the reservoir.

11.5. Proposed Agreements

Water storage agreements for Southwest Missouri Regional Water seeking storage in Stockton Lake will be drafted using the model water storage agreement. The water supply storage agreement both red-lined version and clean version are provided in Appendix I.

11.6. 408 Considerations/Real Estate Consideration

Southwest Missouri Regional Water will seek permission for a real estate action and 408 consideration once plans for their water intake structure are finalized. The preliminary plans for the new water intake construction is to construct it next to the existing City Utilities intake structure at the south end of the lake. City Utilities already has an existing easement with enough space for a second intake. Southwest Missouri Regional Water will submit a written request, complete with maps, engineering plans, and other pertinent documentation to the Stockton Lake Project Office. The package will then be routed through relevant district offices for review. A separate submission will be sent through the Regulatory Branch via the Jefferson City office.

12.0 Conclusion and Recommendation

Based upon the data and analysis provided herein and the results of the National Environmental Policy Act compliance and expected signed Finding of No Significant Impacts (FONSI), and pursuant to the Water Supply Act of 1958, as amended at 43 U.S.C. § 390b, the Recommended Plan is to reallocate 45,750 AF of storage from the multipurpose pool and 49,000 AF of storage in the flood control pool, resulting in an increase of 1.8 feet to the normal pool elevation from 867 feet NGVD 29 to 868.8 feet NGVD 29 in Stockton Dam and Lake to municipal and industrial (M&I) water supply storage through a phased reallocation. Reallocation, as described in Section 6.0, is considered the most efficient means to satisfy the current and projected water demands for the Tri-State Water Resource Coalition, to be implemented by the sister organization of Southwest Missouri Regional Water. The phased water reallocation would allow water storage agreements to be immediately executed for 45,750 AF of multipurpose pool storage after the final approval of this water reallocation report. Once all dam safety requirements are met and implemented, a water storage agreement for the remaining 49,000 AF and pursuant pool raise could be executed under the existing environmental analysis contained within this report and FONSI.

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Date

_____
William C. Hannan, Jr.
Colonel, USACE
District Commander

13.0 Acronyms and Abbreviations

ACS..... American Community Survey
AF ..... acre-feet
AFY ..... acre-feet per year
amsl..... above mean sea level
EDR ..... environmental data resources
EPA..... U.S. Environmental Protection Agency
ESA..... Endangered Species Act
BCC ..... birds of conservation concern
BCR ..... Bird Conservation Region
BFE ..... base flood elevation
CDM Smith..... CDM Federal Programs Corporation
CESQG ..... Conditionally Exempt Small Quantity Generator
cfs..... cubic feet per second
Chl-a ..... chlorophyll-a
City Utilities..... City Utilities of Springfield
CWA ..... Clean Water Act
CWCCIS ..... Civil Works Construction Cost Index System
DO..... dissolved oxygen
DSAC..... Dam Safety Action Classification
DSOG..... Dam Safety Oversight Group
DYMS..... dependable yield mitigation storage
EDR ..... environmental data resources
EM ..... Engineer Manual
ENR ..... Engineering News Record
EO ..... executive order
EPA..... U.S. Environmental Protection Agency
EQ ..... environmental quality
ER ..... Engineer Regulation
ERC..... Environmental Research Center
FONSI..... finding of no significant impact
FP ..... flood pool
FWOP ..... future without project
FWP ..... future with project
FY ..... fiscal year
GWh..... gigawatt-hour
H&H..... Hydrology and Hydraulic
HAC ..... Hydropower Analysis Center
HPA ..... Historic Preservation Association
HPMP..... Historic Properties Management Plans
HQUSACE..... Headquarters USACE
HTRW..... hazardous, toxic, and radioactive waste
I&A ..... interest and amortization
kFP ..... thousand acre-feet from flood control pool
kMP..... thousand acre-feet from multipurpose pool
M&I ..... municipal and industrial
MAS..... Missouri Archeological Society
MDC ..... Missouri Department of Conservation
MoDNR ..... Missouri Department of Natural Resources
MGD ..... million gallons per day

mg/L ..... milligrams per liter
MU ..... University of Missouri
MW ..... megawatt
MWh ..... megawatt-hour
NAAQS ..... National Ambient Air Quality Standards
NED ..... National Economic Development
NEPA ..... National Environmental Policy Act
NGVD 29 ..... National Geodetic Vertical Datum of 1929
NLCD ..... National Land Cover Database
NHPA ..... National Historic Preservation Act
NHRP ..... National Register of Historic Places
NPDES ..... National Pollution Discharge Elimination System
NPS ..... National Park Service
NWI ..... National Wetland Inventory
NWS ..... National Weather Service
O&M ..... operation and maintenance
OMRR&R ..... operation, maintenance, repair, replacement and rehabilitation
OSE ..... other social effects
PA ..... periodic risk assessment
PIs ..... periodic inspections
PDT ..... project development team
PMF ..... probable maximum flood
RCRA ..... Resource Conservation and Recovery Act
RED ..... regional economic development
RESOP ..... Reservoir Operations Study Computer Program
RR&R ..... repair, replacement, and rehabilitation
SHPO ..... State Historic Preservation Officer
SPRA ..... Screening for Portfolio Risk Analysis
SWPA ..... Southwestern Power Administration
TN ..... total nitrogen
TP ..... total phosphorus
TSP ..... tentatively selected plan
USACE ..... U.S. Army Corps of Engineers
USC ..... United States Code
USFWS ..... U.S. Fish and Wildlife Service
USGS ..... U.S. Geological Survey
WRDA ..... Water Resources Development Act
WSA ..... Water Supply Act (of 1958)
≥ ..... greater than or equal to
< ..... less than
≤ ..... less than or equal to
µg/L ..... micrograms per liter

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