Stockton Lake Reallocation Study

Draft Integrated Water Supply Storage Reallocation Report and Environmental Assessment

Appendices A through M

June 2020

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Kansas City District

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Appendix A-Needs Analysis

June 2020

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Acronyms

Ag Census	Census of Agriculture
AF	acre-feet
AFY	acre-feet per year
AVD	average day demand
CDM Smith	CDM Federal Programs Corporation
cfs	cubic feet per second
GED	gallons per employee per day
FY17	fiscal year
MDNR	Missouri Department of Natural Resources
MERIC	Missouri Economic Research and Information Center
MGD	million gallons per day
MMD	maximum month demand
NAICS	North American Industrial Classification
NRW	non-revenue water
PS	public supply
SIC	Standard Industrial Classification
TMDL	Total Maximum Daily Load
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey

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Section 1

Background and Purpose

1.1 Introduction

This report has been prepared by CDM Smith Federal Programs Corporation under contract Number W912DQ-14-D-1003. This document serves as a comprehensive summary of work completed for the Southwest Missouri Water Resources Study through December of 2017. The objective of this stand-alone document is to provide clarity on the final requested reallocation amount and address the methodology and assumptions of the supply and demand modeling previously completed under the Planning Assistance to States Phases I and II.

1.2 Background

In Southwest Missouri, meeting demands in the more urban areas during drought periods is a challenge. It is possible that in the future meeting demands in these areas during normal weather conditions could prove challenging. The larger communities, including Springfield, Joplin, and Branson, Missouri rely primarily on surface water; whereas the majority of the remaining area relies solely on groundwater as their source of supply. In the Springfield and Joplin areas, there continues to be a growing cone of depression in the underlying Ozark Aquifer, assuming the trend identified by the Missouri Department of Natural Resources (MDNR) in 2007 of continued groundwater declines. There have been numerous studies on the Ozark Aquifer and alternative pumping scenarios evaluated over the past couple of decades pointing toward the need for additional surface water sources. These past studies have not defined the quantity needed, timeframe in which the additional water will be needed, and the variation in seasonal demands to be met. This study will attempt to do that at a regional planning level.

1.3 Study Purpose

The purpose of the Southwest Missouri Water Resources Study is to provide a planning-level evaluation addressing both short-term and long-term water supply availability gaps. Current and future phases will assist in determining the most economically viable sources for satisfying the region's future water demand requirements. This report provides an overview of the supply and demand evaluation completed to quantify the reallocation request for Tri-State Water Resources Coalition. The study focuses on 16 counties in Southwest Missouri as shown in Figure 1-1, including the counties of Barry, Barton, Cedar, Christian, Dade, Greene, Hickory, Jasper, Lawrence, McDonald, Newton, Polk, Saint Clair, Stone, Taney, and Vernon. The study evaluates current and future demands and supply availability through 2060 in the Southwest Missouri area as primarily demanded by municipal, agricultural, and industrial/commercial water users.

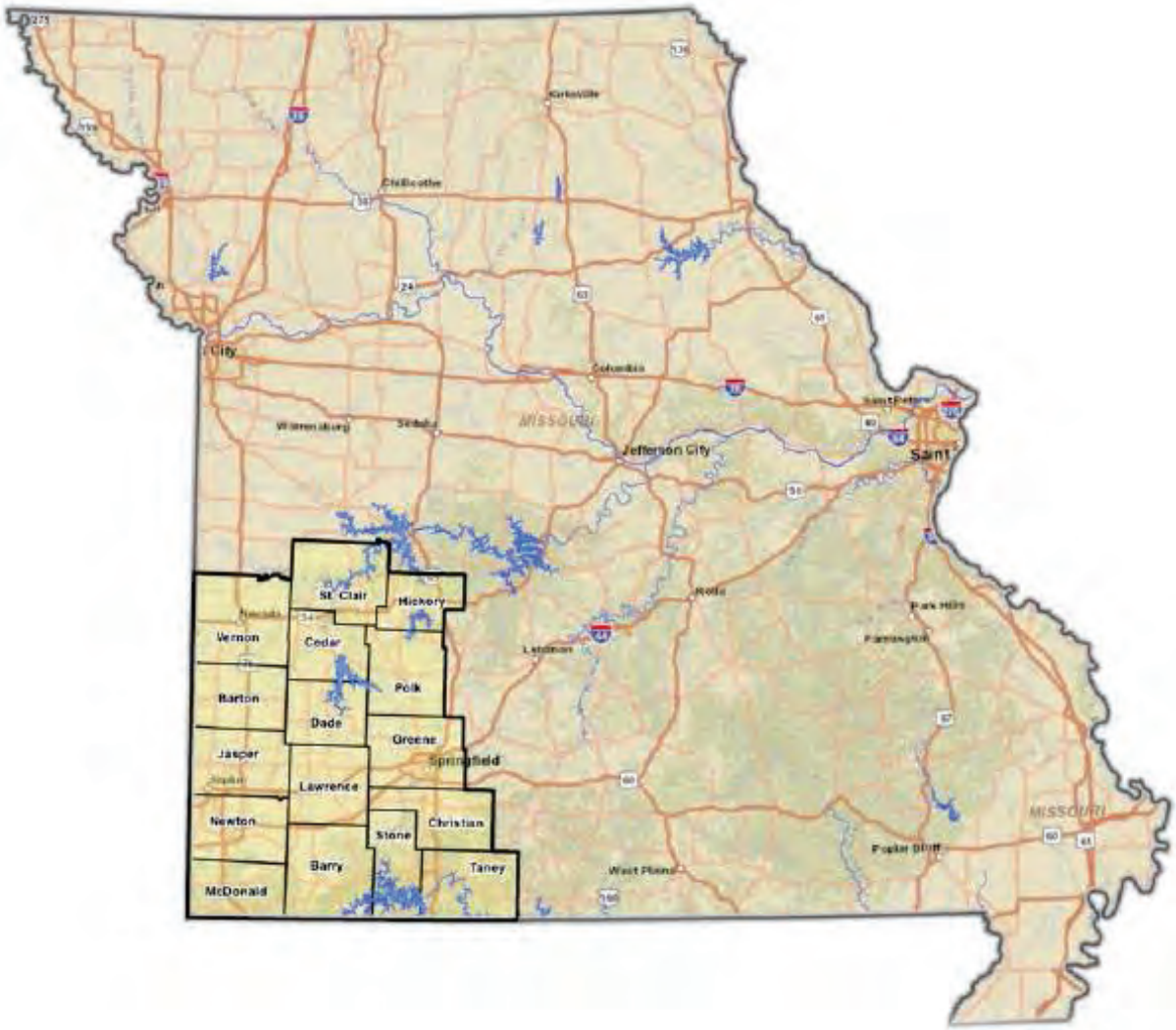

Figure 1.1: 16-County Study Area in Southwest Missouri

Section 2

Future Water Demands (Phase I)

A water demand forecast model was developed based on 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 through 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 approach of the water demand forecast is to estimate water demand separately for each group of water users, also referred to as a water use sector. The methodology selected to forecast water demand for each sector is driven by data availability. This is the case for all sectors of the Southwest Missouri forecast.

For each sector, the basic methodology for estimating water demand is to calculate a product of the driver and the rate of use. The driver is defined as a countable unit driving water demands up and down, which can be projected in future years, such as population or number of households, number of acres irrigated, number of employees in a business, etc. The rate of use is defined as the quantity of water used by the driving unit, such as gallons per person per day, gallons per household, or acre-feet (AF) per irrigated acre.

The per unit water use rate, or water use factor, can be developed for most sectors given historical or current water use data and a defined demographic unit. Projection of future water demand then requires having projected values of the defined demographic unit.

With this approach, the water use factor of each sector can be assumed to either remain constant into the future, decrease over time due to improvements in water use efficiency, or increase over time due to more intensive water use patterns. While trends in future water use can be difficult to know with certainty, reasonable assumptions can be made that provide the foundation for estimating trends in the future, and scenarios can be developed that consider future water demands under potential alternative conditions.

Information used to analyze both historical and estimated future water use include metered water use data and data describing factors that influence water use for specific water use sectors. The Southwest Missouri Water Demand Forecast Model was developed with the sector structure shown in Figure 2-1.

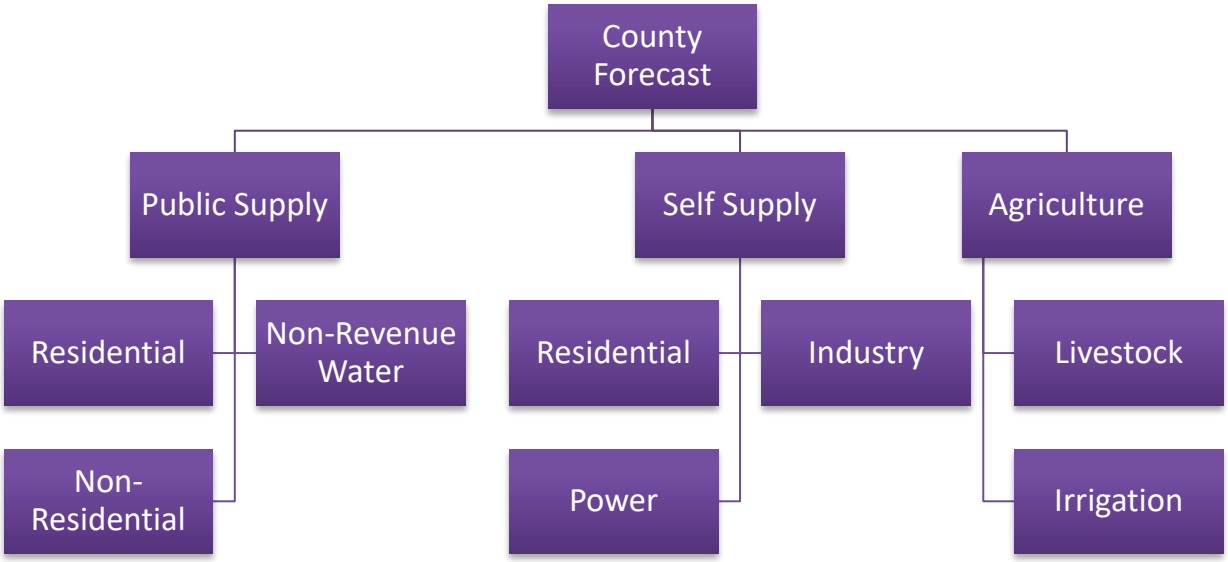

Figure 2-1: Structure of the Southwest Missouri Water Demand Forecast Model

In collaboration with MDNR, a comprehensive water use database with information from 2005 through 2010 was developed consisting of baseline and historical data for characterization of existing conditions for municipal water systems. The data set included monthly water consumption by sector, number of metered customers by sector, total population served, average annual monthly production and metered use, total accounts served, percent of water demand delivered to each sector, as well as information on billing rates and conservation efforts. The data within this database accounted for 75 percent of the population served by public supply water systems within the study area. Within this document this dataset will be referred to as the Baseline Water Use Dataset.

2.1 Public Supply

A public supply municipal forecast can be derived using multiple forecast methodologies but must be based on available data. For the purposes of this model the Little Rock and Kansas City Districts of the U.S. Army Corps of Engineers (USACE), with input from MDNR and CDM Smith (CDM Federal Programs Corporation), agreed that ideal data for this analysis would include monthly water use data by county for the period of 2005 through 2010 for the following sectors:

- Single Family Residential
- Multi-Family Residential
- Commercial
- Industrial
- Institutional

Analysis of historical data from 2005 through 2010 allows for an accurate estimate of baseline water use while normalizing for weather variability during this period (i.e. periods that are wetter or dryer than the regional average). The Baseline Water Use Dataset was utilized to establish existing water use trends for each sector. Where necessary, the data were supplemented with data from the Missouri Public Water Census to fill in data gaps and derive the information needed for the demand model.

Using the available data, the provider average per capita water use by sector was derived. The following equation was used to calculate per capita water demand by provider:

$$\mathrm{GPCD}_{s,m} = \frac{\left(\frac{G_{s,m}}{D_m}\right)}{P_{s,m}}$$

Where:

$\mathrm{GPCD}_{c,s,m}$= per capita demand for sector$_{(s)}$, and month$_{(m)}$ in gallons per capita per day (GPCD)
$G_{s,m}$ = consumption by sector$_{(s)}$ for month$_{(m)}$ in gallons
D_m = number of days per month$_{(m)}$
$P_{s,m}$ = population served by provider by sector$_{(s)}$ and month$_{(m)}$

In addition to generating per capita water use values by sector, the results of this analysis were used to identify any outliers or data entry errors in the dataset. In many cases, outliers were determined to be the result of incorrect units of measure. In these cases, gallons per day were calculated with the available data. Any additional outliers or data entry errors were deleted from the database to avoid miscalculation of per capita demands[1].

Following a detailed review of per capita water use values by sector, it was determined that while trends in residential water use were consistent, non-residential water use values were extremely variable. Based on this analysis, CDM Smith determined that an econometric modeling approach would best represent water use in the residential sector, while a per unit use approach would best capture water use in the non-residential sectors. Each of these approaches is explained further in the following sections.

2.1.1 Residential Econometric Model

An econometric approach statistically correlates sector water demands with factors that influence those demands. The econometric model relies on regression analysis to compute coefficients or elasticities that describe how a water use factor influences water demand. A regression analysis calculates elasticity values for each water use factor, or explanatory variable, used to explain the variation in water use. For instance, a price elasticity of -0.10 implies that a 10 percent increase in the real price of water will result in a 1 percent decrease in water demand.

The following is an example of an equation used to calculate sector water demand using an econometric approach:

1 The seasonality of Taney County water use can be explained by the high influx of tourists in the Branson/Ozark area especially during summer months. A very high reduction in water use in January and February is due to low tourism during those months.

$$BRD_{c,m}^{GPCD} = a + b_1x_1 + b_2x_2 + b_nx_n$$

Where:

$BRD_{c,m}^{GPCD}$ = Baseline residential demands in GPCD in county (c) and month (m)
a = intercept, or the value of (y) when x = 0
b = coefficient of x, or the change in y given a change in x
x = value of the independent variable

Based on the available data, a single statistical model was generated for residential water use. The independent variable is the residential per capita water use for the combined single family and multi-family sectors. These per capita values were calculated using the data collected from the Baseline Water Use Dataset. The dataset is both time-series and cross-sectional, meaning that data observations occur throughout a given time period (multiple years of monthly data) and in each month there are data observations across multiple counties.

The statistically significant explanatory variables in the public supply residential model include:

- Monthly binary variables (seasonality of the forecast January-December)
- County binaries for the following counties (intercept adjustments):
  - Cedar County
  - Dade County
  - Stone County
  - Taney County
- Weather (maximum monthly temperature and total monthly precipitation)[2]
- Average county income in thousands of dollars (kincome) (taken from US Census data)
- Leak detection program indicator (the percentage of a county currently utilizing leak detection programs – taken from Baseline Water Use Dataset)
- Residential water rate (average block two residential rate calculated from Baseline Water Use Dataset)

Binary variables (variables in a dataset with value of one or zero) are used in regression analysis to reflect non-quantified characteristics associated with the condition in which the variable has a value of one. For example, a binary variable for the month of January has a value of one in all records occurring in January and a value of zero in all records that are not in January. If this binary variable is determined to be statistically significant, then there is some variation of the dependent variable that is unique to observations occurring in January that is not accounted for by other independent variables in the model. The interpretation of such a binary variable is that the estimated coefficient for the binary variable is added to the intercept of the model to provide

[2] Historical weather data including total monthly precipitation and the monthly average of daily maximum temperature were collected for the years 2005-2010 for each county. Data were collected from the High Plains Regional Data Center. This monthly data is averaged to establish average monthly maximum temperature and precipitation for each county.

a modified model intercept for conditions indicated by the binary variable. For example, if a binary variable representing the month of January is statistically significant, then the model intercept plus the estimated coefficient for the January binary is used as the model intercept in all months that are January.

One caveat to the use of binary variables in a regression model is that a 'full complement' of binary variables cannot be used at the same time. For example, all the data in a dataset occurs in one of 12 months. The model cannot contain binary variables representing all 12 months of the year. At least one of these variables must be dropped from the model. The dropped variable is considered to be represented by the intercept.

The use of monthly binary variables is frequently used to reflect variation in monthly observations of the dependent variable that are not otherwise correlated with dependent variables in the model. For example, monthly water use may be statistically significantly correlated with monthly average temperature and precipitation. However, in a location with a significant number of summer homes the water use may increase in addition to the influence of weather.

The residential demand model presented in Table 2-1 contains monthly binaries that are statistically significant for June, July, August, and September. The parameter estimates associated with each of these months is added to the model intercept value shown in Table 2-1. The interpretation of this is that the model intercept is appropriate for estimating residential per capita water use in the months of October through May. However, this model intercept is augmented by the addition of the respective coefficient (parameter estimate) in June through September. That is, the monthly data used as the basis of this model shows significantly higher water use in these summer months "above and beyond" the monthly variation attributed to the monthly variation in average monthly maximum day temperature and total monthly precipitation.

Similarly, a binary for each county can be included in the model. As with the monthly binaries, not all county binaries can be included in the model simultaneously. At least one county binary must be excluded. The binaries act to adjust the intercept to capture water use patterns higher or lower than average.

The process of identifying the best model is an iterative process. Typically, the process begins with a simple set of explanatory variables such as monthly weather variables and socioeconomic variables that the analyst perceives as having a theoretical basis for explaining the variation in the dependent variable (i.e., average gallons per capita by county and by month over a given time period). Variables that are not statistically significant are removed from the model (although some of these excluded variables may be tested with later models to determine if the variable is significant with a different set of explanatory variables). Monthly binaries are added to the set of explanatory variables to (a) test the significance of individual months, and (b) see if addition of month binaries improves the 'explanatory power' (i.e., R2) of the model. Only monthly binaries with positive and statistically significant coefficients are retained in the model.

Similarly, county binaries can be added to the set of explanatory variables. Initially, these variables are added one at a time to test the significance of each county with respect to the model estimate of residential demand. It is possible that county binaries are statistically significant and have negative coefficients. A negative value indicates that the county has some characteristic

resulting in significantly lower than average water use, while a positive value indicates that the county has some characteristic resulting in significantly higher than average water use. A negative county binary could be a reflection of higher water rates, stronger conservation ethics, stronger conservation incentives and education, fewer people per household, or any other factor resulting in lower water use.

The results of this statistical analysis and the model structure is provided in Table 2-1.

Table 2-1: Residential Demand Model

Number of Observations				1,190
Adj. R-Squared				0.5709
Explanatory Variables	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr> I t I**
Intercept	98.21162	5.98864	16.4	<.0001
Monthly Binaries:				
June	8.32075	1.73452	4.77	<.0001
July	10.74014	1.82431	5.89	<.0001
August	16.72634	1.87811	8.91	<.0001
September	14.53823	1.62978	8.92	<.0001
County Binaries:				
Cedar	-11.34033	1.62908	-6.96	<.0001
Dade	30.77839	1.8956	16.24	<.0001
Stone	-11.15498	1.65494	-6.74	<.0001
Taney	26.58822	1.6253	16.36	<.0001
Weather Variable:				
MaxTemp	0.09322	0.03971	2.35	<.0001
Precip	-0.66481	0.15579	-4.27	<.0001
Other Variables:				
kincome	-0.88276	0.14632	-6.03	<.0001
Leak Detection	-13.411	0.86217	-15.55	<.0001
Residential Rate	-1.18563	0.08428	-14.07	<.0001

Results of the regression analysis were used to calculate the monthly per capita baseline (2010) water use in GPCD by county. The following equation incorporates the values from Table 2-1 into the econometric equation for monthly baseline per capita water use provided above.

$$BRD_{c,m}^{GPCD} = Intercept + Binary_m + Binary_c + (0.093 * \text{MaxTemp}_m) + (-0.665 * Precip_m) + (-0.883 * kincome_c) + (-13.411 * LeakDetection_c) + (-1.186 * ResidentialRate_c)$$

Where:

$BRD_{c,m}^{GPCD}$ = Baseline residential demands in GPCD in county (c) and month (m)

These per capita values were then driven by the residential public-supplied population served using the following equation:

$$PSR_{c,m,y}^{GPD} = BRD_{c,m}^{GPCD} \times \text{POP}_{c,y} \times \%\text{PS}_c$$

Where:

- $PSR_{c,m,y}^{GPD}$ = Public-supplied residential water demand in gallons per day in county (c) in month (m) in year (y)
- $BRD_{c,m}^{GPCD}$ = Baseline residential demands in gallons per capita per day in county (c) and month (m)
- $\text{POP}_{c,y}$ = Population in county (c) in year (y)
- $\%\text{PS}_c$ = Percentage of the population in county (c) served by public supply systems

Population projections were used as the driver of the residential forecast. Historical county populations from 2000-2010 were obtained from the Missouri Census Data Center, while population projections through the year 2030 were obtained from the Missouri Office of Administration. Population projections were extended to 2060 by MDNR as follows:

- Historical population from 2000-2010 and Office of Administration projections from 2010-2030 were obtained and the annual growth rates were calculated. Two types of population projections were made – first, a linear population projection and second, a method based on births, deaths, and immigration data.
- Linear projections were computed by assuming that the population for each county would grow at the same rate as that of 2025-2030, in other words, the population growth rate would be constant between 2025 and 2060.
- Projections using the second method were developed using data on births, deaths, and immigration obtained for 2000-2030 from Missouri Department of Health and Senior Services. Three types of projections – a base-case low growth, a medium growth and high growth scenarios were developed. The population for the base-case low growth was calculated based on:

  $\text{Population}_t = \text{Population}_{t-1} + \text{Births}_t - \text{Deaths}_t + \text{Net Immigration}_t$

  Where :

  t = current year

  t-1= previous year

- Projections for base-case low growth from 2030-2060 were calculated based on a moving average population for the past 15 years and a standard deviation. The projections were very conservative and hovered around the average population. Typically, the population growth rate slowed down for most of the counties as the 2060 planning horizon was approached.
- Growth rates for each county from 1970-2000 were calculated and the lowest growth and the highest growth were calculated. Medium growth was derived as an average between

low growth and high growth scenarios. Based on this data, the medium and high-growth scenarios projections were made.

Following examination of the results of each method of population projections, it was concluded that the method based on births, deaths, and immigration data would provide the most accurate estimation of population growth in this region. The three growth scenario projections were used to accommodate low, medium, and high water demand scenarios for the public supply forecast[3].

Since population projections were based on the entire county, a percent served was applied to the population for each county to estimate the population served by public supply utilities. This percentage is calculated by dividing the 2010 population served by public supply community classified utilities (taken from the Missouri Census of Public Water Supply) by the 2010 total county population. For the purposes of this model, it is assumed that the percent served will remain constant into the future for each county.

Residential baseline per capita water use, by county, as determined by the econometric model, was multiplied by the projected population, in 10-year increments, to determine estimated future demands.

2.1.2 Non-Residential Per Unit Use Model

To best represent current trends while establishing a baseline public supply non-residential forecast, a unit use approach was constructed using gallons per employee per day (GED) water use factors. The rate of water use per employee is unique to the type of establishment, e.g., water use per employee would be significantly higher at a restaurant where water is being used to wash dishes and prepare food than at a bank where water use is for sanitary purposes. To account for this, the per employee water use rates were developed from the IWR-MAIN Water Demand Management Software Non-residential Database. The non-residential database contains average GED at the 2-digit and 3-digit North American Industrial Classification System (NAICS)[4] code. A special tabulation was computed to transform the data to 2-digit NAICS code, where required. The water use coefficients represent all water used at a given establishment on an average day divided by the number of employees. The IWR-MAIN water use per employee coefficients used in this analysis were originally develop by CDM Smith (Planning and Management Consultants, Ltd. at that time). The water use and employment was identified for more than 7,000 establishments representing 432 categories of non-residential water users. These categories were originally grouped by Standard Industrial Classification (SIC) codes and later regrouped by the NAICS codes. The initial database was derived from a special tabulation of US Census of Manufacturing data and then augmented with establishment level data from a variety of service areas across the

[3] Extremely high recent growth rates in Christian County resulted in unrealistic estimated projections in future populations. As a result, the approach for Christian County population projections was slightly altered. For the time period from 2030 to 2060, the regional (10 county) average growth rate was applied to Christian County. Additionally, during a review and comment period for members of the Tri-State Water Resource Coalition, City Utilities of Springfield provided population served data. Based on the additional data, it was determined that the public supply population served of Springfield would be best represented by an increase to 236,000 in the base year. This resulted in an increase of 48,167 public supply individuals from the original MDNR estimates. Because population served by public supply is based on a percentage of the total population, these changes resulted in a decrease of 48,167 individuals under the self-supplied residential sector of the forecast.

[4] NAICS is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy.

country. Unfortunately, the U.S. Census of Manufacturing no longer includes questions regarding water use in its survey of manufacturers.

It is acknowledged that these water use coefficients are dated. However, this dataset of water use coefficients by SIC/NAICS continues to be used and cited in the water industry primarily because no other data analysis of non-residential water use of this magnitude has been conducted since. Some of the establishment level data collected during the 1990's was known to reflect updated and efficient water use practices in select business types. However, much of the dataset may represent less efficient water use in those business types with significant water use practices.

The Baseline Water Use dataset included aggregate sector level water use data and a listing of major individual water users (hospitals, schools, food processing facilities, etc,) within the service area that were on the municipal water supply systems. However, water use and employment data by individual establishment was not available for either municipally-supplied or self-supplied businesses.

Employment data reviewed at the 3-digit NAICS level provided information regarding the types of employment establishments in the arts, entertainment, and recreation NAICS classification in the Southwest Missouri Region show that establishments in this classification generally can be categorized as performing arts, spectator sports, and related industries. According to 3-digit NAICS codes, water use for performing arts averages 33.0 GED, as opposed to 446.6 GED for the 2-digit NAICS for arts, entertainment, and recreation. Therefore, the 33.0 GED water use value was assigned to all 16 counties. Similarly, 3-digit NAICS level employment shows water use in the local, state, and federal government employment group more closely follows the average of NAICS GED of 68.2 for NAICS codes 921 (executive, legislative, and other general government), 922 (justice, public order, and safety activities), 923 (administration of human resource programs), and 924 (administration of environmental quality programs), as opposed to 125.4 GED for the two-digit NAICS for Public Administration. Therefore, the 68.2 GED water use value was assigned to all 16 counties. Similarly, the 2-digit NAICS for accommodations and food services (NAICS code 71) of 185.5 was higher than average usage for this employment group in the Southwest Missouri region, therefore a GED of 149.8, taken from the average of 3-digit NAICS codes for accommodation (code 721, GED 213.4) and food services and drinking place (code 722, GED 86.2), was assigned to the accommodations and food services employment group. The resulting water use factors are summarized by major employment groups in Table 2-2.

Table 2-2: Non-residential Water Use Coefficients from IWR-MAIN

NACIS	GED*
11 - Agriculture, forestry, fishing and hunting	111.8
21 - Mining	488.4
22 - Utilities	28.4
23 - Construction	66.6
31 - Manufacturing[1]	144.5
42 - Wholesale trade	44.1
44 - Retail Trade	46.4
452 - General Merchandise Stores	36.5
453 - Miscellaneous Store Retailers	66.1
48 - Transportation and Warehousing[2]	

Table 2-2: Non-residential Water Use Coefficients from IWR-MAIN (continued)

NACIS	GED*
51 - Information	28.0
52 - Finance and insurance	59.8
53 - Real estate and rental and leasing	163.5
54 - Professional and technical services	68.6
55 - Management of companies and enterprises	64.0
56 - Administrative and waste services	41.2
61 - Educational Services	103.6
62 - Health care and social assistance	84.7
71 - Arts, entertainment, and recreation[3]	33.0
72 - Accommodation and food services[3]	149.8
81 - Other services, except public administration[4]	73.9
Local, State and Federal Government[3]	68.2

* GED - gallons per employee per day
[1] Manufacturing GED adjusted for Barry County: 354.0 and McDonald County: 778.0 (See Section2.2.2)
[2] Transportation and Warehousing GED adjusted to 216.00 for Jasper County
[3] Adjusted from standard GED based on supplemental regional information
[4] Average county-wide employment GED applied for each individual county (overall average 73.9)

In some instances, such as the transportation sector of Jasper County, the employment data at the 3-digit level was used in conjunction with the 3-digit NAICS GEDs to derive a 2-digit NAICS GED that was more representative of the employment in that sector in that county. This 3-digit weighting was used when the county employment data did not reflect employment at the 3-digit level in NAICS levels with higher GEDs. In Jasper County, the Transportation & Warehousing sector accounts for 12.8 percent of total employment. Therefore, a more representative weighted GED was used for this sector. Note that similar adjustments were made within the manufacturing sector for Barry and McDonald counties based on self-supplied industry data. Additionally, GED values for NAICS code 81 – Other Services Except Public Administration, were changed to represent average GED values for all employment groups by county. This change resulted in an average value for the 16-county region of 73.9 GED; however, each county was assigned its own individual county-wide average employment GED water use for this category of employment. Overall, given the relatively low percent of total employment in the Other Services sector to which this calculated GED is applied, the overall effect of revising this GED is negligible.

The public supply non-residential forecast is driven by economic activity, which can be difficult to predict. Thus, a typical measure of non-residential water use in forecasting is employment, which is more foreseeable. Employment projections were developed for Southwest Missouri and provided by MDNR by county and by employment group. Employment projections through 2018 were obtained from the Missouri Economic Research and Information Center (MERIC). The employment projections were developed by MERIC and MDNR as follows:

- Survival rates for male and female population were obtained from Office of Administration. The data are at a 5-year cohort level from 2000 to 2060. The current male and female population projections that are available until 2030 were extended to 2060 based on the survival rates.

- The labor force participation rate, i.e. population in the age group of 15-64, was calculated for each year. This labor force participation rate was applied to the population projections from 2030 to 2060 to develop the employment projections.
- Quarterly Census of Employment and Wages data were used to calculate the percent of employment in each NAICS sector for the year 2010 for each county. It is assumed that the percentage of employment in each NAICS sector will hold constant in each county until 2060. The county percentage employment by NAICS was applied to total employment for each county until 2060 to derive estimates of employment by NAICS sector.

County non-residential water use was estimated by multiplying county employment by water use per employee. Projections of employment and water use are obtained at the most detailed level available. Both employment and water use per employee are available at the 2-digit NAICS level. Water use per employee is assumed to remain constant while employment grows in the future. The equation below provides the detailed formula for estimating water use for the public-supplied non-residential sector.

$$PSNR_{c,m,y}^{GPD} = \left[\sum\left(E_{c,y}^{NAICS} \times GED_{c}^{NAICS}\right) - SSI_{c,m,y}^{GPD}\right] \times S_{c,m}$$

Where:

- $PSNR_{c,m,y}^{GPD}$ = Public-supplied non-residential water use in county (c) in month (m) in year (y) in GPD
- $E_{c,y}^{NAICS}$ = Employment by NAICS group in county (c) and year (y)
- GED_{c}^{NAICS} = Water use per employee by NAICS group, which may be adjusted for a specific county (c)
- $SSI_{c,m,y}^{GPD}$= Self-supplied industrial water use in county (c) in month (m) in year (y) in GPD
- $S_{c,m}$ = Seasonality of Public-supplied non-residential water use in county (c) in month(m)

2.1.3 Non-Revenue Water (System Losses)

The Baseline Water Use Dataset provided data on both water production and consumption. This information was used to derive an average non-revenue water (NRW) percentage for each municipality. The difference between water produced and billed water sales includes authorized meter water usage that is not billed, unauthorized water use, billing errors, metering errors, line breaks, and system losses. Baseline Water Use Dataset analysis for NRW ranged from 10.9 percent to over 40 percent. For the purposes of the model, any reported NRW over 15 percent was assumed to be un-metered consumption; thus, the percentage was capped at 15 percent and referred to as system losses. Based on this methodology, the overall average system loss percentage was 14.0 percent. To aggregate this data from the provider level to the county level, a weighted average approach was utilized based on the population served by each provider. For those providers without available NRW data, the region-wide average of 14.0 percent system losses was applied. No NRW data were available for Barton, Christian, McDonald, Newton, St Clair, and Stone counties; therefore, the region-wide estimate of 14.0 percent system losses was applied for these counties. Results of the system loss percentage for each county are shown in Table 2-3.

No seasonality was applied to system losses; therefore, for the purposes of this model system loss percentages remain constant during all months of the year. For the purposes of the demand modeling, system loss percentages are assumed to remain constant into the future.

Table 2-3: Estimated Public Supply System Losses

	System Losses		System Losses
Barry	14.3%	Lawrence	14.6%
Barton	14.0%	McDonald	14.0%
Cedar	12.8%	Newton	14.0%
Christian	14.0%	Polk	14.6%
Dade	13.6%	St Clair	14.0%
Greene	14.8%	Stone	14.0%
Hickory	14.1%	Taney	14.2%
Jasper	14.2%	Vernon	14.4%

The system loss percentages by county are applied to the sum of public supply residential and non-residential demands. System losses are applied to the demand forecast using the following equation:

$$NRW_{c,m,y}^{GPD} = (PSR_{c,m,y}^{GPD} + PSNR_{c,m,y}^{GPD}) \times [\%\text{NRW}_c/(1 - \%\text{NRW}_c)]$$

Where:

- $NRW_{c,m,y}^{GPD}$ = System loss water demand in gallons per day in county (c) in month (m) in year (y)
- $PSR_{c,m,y}^{GPD}$ = Public supply residential water demand in gallons per day in county (c) in month (m) in year (y)
- $PSNR_{c,m,y}^{GPD}$ = Public supply non-residential water use in county (c) in month (m) in year (y) in GPD
- $\%\text{NRW}_c$ = Percentage of system loss water in county (c)

2.2 Self-Supply

The self-supplied residential sector captures water use from households not connected to a public water supply system. For the purposes of this model, it is assumed that public-supplied residential water use trends are representative of self-supplied residential users as well. The residential public-supplied per capita water use values are applied to the self-supplied residential population to determine total baseline water use for the self-supplied residential population.

A sector was added to the Southwest Missouri demand forecast to represent water use from large self-supplied non-residential users, such as manufacturing, aquaculture, thermoelectric power, mining, and food processing facilities. The data used in this sector were obtained from U.S. Geological Survey (USGS) *Estimated Water Use in the United States, County-Level Data*. This dataset contains state-provided county-wide estimates of total surface water and groundwater withdrawals for self-supplied non-residential users in million gallons per day (MGD).

Additionally, golf course irrigation totals were provided for selected counties in the study region by MDNR. These golf course irrigation totals were added to the self-supplied non-residential demands for the months of May through October.

2.2.1 Self-Supplied Residential

For the purpose of this model, the assumption is made that self-supplied residential water use is equal to the per capita water use for publicly-supplied water users of the same county. The assumption that self-supplied water use within a county is analogous to public-supplied water use has been used in prior state water plans and has been used by the USGS in estimating self-supplied domestic water use by county. It is common for suburban or peri-urban developments on self-supplied groundwater to mimic the water use of their municipally-supplied neighbors with similar affluence, landscaping preferences, etc.

The total number of self-supplied residential customers is calculated by subtracting the total public supply customers by county (data from the Missouri Public Water Census) from the total county population. These data allow calculation of the percentage of self-supplied residential customers in each county. The assumption was made that all users not served by a public water supply provider are self-served water users. Self-supply residential demand is calculated and projected using the following equation:

$$SSR_{c,m,y}^{GPD} = BRD_{c,m}^{GPCD} \times \mathrm{POP}_{c,y} \times \%\mathrm{SS}_c$$

Where:

- $SSR_{c,m,y}^{GPD}$ = Self-supplied residential water demand in gallons per day in county (c) in month (m) in year (y)
- $BRD_{c,m}^{GPCD}$ = Baseline residential demands in gallons per capita per day in county (c) and month (m)
- $\mathrm{POP}_{c,y}$ = Population in county (c) in year (y)
- $\%\mathrm{SS}_c$ = Percentage of the population in county (c) under self-supply

Population is the driver of the self-supplied residential forecast. The assumption is made that all water users not served by a public water supplier are self-served water users. Therefore, the population estimates for self-supplied residential customers are calculated by subtracting the estimated public supply population from total county population in each year. The self-supplied residential population projections were calculated for each county assuming a constant percentage into the future.

2.2.2 Self-Supplied Industry and Power

Self-supplied industrial users may include food processing facilities, aquaculture, mining operations, or any other commercial or industrial user that is not served by a public water supplier. Data for analysis of this sector is taken from USGS water use estimates. At the time the model was created, the most recent data currently available for the 16-county region for industrial, mining, thermoelectric, and aquaculture self-supplied employment categories was 2005 estimates. Therefore, the total 2005 USGS estimates were designated as the baseline

demands by county for self-supplied non-residential water use. Self-supplied irrigation data for golf courses provided by MDNR for selected counties (2010 estimates) are added to the forecast for the months of May through October.

Self-supplied industry employment numbers were needed to subtract employment from the total county employment projections used in the public supply non-residential forecast, to avoid double-counting. However, employment estimates were available only for self-supplied manufacturing in Barry and McDonald Counties, the two largest water users in the self-supplied industry sector. For these counties, GEDs were re-estimated in the public-supplied non-residential sector for manufacturing using a weighted average approach. The new manufacturing GED was estimated using the average of the standard NAICS code manufacturing GED multiplied by the total county public supplied employment and the provided self-supplied manufacturing GED multiplied by the total county self-supplied employment. These calculations resulted in an increase of 209.5 GED for manufacturing in Barry County, to bring the new total to 354.0 GED and an increase of 633.5 GED for manufacturing in McDonald County, to bring the new total to 778.0 GED.

Because future conditions in the self-supplied non-residential sector are unknown, this sector was forecasted into the future using a no growth scenario in which water use demands remain constant through 2060. Additionally, seasonality of the sector is only included for irrigation demands at golf courses (May through October). It is assumed that industrial, thermoelectric power, mining, and aquaculture self-supplied users do not exhibit significant trends in seasonality throughout the year, and therefore no seasonality for these users are captured in the forecast.

2.3 Agriculture

Agricultural water demands for livestock and crop irrigation in 2010 were combined to give the baseline agricultural demand forecast.

2.3.1 Livestock

Livestock require water for animal nutrition, animal cooling, sanitation, and waste removal. Current estimates of livestock water demand were developed based on the major livestock groups in Southwest Missouri and their respective daily water requirements. Major livestock groups evaluated include: cattle/calves, beef cows, milk cows, other cattle, hogs/pigs, sheep/lambs, poultry-layers, poultry-pullets, poultry-broilers, turkeys, goats, and horses/ponies. The monthly livestock water demand is calculated by multiplying the daily water requirement (gallons) for each group by the number of livestock and then the number of days in a month.

$$QLS_{n,\,c,\,m} = LSC_{n,\,c,\,m} \times DWR_n \times D_m$$

Where:

- $QLS_{n,\,c,\,m}$ = Livestock water demand in gallons for animal group (n) in county (c) in month (m)
- $LSC_{n,\,c,\,m}$ = Livestock count for animal group (n) in county (c) and month (m)
- DWR_n = Daily water requirement per animal (n) in gallons per day
- D_m = Days in month (m)

For the purposes of this model, it is assumed that daily water use is constant year-round for each animal group. Total monthly water demand for each animal group is then summed by county to determine total daily consumption for each county.

Once current livestock inventories by county were collected, a methodology was developed to project livestock inventories by county to 2060. Two separate growth scenarios were developed for the projection of water use by livestock. The moderate growth scenario for livestock is applied to the high growth scenario of the municipal water demand forecast. The no growth scenario for livestock is applied to both the medium and low growth scenarios of the municipal forecast.

The moderate growth scenario is used to estimate a reasonable maximum projection for livestock. To develop this scenario an analysis was conducted from the three most recent datasets produced by the U.S. Department of Agriculture (USDA) Census of Agriculture (Ag Census). The Ag Census data from 1997, 2002, and 2007 were analyzed to obtain the highest reported number of livestock by livestock group in each county. It is believed that using the highest reported number represents a future high growth scenario. The historical maximum was then assumed to be the build-out inventory for 2060. Linear interpolation was applied to obtain the inventory for forecast years between 2007 and 2060. In some instances, 2007 represents the highest livestock count for a given county and animal group, in which case no growth is assumed.

In the no growth scenario, 2010 water use demands from livestock are assumed to remain constant through 2060.

2.3.2 Crop Irrigation

Variation in weather, politics, and socioeconomic forces cause significant swings in cropping patterns, irrigation use, and ultimately artificial water demand for irrigation. The demands developed for 2060 under this task represent a reasonable maximum demand for each county under average weather and current economic conditions (i.e., base scenario) that is a useful input into the planning process. A basic methodology was developed based on the best available data to estimate irrigation water demands now and in the future. The methodology is total irrigated acres by county times a crop irrigation water requirement.

Crop irrigation water demand for a given county is driven by the type of crops planted, irrigation water required for those crops, number of acres planted, and type of irrigation system utilized. The crop irrigation water requirement was determined by subtracting average growing season precipitation from 2001-2010 by county from an average crop water requirement of 19 inches for this study area.

The total irrigation water demand was converted from acre-inches to gallons. Equations used to complete crop irrigation requirements are shown in the equations below:

$$\mathrm{CIR_c} = \mathrm{PR_{c,b}} - \Delta\mathrm{P_{c,b}}$$

$$QI_{c,b}^{Gal} = \mathrm{IA_{c,b}} \times \mathrm{CIR_c} \times 27{,}156$$

Where:

- $\mathrm{CIR_c}$ = Total crop irrigation requirement in inches per growing season in county (c)

- $PR_{c,b}$ = Crop precipitation requirement in inches in county (c) in base year (b)
- $\Delta P_{c,b}$ = Average growing season precipitation in inches in county (c) for base year (b) (2001-2010 average)
- $QI_{c,b}^{Gal}$ = Irrigation water demand in county (c) in the base year (b) (2007) in gallons
- $IA_{c,b}$ = Irrigated acres in county (c) in base year (b) (2007)
- 27,156 = gallons per inch per acre

Irrigated acreage by county was collected from the Ag Census for the base year (2007)[5] (variable $IA_{(c,b)}$ in the equation above). This Ag Census category includes all land watered by any artificial or controlled means, such as sprinklers, flooding, furrows or ditches, sub-irrigation, and spreader dikes. The crop precipitation requirement (variable $PR_{(c,b)}$) and average growing season (June – Sept) precipitation from 2001-2010 (variable $\Delta P_{(c,b)}$) were collected from the agricultural extension service. The extension estimates that there is a 19 inch precipitation requirement for the study area, regardless of crop type. For the purposes of this model, we assume that for this region the growing season is a 122 day period from the beginning of June through the end of September. Also, the model assumes that required precipitation is the same for each month regardless of crop growing stage. The model assumes that all soil types are consistent and there is 100 percent efficiency in irrigation systems. These assumptions are reasonable for general planning purposes. The assumption regarding irrigation efficiency may be modified to adjust for water losses during irrigation practices and subsequently used as a base for estimating water savings from improved irrigation techniques. However, such an analysis would require estimates of the percent of irrigation water that is applied from flood, spray, and micro-drip technologies by county.

Two separate growth scenarios were developed for the projection of irrigation water use. The moderate growth scenario for irrigation is applied to the high growth scenario of the municipal water demand forecast. The no growth scenario for irrigation is applied to both the medium and low growth scenarios of the municipal forecast.

The moderate growth scenario is used for estimation of future water requirements for irrigation and is based upon the projection of future irrigated acres within each county. Thus, estimates were developed to project the total number of irrigated acres by county through 2060. Historical levels of irrigated acres by county as reported in the Ag Census were reviewed. The maximum number of acres irrigated from 1987 to 2007 is assumed to represent the maximum build-out irrigated acres in 2060. For a number of counties, irrigated acres were highest in 2007 in comparison to prior periods, resulting in "no growth" in the forecast for those counties. The number of irrigated acres per forecast year is interpolated from the 2007 current acreage to the 2060 build-out maximum using linear interpolation. Thus, crop irrigation demand will show a linear growth from 2007 to 2060 for most counties.

[5] It is acknowledged that since the release of this model more recent Ag Census data is available; however, the agricultural sector is not included in the reallocation analysis and therefore the Project Team has determined that the substitution of more recent data is not required.

In the no growth scenario, 2010 water use demands from irrigation are assumed to remain constant through 2060.

2.4 Assessment of Future Conservation

To assess the impacts of potential future conservation activities in Southwest Missouri, conservation scenarios were developed that are applied to the previously developed baseline forecast for the public supply sector of the Southwest Missouri Regional Demand Model. Demand scenarios with conservation were developed based on patterns of current regional conservation and factors affecting future conservation activities occurring throughout the region and state. These factors include cost-effectiveness of potential programs, ease of implementation, and acceptance by both the citizens of Southwest Missouri and water provider decision makers. To provide useful and realistic conservation scenarios for the Southwest Missouri Region, an analysis of current regional conservation activities was conducted identifying current conservation activities occurring at the provider-level throughout Southwest Missouri. Information on conservation activities were gathered from available resources including the Baseline Water Use Dataset and water provider websites.

One of the main goals of this study is to build on current successful conservation activities which are being implemented by individual water providers in the region. To achieve this goal, the conservation matrix was utilized as an essential tool for determining potential future conservation activities. Analysis of the matrix database resulted in percentages of water providers currently practicing specific conservation activities for a given county. Analysis of the matrix revealed that City Utilities of Springfield in 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, residential and commercial meters, and residential and commercial water use audits among other programs. These fundamental programs were used to form the basis of future conservation potential throughout the region.

Assessed conservation activities included commercial and residential metering, community education and information, and residential and commercial water use audits. These activities were combined in a logical and consistent manner to develop two conservation scenarios for Southwest Missouri. Using these scenarios, the potential reduction in demand is estimated at the county level. Scenario I, Moderately Expanded Conservation, is an analysis of expanded metering, leak detection, and education programs. Scenario II, Substantially Expanded Conservation, is an analysis of more aggressive levels of the Scenario I programs with the addition of the residential and non-residential water audits. More specific details on the assumptions follow.

Scenario I includes the following assumptions:

- 90 percent of water providers in each county will be metering their customers, unless current metered percentage is greater than 90 percent
- NRW system losses will be reduced to 12 percent, where applicable

- Educational programs will be implemented by all providers, which include billing inserts to reduce residential demands by 3 percent and non-residential demands by 1 percent[6]

Scenario II includes the following assumptions:

- Implementation of metering by all purveyors statewide
- NRW system loss reduction to 10 percent where applicable
- Water conservation education programs include school educational programs and conservation tip website in addition to billing inserts to reduce demands by 3-5 percent
- Implementation of residential and non-residential water audits[7]

2.5 Demand Analysis Results

Figure 2-2 illustrates the average water demand projections for each decade from 2010 to 2060 under the medium population growth scenario for the study area. Demand projections from this medium growth scenario without conservation are carried forward into the gap analysis completed under Phase II of this study.

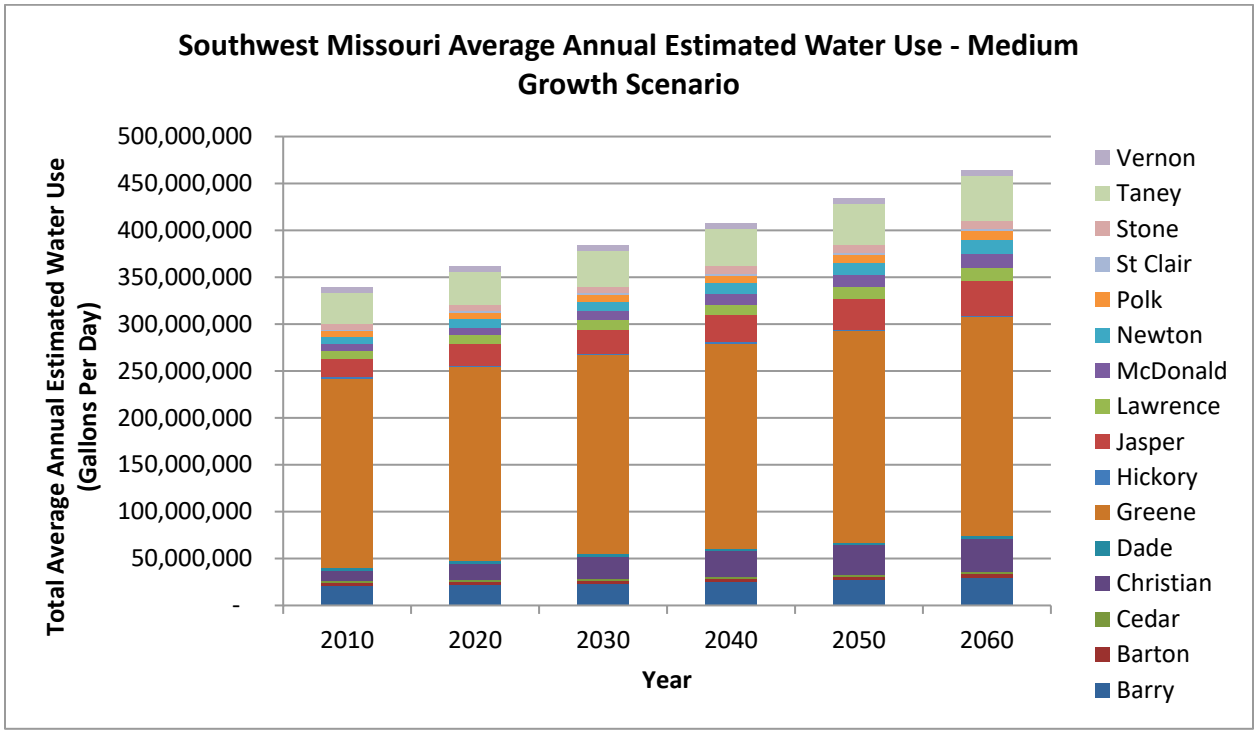

Figure 2-2: Study Area Average Annual Estimated Water Use – Medium Growth Scenario

[6] Targeting a population with a water conservation educational program is assumed to reduce public supply (PS) residential and PS non-residential sector demand by 1-5 percent, depending on the program and the sector.

[7] Implementation of a residential water audit program is assumed to reduce PS residential sector demand by 7 percent; implementation of a non-residential water audit program is assumed to reduce PS non-residential sector demand by 8 percent.

Under the medium growth scenario, the estimated average annual baseline water demand for the study area is 339.1 MGD in 2010. Under this scenario, demand for the 16 counties reaches 464.0 MGD in 2060, an increase of 124.9 MGD. Taney, Christian, Jasper, and Greene Counties combined account for about 70 percent of this increase here as well. Under the high growth scenario, every county experienced some level of population growth. Under the medium growth scenario, Cedar, Hickory, Saint Clair, and Vernon Counties all lost population, so their water demands actually decline. Table 2-4 displays the water usage numbers used to generate the figure above.

Table 2-4: Study Area Average Annual Estimated Water Use (gallons per day) Medium Growth Scenario

	2010	2020	2030	2040	2050	2060
Barry	21,126,701	22,281,921	22,974,532	24,996,332	27,223,210	29,783,988
Barton	3,126,918	3,211,488	3,255,046	3,361,130	3,487,942	3,619,893
Cedar	1,954,753	1,917,094	1,877,562	1,838,152	1,802,536	1,767,900
Christian	11,101,445	17,131,329	24,081,366	27,708,169	31,721,896	36,130,751
Dade	2,795,139	2,800,735	2,783,058	2,793,316	2,806,668	2,821,284
Greene	201,924,381	207,233,827	212,226,876	218,684,747	225,706,603	233,468,068
Hickory	1,603,674	1,606,133	1,559,932	1,489,718	1,424,311	1,360,821
Jasper	19,774,737	22,879,378	25,733,989	29,185,388	32,836,248	36,738,079
Lawrence	8,073,572	8,962,142	9,830,278	11,013,467	12,323,327	13,779,054
McDonald	7,098,007	8,291,464	9,517,879	11,229,539	13,272,774	15,743,968
Newton	8,134,179	9,037,573	10,040,999	11,426,902	12,979,166	14,732,872
Polk	5,898,760	6,777,260	7,563,205	8,179,199	8,703,075	9,195,204
St Clair	2,024,160	2,051,374	2,032,604	2,006,407	2,000,435	2,018,620
Stone	5,546,795	6,452,336	6,994,107	7,821,440	8,712,649	9,617,109
Taney	33,110,314	35,094,225	37,514,487	40,450,540	43,746,998	47,420,072
Vernon	5,834,426	5,776,017	5,763,509	5,774,854	5,793,786	5,814,029
Total	**339,127,961**	**361,504,296**	**383,749,429**	**407,959,300**	**434,541,624**	**458,197,683**

The estimated additional regional water demand in 2060 under the medium growth scenario compared to the 2010 baseline demand is 125 MGD, a nearly 40 percent increase, as shown in Table 2-5. Under Conservation Scenario I, water demand projections for future forecast years are 1 to 3 percent lower than baseline future projections annually based on moderate conservation activities. Under a more restrictive Conservation Scenario II, water demands are projected to be 4 to 7 percent lower than baseline future projections annually, as shown in Figure 2-3.

Table 2-5: Study Area Average Annual Estimated Water Use (MGD) with Conservation

Units in MGD	Baseline Demands			Conservation Scenario I			Conservation Scenario II		
	Growth Scenario								
Year	High	Medium	Low	High	Medium	Low	High	Medium	Low
2010	339	339	339	339	339	339	339	339	339
2060	584	464	388	569	454	382	544	437	371
Total Increase in Demand	245	125	49	230	115	42	204	98	32

*Variation in 2010 baseline demands between growth scenarios is due to the methodology used to determine future agricultural demands from a 2007 baseline. Development of High, Medium, and Low scenarios are explained within Sections 2.1-2.3.

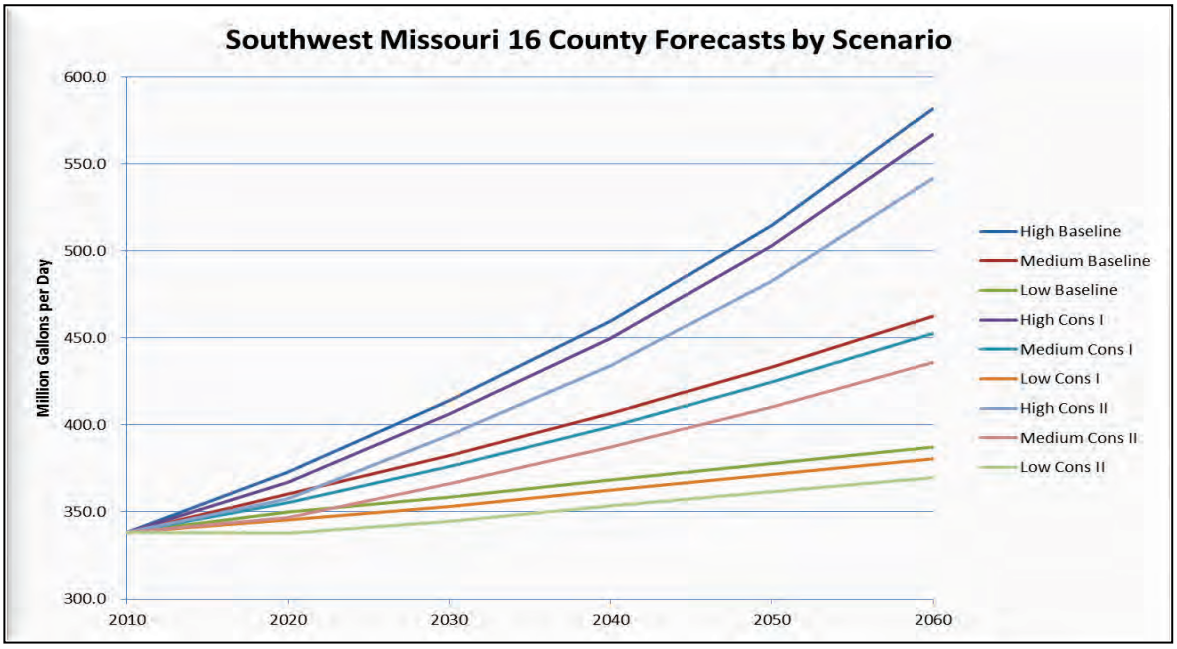

Figure 2-3: Southwest Missouri Water Demand Projections with Conservation Scenarios

Section 3

Supply Availability and Gap Evaluation (Phase II)

This section presents findings of the comparison of future estimated demands with known and projected available water supplies. Where available surface water and groundwater do not meet the future forecasted demands, the term "gap" is used to characterize the deficit. The difference between the future demand from the current capacity to treat and deliver is referred to as the future "need" to supply the water.

3.1 Availability Scenarios

To assess both surface water and groundwater availability in both normal and drought conditions, four management scenarios were developed for the gap analysis. Following Tri-State Water Resources Coalition technical review in June 2016, Scenario 5 was developed to address concerns of high groundwater availability assumptions in the Springfield, Missouri region under drought conditions. The following five management scenarios are applied in the gap analysis and are further explained in the paragraphs below:

- **Scenario 1.** Normal weather surface water flows or withdrawals. USGS groundwater model with current rate of growth reflecting continual declines.
- **Scenario 2.** Normal weather surface water flows or withdrawals. Sustainable groundwater management option (fully saturated Ozark Aquifer).
- **Scenario 3.** Drought condition surface water flows or withdrawals. USGS groundwater model with current rate of growth reflecting continual declines.
- **Scenario 4.** Drought condition surface water flows or withdrawals. Sustainable groundwater management option (fully saturated Ozark Aquifer).
- **Scenario 5.** Combines drought surface water flows and withdrawals with adjusted USGS groundwater models representing current rate of growth with continual declines.

Previous studies conducted to model and evaluate groundwater reliability in the study area have delineated study boundaries based on physiographic and geologic characteristics. To compare the future forecasted demands with the appropriate groundwater evaluations, the gap analysis needs to reflect these similar delineations to make demands and supply availability comparable. Thus, the 16-county study area was divided into 4 sub-regions that are shown in Figure 3-1.

- **Sub-region 1.** Barry, Barton, Jasper, McDonald, and Newton counties
- **Sub-region 2.** Christian, Greene, Lawrence, Polk, and Stone counties
- **Sub-region 3.** Taney County
- **Sub-region 4.** Cedar, Dade, Hickory, St. Clair, and Vernon counties

Similarly, the previous groundwater studies focused primarily on public supplied, self-supplied residential, and self-supplied industrial sectors of demand in their scenarios of impacts on the groundwater resource. To make the future forecasted demands comparable, the total demands by county, using the USGS water use data, were first separated into groundwater and surface water. For this study, the Phase I medium growth, without conservation, public supplied, self-supplied residential, and self-supplied industrial sectors were used to compare to the USGS groundwater evaluations. Average daily demands per month by county and forecast year were used to compare to surface water and groundwater supply availability by sub-region[8].

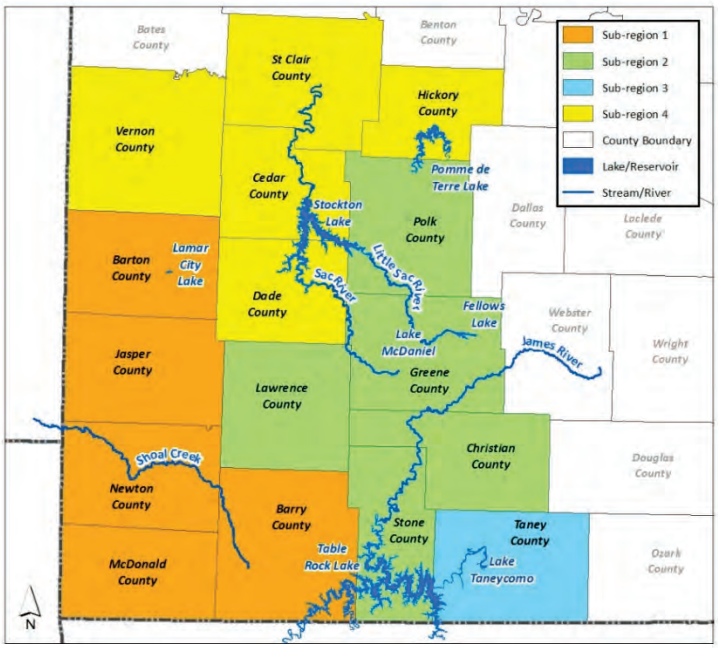

Figure 3-1: Study Area Gap Analysis Sub-regions

3.1.1 Sub-region Gap Analysis

Sub-region 1 includes Barry, Barton, Jasper, McDonald, and Newton counties. Within this sub-region, there are three communities that rely primarily on surface water. The primary source of water for both Joplin in Jasper and Newton counties and Neosho in Newton County is Shoal Creek. The primary source of water for the City of Lamar is Lamar Lake. For all other communities, the sole source is groundwater.

Lamar built their city lake after the 1954 drought of record. In 2012, the most recent drought, Missouri-American Water, Joplin, Missouri, built a wooden gate system on top of the concrete dam for additional 2 feet of storage that provides an additional 68 million gallons annually. The primary dam for Joplin is at Grand Falls on the downstream end of Shoal Creek as it leaves the city. There is limited storage with quantities available primarily controlled by Shoal Creek flows. The available amount of Shoal Creek water for public supply is assumed to be the amount after minimum stream flows are met. The minimum flow required is 43 cubic feet per second (cfs). The average flow upstream of the impoundment is 400 cfs. From nearly 70 years of record, the average flow in August is just over 200 cfs. The stream flow per month in MGD for the average stream flow (70 years of record), drought of record (1954), and most recent drought 2012 are shown in Table 3-1 to allow comparison to the future forecasted demands.

[8] Additional information on supply availability and previous studies can be found in the Southwest Missouri Water Resource Study Phase II Report, Section 6.0, Supply Availability (CDM Smith 2014)

Table 3-1: Shoal Creek Flows Converted to MGD at Joplin, Missouri

Year (MGD)	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Jul	Aug
Monthly Median*	109	117	114	153	162	239	270	314	324	273	159	108
2011 - 2012	141	103	276	249	165	123	470	401	179	92	57	45
1953 - 1954	30	35	38	41	40	41	37	36	136	53	30	24

* Median monthly flow from the most recent 70 years of compiled data

In an average year, there is sufficient water available from Shoal Creek to meet current and future demands, even in the summer season. Although there is surface water available, the infrastructure is not in place to store or readily utilize the majority of these flows above the minimum flow. In the drought of record, minimum stream flows are not met. The gap analysis assumes surface water availability under normal weather (Scenarios 1 and 2) as the median monthly Shoal Creek flows (1941-2012) shown in Table 3-1, minus the 43 cfs minimum flow requirement (27.79 MGD). Under drought conditions (Scenarios 3, 4, and 5), the gap analysis assumes surface water availability as the 1953-1954 drought of record Shoal Creek flows also shown in Table 3-1, minus the 43 cfs minimum flow requirement (27.79 MGD).

Groundwater levels have been declining in this sub-region in part due to greater demands and slower recharge in this part of the aquifer. In 2006, Black &Veatch completed the *Coalition Water Supply Study* (Black & Veatch 2006). The study, relying on additional modeling from the *Source of Supply Investigation for Joplin, Missouri* (WHPA 2003) study, suggested that the Ozark Aquifer could produce 27 MGD, which is 50 percent more than was pumped in 2000, but not without further predicted declines of 150 to 250 feet. This 27 MGD from groundwater is similar to the demand forecast between 2030 and 2040 forecast years. For the purpose of this study, 27 MGD was applied to both normal weather and drought year scenarios (Scenarios 1, 3, and 5) as the likely future groundwater withdrawal at the current rate of use, based on the results of the three studies explained above.

The WHPA 2003 report noted that the "best-fit" model demonstrated a more sustainable withdrawal in the sub-region between 5.2 and 8.04 MGD. The higher value was used to reflect a sustainable groundwater withdrawal in combination with the normal and drought year scenarios (Scenarios 2 and 4).

In the drought scenarios under both groundwater management options, if the drought of record were to happen today, there would not be sufficient available water to meet demands. For example, the gap expands by as much as 10 to 20 MGD in the summer months in Scenario 3 in 2020. Similarly, Figure 3-2 shows Shoal Creek availability in the drought of record as compared to baseline (2010) demands for Sub-region 1, indicating there is a potential shortage now as was demonstrated in the 2012 drought. The gap in availability grows with each forecast period to include deficits in all months of the year by 2060, with as much as 54 MGD in the month of August for Scenarios 3 and 5[9].

[9] Supply availability assumptions under Scenarios 3 and 5 are identical in Sub-region 1, therefore gap results are identical under both Scenarios. Availability for each of these Scenarios is different in Sub-region 2.

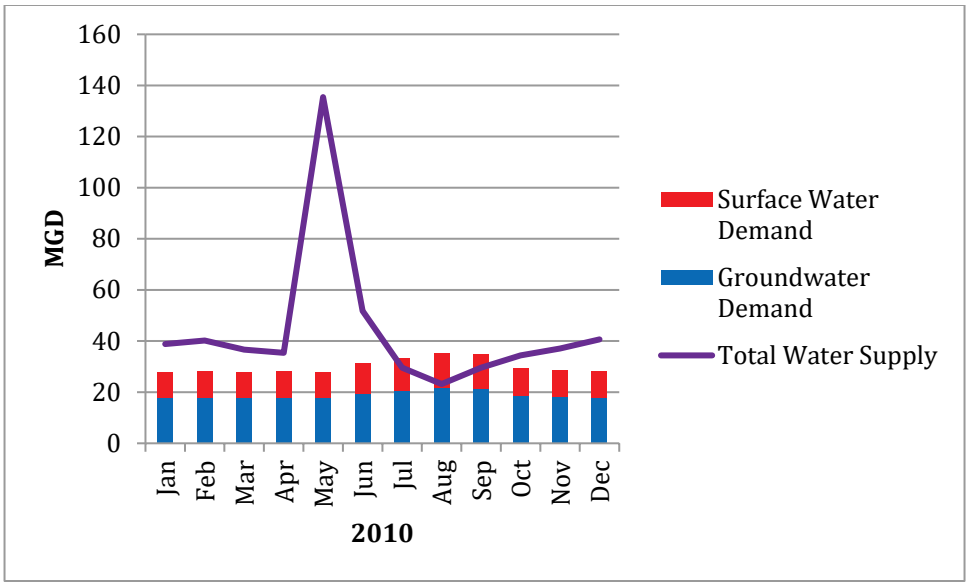

Figure 3-2: Sub-region 1, Scenarios 3 and 5 Supply Availability Gap Under Drought Conditions 2010

Sub-region 2 includes Christian, Greene, Lawrence, Polk, and Stone counties. The primary source of water for Springfield in Greene County is surface water from Fellows and McDaniel Lakes and the James River. For all other communities, the sole source is groundwater.

Springfield built its second city lake, Fellows after the 1954 drought of record. Several decades later, foreseeing a future need for water during drought periods, the City of Springfield retained Burns and McDonnell to pursue an allocation of water supply from Stockton Lake. In the 1993 Burns and McDonnell study, the estimated drought yield of existing sources was 28 MGD. An additional 28 MGD would be needed by Springfield by 2040. As a result, since 1996, the city has relied on a Stockton Lake allocation, with a maximum allowance of 50,000 AF or an average of 30 MGD, utilized mostly during times of drought. Since Springfield is the only utility within this sub-region relying on surface water presently, CDM Smith focused on identifying the withdrawals for all surface water sources (i.e., Fellows and McDaniel Lakes, James River, and Stockton Lake) to quantify the need during both normal and drought years. City Utilities provided annual reports, which reflect total raw water production by source for the fiscal years (FY) (October through September) of 2008 through 2012. However, Stockton Lake raw water is pumped to the city's lakes system and thus had to be isolated from the analysis to determine normal and drought year Springfield City Utilities surface water supply thresholds by month. The Corps provided Springfield Stockton Lake withdrawal data by month.

CDM Smith evaluated the Stockton Lake withdrawals as compared to City Utilities annual reports to determine the years that best represent normal and drought conditions. First, Stockton Lake withdrawals were reviewed to identify the trend in City Utilities use of supplemental supply. Reviewing the use of Stockton Lake since 1996, it was found that despite average precipitation in 2010, there was reliance on Stockton Lake primarily in the summer months with some limited withdrawals in several winter months as well. Thus, 2010 appeared to best represent a close to normal weather year for which there was reliance on Stockton Lake. Therefore, lake supply use

during 2010 is used to reflect a likely continued reliance into the future. The most recent drought was in 2012 during which City Utilities nearly issued mandatory conservation measures. City Utilities relied heavily on withdrawals from Stockton Lake in 2012 of approximately 15 MGD during the summer months. City Utilities water withdrawals by month and source for FY 2010 and 2012 are shown in Table 3-2.

Table 3-2: Springfield City Utilities Water Production by Source 2010 and 2012

Month	FY 2010 Water Use (MGD)			FY 2012 Water Use (MGD)		
	Ground	Surface	Stockton	Ground	Surface	Stockton
January	6.17	23.16	0.01	3.67	21.19	0.00
February	6.60	20.42	0.02	4.73	18.39	2.42
March	5.66	19.57	0.00	5.43	13.36	5.86
April	5.82	22.07	0.00	5.74	14.99	6.68
May	4.63	24.26	0.02	3.76	14.98	13.55
June	4.68	31.96	2.88	3.26	16.87	15.53
July	4.76	30.85	0.41	1.68	22.72	16.00
August	3.37	29.23	4.87	0.73	16.24	16.13
September	5.19	20.75	3.19	4.82	2.64	16.37
October	6.12	19.31	0.00	2.09	15.25	9.08
November	5.90	20.25	0.02	2.05	9.33	9.32
December	5.32	20.21	0.00	2.85	11.42	6.62

Sources. Springfield City Utilities annual reports and Stockton Lake withdrawal reports

The gap analysis assumes surface water availability under normal weather (Scenarios 1 and 2) as the 2010 surface water production shown in Table 3-2, with an additional 30 MGD supply from the Stockton Lake allocation. Under drought conditions (Scenarios 3, 4, and 5), the gap analysis assumes surface water availability as the 2012 surface water production also shown in Table 3-1, with an additional 30 MGD supply from the Stockton Lake allocation.

To determine groundwater availability in Sub-region 2, the CDM Smith team utilized the USGS study, *Groundwater-Flow Model and Effects of Projected Groundwater Use in the Ozark Plateaus Aquifer System in the Vicinity of Greene County, Missouri – 1907-2030* (2010). The study evaluated groundwater recharge and movement as well as the interactions with surface water, including lakes, streams, and springs. The purpose of the study was to evaluate the impacts of multiple growth and demand scenarios on the growing cone of depression in the Ozark Aquifer around the Greene County area.

The 2010 USGS study for the Greene County vicinity noted a cone of depression existing below Springfield, Missouri as early as the late 1930s. According to USGS, declines from predevelopment condition were 300, 350, and 500 feet in 1974, 1987, and 1996, respectively. In the cone of depression, the Ozark Aquifer was 259 feet below the top of the aquifer; thus, not fully saturated. At that point, the 1,300 feet thick aquifer was 80 percent saturated. Continued declines were modeled by USGS for seven scenarios. A total of 56 MGD was projected to be used by 2030 compared to the 32.4 documented to be used in 2006. This projected amount is similar to the amount forecast in demand study for the forecast period of 2030 to 2040 in the medium-growth

scenario. The USGS projected 56 MGD as a future groundwater threshold for the current growth rate. Based on this information, it was assumed for Scenarios 1 and 3, reflecting continual groundwater rate of use, groundwater withdrawals would total 56 MGD. To estimate a more sustainable groundwater withdrawal, USGS notes 8 MGD withdrawals in 1962 and 20 MGD in 1987. It was then assumed for Scenarios 2 and 4, reflecting the more sustainable groundwater management, withdrawals would total 16 MGD. Based on concerns of high groundwater availability assumptions under Scenarios 1 and 3, Scenario 5 was developed utilizing the 2006 documented regional withdrawal from the 2010 USGS study of 32 MGD.

Sub-region 3 consists only of Taney County. Until the 1990s, Taney County water demands were met by groundwater. Then in the 1990s, the City of Branson experienced significant tourism growth that put pressure on the groundwater supply, forcing them to drill more and deeper wells to the point that it was economically favorable for the City of Branson to consider an alternate source. Currently the primary source of water for the City of Branson is surface water supplied from Lake Taneycomo. The remainder of the county continues to be supplied by groundwater.

Empire Electric, who operates the dam and hydropower facilities on Taneycomo, has an arrangement with the City of Branson to supply surface water. The City of Branson has expressed that the arrangement has no limitations on the quantity to supply Branson's demands now and into the future. However, it is believed that Lake Taneycomo's drinking water supply arrangement is expressly for the City of Branson and thus unavailable for use by other surrounding communities. As such, the only surface water demands identified in Taney County are the City of Branson demands, which are considered to always be met in all scenarios and forecast years. There is no indication that there would not be sufficient water in Lake Taneycomo to meet these demands particularly in the peak summer season. Peak summer demands also coincide with peak hydropower demands; thus, there would be sufficient releases from Table Rock Lake to meet water supply commitments. Currently, there is a Total Maximum Daily Load (TMDL) regarding dissolved oxygen levels in Lake Taneycomo as a result of hydropower releases. One alternative to improve the dissolved oxygen levels is to have a minimum flow of 400 cfs. This is a similar amount observed for Bull Shoals downstream of Lake Taneycomo and would be assumed to be the same amount that must pass through Lake Taneycomo in all seasons. Currently, flows into Lake Taneycomo are as little as 100 cfs (due to gate leakage etc.) to over 15,000 cfs during high power generation.

Groundwater management options considered are the current rate of growth bounded by parameters and scenarios offered in the USGS 2010 study for Sub-region 2 (Greene County vicinity) and a more sustainable withdrawal that would be more likely to return the aquifer to a fully saturated state (confined) assuming greater recovery in the karst Salem Plateau formations. Since there were no specific models completed by USGS for this portion of the study area, the findings of the USGS 2010 study were applied here, given portions of both Sub-regions 2 and 3 reside in the Salem Plateau aquifer and both the cities of Springfield and Branson, Missouri were experiencing similar rates of decline in the aquifer. Thus, the ratio of the groundwater demand of 32.4 MGD in 2006 as reported in the USGS 2010 study and the future demand of 56 MGD, that in some locations rendered the aquifer less than 50 percent saturated, were applied to Taney County groundwater demands. The baseline demand for Taney County per the Phase I demand study is 5.56 MGD. Applying this ratio to the baseline demand would result in a future withdrawal threshold for the county of 9.6 MGD. The baseline demand of 5.56 MGD is applied as the more

sustainable groundwater demand given that Branson has reduced its groundwater demands by 90 percent in the past decade, and its wells have recovered substantially.

Given that Branson is the only surface water user in Taney County and that their surface water demands are always met by Lake Taneycomo, even during drought, the gaps are deficits in groundwater supply for Taney County. There are gaps in supply in 2050 of 1 to 2 MGD during the summer months and 3 to 4 MGD during the same months in 2060 for Scenarios 1 and 3. Taney County is estimated to reach the USGS assumed groundwater threshold of 9.6 MGD by 2040. The sustainable groundwater management option would reflect a supply gap of 1 MGD in August 2020, growing to as much as 8 MGD in 2060 and having deficits in all months. Based on very small gaps within this region, Scenario 5 was not developed for Sub-region 3, and the sub-region gap is not carried forward into the Stockton Lake reallocation analysis.

Sub-region 4 includes the five northern most counties of the study area, including Cedar, Dade, Hickory, St. Clair, and Vernon. The primary source of water in these counties is groundwater. It is believed that there is sufficient groundwater in the Springfield Plateau aquifer to continue to meet self-supplied residential demands and adequate availability in the Ozark Aquifer to continue to meet future demands of primarily rural counties that are collectively experiencing declining populations.

In summary, the most immediate need identified was in Sub-region 1, where during an extended drought (i.e., Scenarios 3, 4, and 5) there is neither sufficient flow nor storage in Shoal Creek to meet base flow requirements and sub-regional demands. This was observed during the drought of 2012, and based on drought of record conditions, the gap in supply and demand is estimated to be 19 MGD in August of 2020 and could potentially grow to over 50 MGD in August of 2060. Gaps in supply are also projected in Sub-region 2 under extended drought conditions (i.e., Scenarios 3, 4, and 5) and may occur in the summer months as early as 2020.

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Section 4

Determination of Reallocation Amounts

One of the supply alternatives for the 16-county region is a reallocation for water supply from Stockton Lake. Springfield City Utilities has an existing 50,000 AF (30 MGD) allocation from Stockton Lake. For the purposes of a reallocation request, per the example provided by City Utilities reallocation from Stockton, the average annual daily gap by forecast year was calculated by weighting the monthly gap[10] by the number of days in each month as shown in the following equation:

$$\boldsymbol{Average\ Annual\ Daily\ Gap} = (W_{Jan} * D_{Jan} + W_{Feb} * D_{Feb} \ldots + W_{Dec} * D_{Dec})/365$$

Where: *W = Average Daily Gap, by Month*
D = Number of Days in each month

For example, as shown in Table 4-1, in Sub-region 1, Scenario 3 in 2060 the following calculation was completed:

Average Annual Daily Gap =
[(21*31)+(20*28)+(24*31)+(26*30)+(0*31)+(17*30)+(44*31)+(54*31)+(47*30)+(30*31)+(24*30)+(20*31)]/365 = 27

The results of this calculation are shown in the red highlighted columns of Tables 4-1 and 4-2. Table 4-3 is a summary of average daily gap by forecast year for both sub-regions 1 and 2 reflecting Scenarios 3, 4, and 5 defined above.

Table 4-1: Sub-region 1 Average Daily Gap by Forecast Year (MGD)

Sub-Region 1	Scenario 3												MGD	Scenario 4												MGD
Forecast Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
2020	-	-	-	-	-	-	10	19	12	0	-	-	3	13	12	15	17	-	4	29	38	30	19	15	11	17
2030	-	-	0	2	-	-	15	24	17	5	1	-	5	17	16	19	21	-	9	34	43	36	24	20	16	21
2040	5	4	7	9	-	-	24	33	26	12	8	4	11	24	23	26	28	-	17	43	52	45	31	27	23	28
2050	13	12	15	17	-	7	33	43	36	20	16	11	19	32	31	34	36	-	26	52	62	55	39	35	30	36
2060	21	20	24	26	-	17	44	54	47	30	24	20	27	40	39	43	45	-	36	63	73	66	49	43	39	45

	Scenario 5												MGD
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
2020	-	-	-	-	-	-	10	19	12	0	-	-	3
2030	-	-	0	2	-	-	15	24	17	5	1	-	5
2040	5	4	7	9	-	-	24	33	26	12	8	4	11
2050	13	12	15	17	-	7	33	43	36	20	16	11	19
2060	21	20	24	26	-	17	44	54	47	30	24	20	27

[10] Monthly gaps are provided in the Southwest Missouri Water Resource Study Phase II Report, Section 7.0, Gap Analysis (CDM Smith 2014), as well as the Southwest Missouri Water Resource Study: Summary of Phases Tech Memo (CDM Smith 2016)

Table 4-2: Sub-region 2 Average Daily Gap by Forecast Year (MGD)

Sub-Region 2	Scenario 3												MGD	Scenario 4												MGD
Forecast Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
2020	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	18	-	-	-	2
2030	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	4	8	8	21	31	6	7	1	7
2040	-	-	-	-	-	-	-	-	4	-	-	-	0.3	4	9	11	12	14	20	20	34	44	16	16	11	18
2050	-	-	-	-	-	-	-	9	17	-	-	-	2.2	15	20	21	23	26	32	33	49	57	28	27	21	29
2060	-	-	-	-	-	5	7	24	33	-	-	-	5.8	26	32	33	35	38	45	47	64	73	40	39	32	42

	Scenario 5												MGD
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
2020	-	-	-	-	-	-	-	-	2	-	-	-	0
2030	-	-	-	-	-	-	-	5	15	-	-	-	2
2040	-	-	-	-	-	4	4	18	28	-	-	-	4
2050	-	4	5	7	10	16	17	33	41	12	11	5	13
2060	10	16	17	19	22	29	31	48	57	24	23	16	26

Table 4-3: Sub-regions 1 and 2. Average Daily Gap by Forecast Year (MGD)

	Sub-Region 1			Sub-Region 2			Total		
Year	Scenario 3	Scenario 4	Scenario 5	Scenario 3	Scenario 4	Scenario 5	Scenario 3	Scenario 4	Scenario 5
2020	3	17	3	-	2	0	3	19	4
2030	5	21	5	-	7	2	5	28	7
2040	11	28	11	0	18	4	11	46	16
2050	19	36	19	2	29	13	21	65	32
2060	27	45	27	6	42	26	33	87	53

The Project Team is currently evaluating possible reallocation of supply from Stockton Lake to address the regional gap within Sub-regions 1 and 2. The reallocation amount under evaluation is the 2060 total average daily gap under Scenario 5 of 53 MGD, as shown in Table 4-3.

The 2016 Water Resource Study Summary identified a total demand for the 16-county region as 53 MGD. Using this data and adjusting for the population served, the water demand gap by county was disaggregated for individual Tri-State Water members and is presented in Table 4-4 as an annual average day demand (AVD) gap. The demand gap is the difference in current supply and what is needed for future conditions, this is not the total water demand for these utilities.

Because the Tri-State Water membership does not represent the entire 16-county region, a 30 percent growth factor was also added to the AVD values to allow for additional members to be added to the water distribution network in the future. Tri-State Water, the USACE, and MDNR agreed that 30 percent was reasonable to use for a growth factor. Figure 4-1 illustrates the total demand for the 16-county region compared to the demands for current and future Tri-State members.

Table 4-4 – Tri-State Water Demand Gap Projections by Municipality[1]

County	Region	Municipality	Average Day Demand (MGD)
Barry	1	Monett	1.3
	1	Cassville	0.46
Barton	1	Lamar	0.69
Jasper	1	Carthage	2.1
	1	Mo American Joplin	7.5
	1	Wholesale Mo American Joplin Customers	0.90
	1	Webb City	2.2
Christian	2	Nixa	1.4
Greene	2	Springfield	13
Lawrence	2	Mount Vernon	0.34
-	-	For Future Tri-State Members	9
Total of all Sub-region 1 and 2 Counties			**39**

Notes:
1. Table is rounded to two significant digits

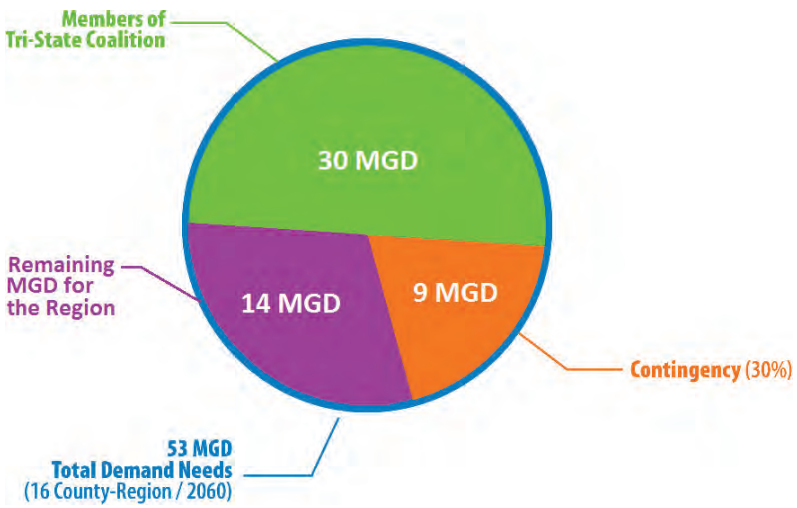

Figure 4-1 – Water Demand Needs for 16-County Region and Tri-State Members

In addition to Stockton Lake, other Corps reservoirs may be considered for reallocations including Pomme de Terre Lake and Table Rock Lake. The Corps will explore whether one or a combination of Corps reservoirs are needed to meet the future supply gap. Current considerations and evaluations are of the various constraints on the reallocation request(s) that include, but are not limited to authorized purpose(s), environmental impacts, and costs. Other alternatives such as a new reservoir and groundwater well fields are also being considered at this time.

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Section 5
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Stockton Lake Reallocation Study

Draft Integrated Water Supply Storage Reallocation Report and Environmental Assessment

Appendix B-Economics

June 2020

US Army Corps of Engineers ®
Kansas City District

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1.0 Introduction

The purpose of this economic evaluation is to investigate the impacts of reallocating water supply storage from the multipurpose and flood control pools at Stockton Lake for the purpose of municipal and industrial (M&I) water supply. The proposed changes (alternatives) to the base condition are compared and analyzed to determine the effects or potential effects and aid in the planning process. In the case of the Stockton Lake Reallocation Study, this evaluation compares reallocating the requested water supply storage solely from the multipurpose pool or from a combination of the multipurpose pool and flood control pool (which includes a pool raise) against the base condition and evaluates any effects these changes have on downstream flood impacts, hydropower benefits forgone, recreation and the cost of storage against the most likely alternative for obtaining the requested amount of water supply storage. Average annual dollars for this report are based on the FY20 price level, the FY20 discount rate of 2.75% and the period of analysis is 50 years.

2.0 Study Area and Project Background

Stockton Lake, located on the Sac River in southwest Missouri, was authorized by the Flood Control Act, approved in 1954, as a multipurpose project with storage allocation for flood control, power production, sediment reserve, recreation, and fish and wildlife management. USACE initiated construction in June 1964 and impoundment was initiated on December 12, 1969. The lake first filled to the top of the multipurpose pool, 867.0 National Geodetic Vertical Datum of 1929 (NGVD 29) on December 18, 1971. In 1993, 50,000 acre-feet of storage was reallocated form the multipurpose pool to water supply storage for City Utilities of Springfield, Missouri.

USACE manages and operates the reservoir which lies in southeastern Cedar County, northeastern Dade County and southwestern Polk County, Missouri. The dam is located on the north end of the lake, about two miles east of the town of Stockton. The reservoir covers 39 square miles with 298 miles of shoreline.

Tri-State Water Resources Coalition is the water supply user requesting a reallocation of storage at Stockton Lake. Tri-State represents a 16 county region in southwest Missouri. In 2010, the Planning Assistance to States Program was used to aid in the development of a demand study (Phase I) followed by a supply availability study, which resulted in a gap analysis to assess the future municipal and industrial needs for southwest Missouri (Phase II). The Water Management and Reallocation Study Center of Expertise (WMRS PCX) approved the needs analysis developed for the Stockton Lake Reallocation Study for use on April 22, 2018.

Figure 2-1 shows a map of Missouri and the 16-county region, which includes, Vernon, Barton, Jasper, Newton, McDonald, St. Clair, Cedar, Dade, Lawrence, Barry, Hickory, Polk, Greene, Christian, Stone, and Taney Counties.

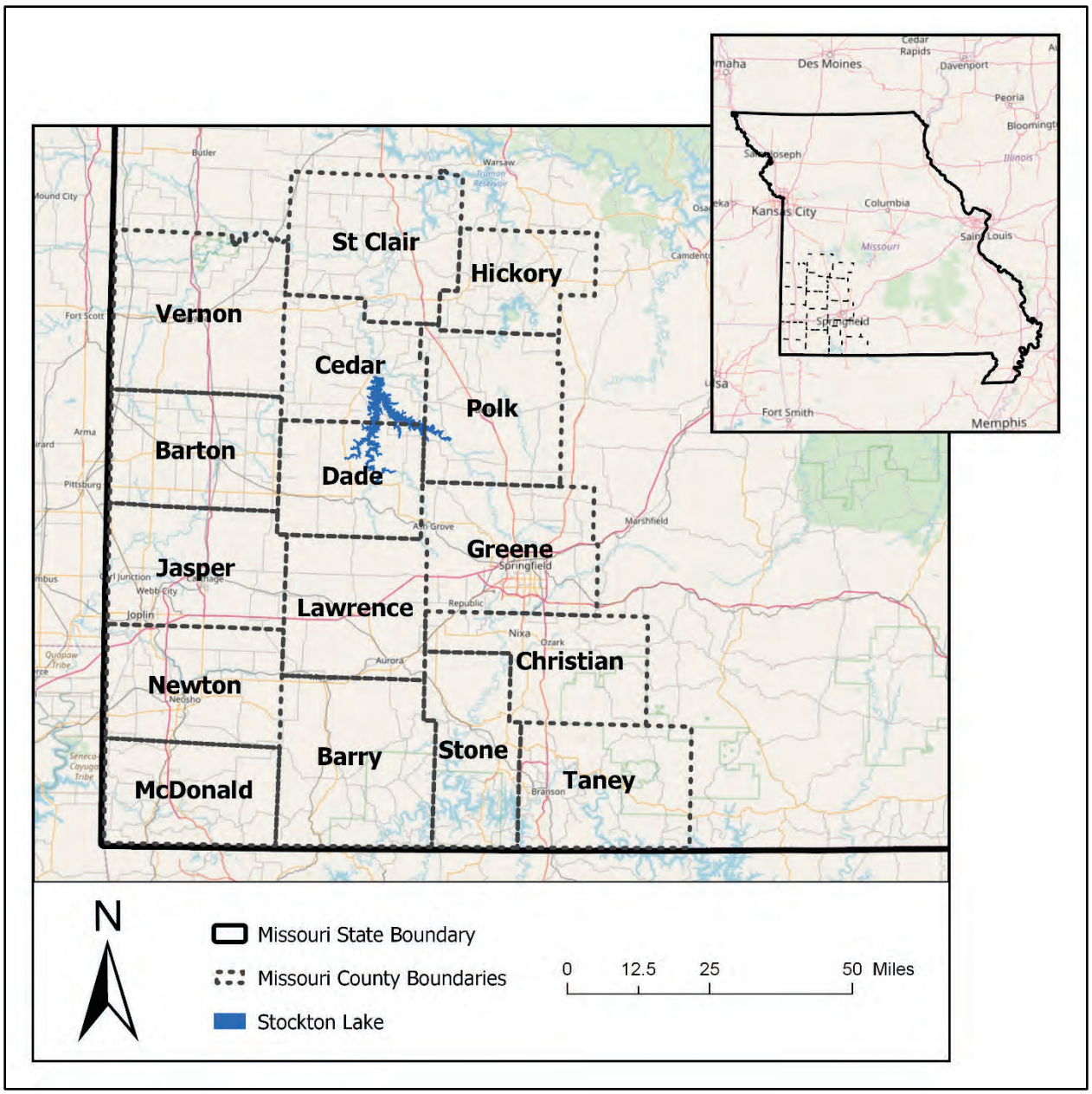

Figure 2-1. Sixteen County Region in Southwest Missouri.

The Phase I study determined that under a medium growth scenario, average annual regional water demands were expected to increase from 2010 to 2060 by approximately 40% to 125 million gallons per day (MGD) for all water use sectors. The Phase II report evaluated supply availability for the region as well as a gap evaluation in water supply and demand based on the demands estimated in Phase I. A regional average annual daily gap of 53 MGD was calculated for the forecast year 2060.

While the analysis was completed for the 16-county area, not all water producers in the 16-county region are members of Tri-State Water Resources Coalition. Based upon the Coalition's membership, it was determined that 39 MGD from Stockton Lake is needed to reduce water shortages that will occur during future drought years. This provides 30 MGD to meet current membership's water supply needs and provides an additional 30% contingency for potential

membership growth in the event other water providers decide to join the Coalition; the contingency also reduces the likelihood the Coalition needs to immediately request another reallocation. The complete needs analysis and documentation can be found in Appendix A.

Table 2-1 describes the population and area demographics for the 16 county southwest Missouri region. Table 2-2 displays the income and housing demographics for the region. Data comes from the U.S. Census Bureau, QuickFacts.

Table 2-1: Population and Area Demographics for the 16-County Region.

County	Population Estimates July 1, 2018	Population, Census, April 1, 2010	Population % Change 2010 to 2018	High School or Higher Graduate	Population /Square Mile	Land Area in Square Miles
Barry	35,886	35,597	0.80%	82.20%	45.7	778.25
Barton	11,798	12,402	-4.90%	87.20%	21	591.92
Cedar	14,165	13,982	1.30%	84.40%	29.5	474.48
Christian	86,983	77,422	12.4%	91.90%	137.6	562.65
Dade	7,569	7,883	-4.00%	86.20%	16.1	490.01
Greene	291,923	275,174	6.10%	91.60%	407.5	675.3
Hickory	9,509	9,627	-1.20%	84.90%	24.1	399.09
Jasper	120,636	117,404	2.80%	87.00%	183.9	638.49
Lawrence	38,359	38,634	-0.70%	83.20%	63.2	611.74
McDonald	23,078	23,083	>0	76.50%	42.8	539.48
Newton	58,266	58,114	0.30%	86.70%	93	624.77
Polk	32,201	31,137	3.40%	87.50%	49	635.52
St. Clair	9,395	9,805	-4.20%	84.10%	14.6	669.98
Stone	31,749	32,202	-1.40%	86.50%	69.4	464.03
Taney	55,852	51,675	8.10%	88.70%	81.7	632.44
Vernon	20,528	21,159	-3.00%	88.50%	25.6	826.4

Source: United States Census Bureau, QuickFacts, https://www.census.gov/quickfacts/fact/table/US/PST045219, accessed on March 3, 2020.

Table 2-2: Income and Housing Demographics for the 16 County Region

County	Median Household Income 2018 Dollars	Persons in Poverty, Percent	In Civilian Labor Force, % of Population	Housing Units (7/1/2018)	Owner Occupied Rate	Median Value Owner Occ.
Barry	$41,463	18.80%	53.50%	17,638	73.60%	$116,400
Barton	$41,625	17.60%	58.50%	5,591	70.20%	$96,100
Cedar	$39,412	17.90%	52.40%	7,255	72.40%	$105,000
Christian	$57,019	8.60%	64.10%	34,786	74.20%	$162,900
Dade	$39,979	16.80%	54.20%	3,951	77.90%	$81,300
Greene	$44,808	15.50%	61.60%	134,568	57.40%	$141,200
Hickory	$36,190	17.80%	43.60%	6,865	81.40%	$94,900
Jasper	$46,929	16.60%	64.80%	51,797	64.80%	$115,900
Lawrence	$43,373	15.50%	60.80%	16,716	71.90%	$105,700
McDonald	$42,019	17.90%	55.90%	9,966	69.60%	$97,400
Newton	$49,023	16.00%	61.00%	24,790	70.80%	$122,900
Polk	$44,892	16.20%	59.20%	13,618	69.20%	$125,700
St. Clair	$38,470	18.20%	48.40%	5,651	77.70%	$83,600
Stone	$46,443	13.40%	47.90%	21,257	82.00%	$165,400
Taney	$41,487	15.40%	58.70%	31,005	59.90%	$128,200
Vernon	$43,379	17.20%	60.80%	9,590	69.70%	$99,000

3.0 Modeling and Alternatives

The Hydraulic Engineering Center Reservoir Simulation (HEC-ResSim) Version 3.4.188 Beta software was used to model the operation of Stockton Lake as well as the Osage River Basin. Stockton Lake's model includes a 63 year period of analysis from 1949 to 2012. This period

includes the drought of record from the 1950's. The reservoir is not 63 years old and was not yet constructed in the 1950's so some of the data is synthesized and is calibrated against known hydrologic events.

As the outcome of plan formulation (described in the main report and Appendix L) the final array of alternatives identified three alternatives for detailed evaluation. The three alternatives are no action, multipurpose pool only, and a combination of the multipurpose and flood control pools. Alternative 5 is sized to provide a yield of approximately39 MGD with a reallocation of 90,200 acre feet from the multipurpose pool. Alternative 7 provides a 39 MGD water supply yield using a combination of pools, including reallocation of 45,750 acre feet of storage from the multipurpose pool and 49,000 acre feet of storage from the flood control pool and equates to a 1.8 foot pool raise, which is within the current normal operational range of the lake. Alternative 2, which is not mentioned in the table below, is construction of a new reservoir. In absence of a Federal reallocation action, the non-federal sponsor's most likely, least costly alternative would be to construct a new reservoir. This alternative is used in Section 10, the Test of Financial Feasibility. Table 3-1 displays the final array of alternatives.

Table 3-1. Final Array of Alternatives.

Alternative 1: Future Without Project (FWOP) Federal No Action-No Change in Reservoir Operations
Alternative 5: Reallocate 90,200 Acre-Feet (AF) from the Multipurpose (MP) Pool
Alternative 7: Tentatively Selected Plan (TSP) Reallocate 45,750 AF from MP Pool and 49,000 AF from the Flood Pool (FP) a 0.8 foot pool raise

4.0 Impacts to Flood Risk Management (FRM)

A flood risk management evaluation was only conducted on Alternative 7 since Alternative 5 is not changing the normal pool elevation and thus not changing flood risk and flood risk management. As described in the water control manual, the surcharge operation criteria are understood to stand as documented post-reallocation, meaning the phased released schedule will remain the same. Any time that the elevation and inflow threshold is 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.

As described in the Hydrology and Hydraulics Appendix (Appendix C), Kansas City District Water Control has discretion in the operation of the dam to make non-damaging releases. Considerations for releases include (1) downstream conditions (i.e., flooding) (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 represents stream capacity (meaning bank full). Any release in excess of Phase II will experience out of banks flooding. Phase III release will flood low lying areas but is not expected to impact structures. Therefore, the same non-damaging, non-surcharge operation criteria releases that occur at or below Phase III releases today are 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 4-1 and 4-2 describe the gage location at Caplinger Mills, which is approximately 22 miles downstream of Stockton Dam. Table 4-1 includes information from the National Weather Service (NWS) flood stage data and Table 4-2 describes the water control manual discharges at different phases. For the NWS data

in Table 4-1, 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 4-2 displays the various stages of discharges during high water or flood events. Phase 3 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 3 releases under either alternative, there is not an impact to flood risk management.

Table 4-1. National Weather Service Percent Time at Various Flood Stages at 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%
Alt 5 (90.2kMP)	2.23%	1.18%	0.46%	0.04%
Alt 7 (45.75kMP / 49.0kFP)	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 4-2. Stockton Lake Water Control Manual Percent Time of Phased Discharges at Caplinger Mills USGS Gage.

Model Simulation	**Action Stage (14') Phase I**	**Flood Stage (16')Phase II**	**Moderate Flood Stage (19') Phase III**
Base/Existing Condition	3.94%	1.23%	0.47%
Alt 5 (90.2kMP)	3.49%	1.18%	0.46%
Alt 7 (45.75kMP / 49.0kFP)	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 operation criteria that currently exists 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 condition conditions. While Stockton Lake may reach higher pools slightly more frequently post-reallocation (with a higher multipurpose pool elevation), the District 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 determined 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. There are not any expected additional or induced flood damages due to Alternative 7.

5.0 Impacts to Hydropower

This section presents a summary of the effects on hydropower and the monetary value of hydropower that are expected to result from the two proposed water reallocation alternatives. The entire analysis and the impacts to hydropower and the hydropower benefits forgone can be found in Appendix E, Hydropower Analysis.

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 FY19 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. Alternative 5, which is reallocating 90,200 AF of multipurpose pool storage, would reduce hydropower benefits by approximately $200,100. A 1.8 foot pool raise under Alternative 7, would reduce hydropower benefits by approximately $242,000. Table 5-1 summarizes the total hydropower benefits forgone.

Table 5-1. Average Annual Combined Hydropower Benefits Forgone by Alternative.

Alternatives			
Energy Value (Table 5-3)			
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 6-5)			
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
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

*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.

6.0 Recreation Analysis

When Stockton Lake was constructed, a total of 6,142 acres of land were acquired specifically for recreation. Nine areas ranging from 40 acres to 900 acres were used for the development of public areas. The developed facilities include roads, parking areas, water supply, comfort stations, boat launching ramps and picnic facilities. A total of 14 public use areas were designated with one area being developed by the State of Missouri as a State Park. Four areas were reserved for future development.

There are ten campgrounds located around the lake. USACE maintains Cedar Ridge, Crabtree Cove, Hawker Point, Masters, Orleans Trail, Ruark Bluff East and Ruark West Campgrounds. In addition, Stockton State Park (operated by the Missouri Department of Natural Resources), Mutton Creek Marina and Orleans Trail Marina also offer camping opportunities on the lake. Both Mutton Creek Marina and Orleans Trail Marina are privately owned marinas. Stockton State Park also has a marina.

Members of the PDT met with the Operations Project Manager, the Park Manager and a Park Ranger from Stockton Lake. During the meeting lake personnel worked with the PDT to complete the Unit Day Value (UDV) Scoring Rubric, which is outlined in the USACE Economic Guidance Memorandum (EGM) 20-03, Unit Day Values for Recreation for Fiscal Year 2020. The rubric is based on five criteria, which are recreation experience, availability of opportunity, carrying capacity, accessibility and environmental quality. Each criteria is assigned a point value based on judgment factors. The completed rubric provides metrics that are used in the comparative analysis as well as being an integral part of the (UDV) Methodology.

6.1. Lake Elevations and Conditions

The lake personnel also provided detailed maps of the park's recreation features and the elevations of all the features. During the meeting, the lake personnel also provided lake elevations where the elevations both low and high begin to have impacts on recreation. For analysis purposes, the recreation season is considered to be the months of April through September.

Multipurpose pool elevation at Stockton Lake is 867.0 feet NGVD 29. Lake personnel stated there are some impacts (predominately aesthetics) to uses operated by USACE at two feet below multipurpose pool which would be 865.0 feet NGVD 29. At four feet below multipurpose pool or 863.0 feet NGVD 29, there would be impacts to uses during the recreation season due to submerged hazards being closer to the surface or exposed at the swim beaches and entrances to some coves and three boat ramps that are prone to closures from low water elevations. At elevations greater than 871.0 feet NGVD 29, some campgrounds, beaches, boat ramps and roads are closed due to high water.

Table 6-1: Lake Elevations and Conditions

Elevation (NGVD 29)	Condition
Above 871'	High
865'-871'	Normal
863'-865'	Low
Below 863'	Very Low

An Excel© spreadsheet model was developed in order to conduct the recreation analysis. Tabs for each recreation resource were included as well as day and elevation counts in order to evaluate the recreation impacts. For the full year, for a given elevation (i.e. >=871 feet or higher), the calculation looked through the period of record data and counted the number of days that have an elevation of 871.0 feet NGVD 29 or greater. To arrive at an annual average,

the total number of days was divided by 63 years, which is the number of years in the period of record.

For the recreation season, for a given elevation (i.e. >= 871 feet or higher) the calculation looked through all the seasonal entries (all days in April, May, June July, August and September) and counted the number of days that have an elevation of 871.0 feet NGVD 29 or greater. To arrive at the annual average, the number of days meeting the criteria was divided by the 63-year period of record.

The following two tables display the annual average number of days the lake would be within an elevation range. The first table is for the entire year and the second table includes only the months of the recreation season.

Table 6-2. Full Year - Annual Average Days at Lake Condition

Alternative	High	Normal	Low	Very Low	Total
	Above 871'	865'-871'	863'-865'	Below 863'	
Base Condition	22	157	70	117	366
Alternative 5	18	109	52	186	365
Alternative 7:	22	164	56	123	365

Note: Slight discrepancies due to rounding

Table 6-3. Recreation Season (April – September) Annual Average Days at Lake Condition

Alternative	High	Normal	Low	Very Low	Total
	Above 871'	865'-871'	863'-865'	Below 863'	
Base Condition	16	93	33	41	183
Alternative 5	13	62	29	79	183
Alternative 7Pool	15	94	32	43	184

Note: Slight discrepancies due to rounding

The following table provides a comparison of the minimum elevation, maximum elevation and the average elevation for the 63 year period of record for the two alternatives and the base condition.

Table 6-4. Period of Record Statistics for Minimum, Maximum and Average Elevations

Alternative	Minimum Elevation	Maximum Elevation	Average Elevation
Base Condition	853.7	888.1	864.8
Alternative 5	845.7	888.0	862.6
Alternative 7	849.8	888.1	864.8

The following two tables provide a comparison of the two reallocation alternatives against the base condition for the differing recreation lake conditions. The first table is for the entire year and the second table is for the recreation season. The base condition represents the current operation of the lake. The "Days/Year" column contains the number of days during a year or recreation season that the pool elevation is in a particular lake condition elevation range. The percent column displays the percentage of the year or recreation season that the pool elevation is in a particular lake condition elevation range. The recreation season is April through September.

Table 6-5. Elevation Comparisons - Average Annual Days and Percentage of Time at Lake Condition

Lake Condition	Elevation (ft) NGVD 29	Base Condition % of Time	Base Condition Days/Year	Alt 5 % of Time	Alt 5 Days/Year	Alt 5 Difference from Base	Alt 7 % of Time	Alt 7 Days/Year	Alt 7 Difference from Base
High	>= 871	6%	22	5%	18	-4	6%	22	0
Normal	865-870.9	43%	157	30%	109	-48	45%	164	8
Low	863-864.9	19%	70	14%	52	-18	15%	56	-14
Very Low	<863	32%	117	51%	186	69	34%	123	7

Table 6-6. Elevation Comparison - Recreation Season Average Annual Days and Percentage of Time at Lake Condition

Lake Condition	Elevation (ft) NGVD 29	Base Condition % of Time	Base Condition Days/Year	Alt 5 % of Time	Alt 5 Days/Year	Alt 5 Difference from Base	Alt 7 % of Time	Alt 7 Days/Year	Alt 7 Difference from Base
High	>= 871	9%	16	7%	13	-3	8%	15	-1
Normal	865-870.9	51%	93	34%	62	-31	51%	94	1
Low	863-864.9	18%	33	16%	29	-4	17%	32	-1
Very Low	<863	23%	41	43%	79	38	23%	43	1

As the combination pool alternative has a pool raise that falls within the current operational range of the lake, the recreation analysis was done by comparing expected lake elevation changes based upon the modeled reallocation alternatives against the modeled base condition which reflects the current operation of the lake and includes the 50,000 acre feet reallocation from 1993 for City Utilities of Springfield, Missouri. After comparing the results of the changes in lake elevations between alternatives and looking at the negligible impacts that the pool raise would have since it falls within the current operation range of the lake, the PDT decided to forgo the UDV-based NED recreation analysis because of the negligible changes between the future without project (base condition condition) and the future with project. A reallocation that is solely from within the multipurpose pool does not require a UDV-based NED recreation analysis because there is no proposed change to the normal lake elevation.

6.2. Boat Ramps

Stockton Lake has 15 boat ramps around the lake. Stockton Lake personnel provided the PDT with two elevations for each boat ramp, a top elevation and bottom elevation. The top elevation is the elevation at which the boat ramp becomes inaccessible due to high water. The bottom elevation is the elevation at which the boat ramp becomes unusable due to low water.

The majority of the boat ramps have low bottom elevations that keep them usable to relatively low water elevations. Due to underlying geomorphic conditions, three of the ramps, Greenfield, Cedar Ridge's east ramp and Masters, have relatively high bottom elevations that necessitate closing those ramps in "very low" water conditions as defined above in Section 6.1 (elevation less than 863.0 ft NGVD 29). There is a danger of the wheels on boat trailers going off the lower end of those three ramps and the trailer axels getting caught on the end of the ramps when launching or retrieving boats. Table 6-7 displays the average number of days per year when lake elevations are below the bottom elevation of the boat ramps. While the table displays average annual days from the 63-year period of record, most of the days for low elevation closures occur in periods of drought and predominantly outside of recreation season. The bottom elevations of the boat ramps were compared with the daily elevations of the lake for the period of record for the base condition, multipurpose pool only reallocation alternative (Alternative 5) and the combination pool reallocation alternative (Alternative 7). These counts were then divided by the model's period of record of 63 years in order to arrive at the annual averages. Figure 6-8 displays the net difference in the average number of days for the two reallocation scenarios and the base condition on an annual basis. Please note that the boat ramp analysis included year-round data since boat ramps unlike campgrounds and beaches are not seasonal facilities. Much of the low elevation boat ramp closures occur during the non-recreation season when fewer recreators are present at the lake. These closures during periods of very low water elevations are not expected to have an impact on recreation as the other twelve boat ramps are located around the lake and near recreation facilities and provide broad access to the lake for boating. Likewise, all the boats that are kept in marinas on the lake are not impacted by the closure of the three ramps.

Table 6-7. Total Average Days per Year Lake Elevations Are Below the Bottom Elevation of Boat Ramps

Ramp Name	Bottom Boat Ramp Elevation	Base condition	Alternative 5	Alternative 7
Stockton	844	0	0	0
Orleans Trail Marina	838	0	0	0
Orleans Trail	838	0	0	0
Hawker Point	844	0	0	0
Ruark Bluff West	844	0	0	0
Greenfield	859	12	74	41
Mutton Creek Marina	843	0	0	0
Mutton Creek	834	0	0	0
Stockton State Park	844	0	0	0
State Park Marina	844	0	0	0
Cedar Ridge	828	0	0	0
Cedar Ridge (east ramp)	859	19	86	48
Masters	860	30	106	60
High Point	843	0	0	0
Crabtree Cove	828	0	0	0

Table 6-8. Net Difference in Average Days per Year Between Reallocation Scenarios and Base condition for Boat Ramps

Ramp Name	Bottom Boat Ramp Elevation	Base Condition	Alternative 5 Difference from Base Condition	Alternative 7 Difference from Base Condition
Stockton	844	0	0	0
Orleans Trail Marina	838	0	0	0
Orleans Trail	838	0	0	0
Hawker Point	844	0	0	0
Ruark Bluff West	844	0	0	0
Greenfield	859	12	62	29
Mutton Creek Marina	843	0	0	0
Mutton Creek	834	0	0	0
Stockton State Park	844	0	0	0
State Park Marina	844	0	0	0
Cedar Ridge	828	0	0	0
Cedar Ridge (east ramp)	859	19	67	29
Masters	860	30	76	30
High Point	843	0	0	0
Crabtree Cove	828	0	0	0

Tables 6-9 and 6-10 describe the impacts of high lake elevations on the boat ramps. High elevations make it difficult to launch boats and to access the courtesy docks during both the launch and retrieval processes. The upper or top operating elevations of the boat ramps were compared with the daily elevations of the lake for the period of record for the base condition, multipurpose pool only reallocation alternative (Alternative 5) and the combination pool reallocation alternative (Alternative 7). These counts were then divided by the model's period of record of 63 years to arrive at the annual averages. Table 6-9 displays the average number of days per year that lake elevations are above the upper operating elevation of the boat ramps. Table 6-10 displays the net difference between the number of days for each of the reallocation scenarios and the base condition. With the exception of Masters, all the other boat ramps show no change in the number of days between the base condition and Alternative 7. The multipurpose pool only scenario shows four fewer days on average for all boat ramps.

Table 6-9. Total Average Days per Year Lake Elevations Are Above Boat Ramp Operating Elevations

Ramp Name	Upper Boat Ramp Elevation	Base Condition	Alternative 5	Alternative 7
Stockton	871	22	18	22
Orleans Trail Marina	871	22	18	22
Orleans Trail	871	22	18	22
Hawker Point	871	22	18	22
Ruark Bluff West	871	22	18	22
Greenfield	871	22	18	22
Mutton Creek Marina	871	22	18	22
Mutton Creek	871	22	18	22

Ramp Name	Upper Boat Ramp Elevation	Base Condition	Alternative 5	Alternative 7
Stockton State Park	871	22	18	22
State Park Marina	871	22	18	22
Cedar Ridge	871	22	18	22
Cedar Ridge (east ramp)	871	22	18	22
Masters	871	22	18	22
High Point	870	26	21	22
Crabtree Cove	871	22	18	22

Table 6-10. Net Difference in Average Days per Year Between Reallocation Scenarios and Base Condition for Boat Ramps

Ramp Name	Upper Boat Ramp Elevation	Base Condition	Alternative 5 Difference from Base Condition	Alternative 7 Difference from Base Condition
Stockton	871	22	-4	0
Orleans Trail Marina	871	22	-4	0
Orleans Trail	871	22	-4	0
Hawker Point	871	22	-4	0
Ruark Bluff West	871	22	-4	0
Greenfield	871	22	-4	0
Mutton Creek Marina	871	22	-4	0
Mutton Creek	871	22	-4	0
Stockton State Park	871	22	-4	0
State Park Marina	871	22	-4	0
Cedar Ridge	871	22	-4	0
Cedar Ridge (east ramp)	871	22	-4	0
Masters	871	22	-4	0
High Point	870	26	-5	-4
Crabtree Cove	871	22	-4	0

6.3. Campgrounds

There are nine campgrounds around Stockton Lake. Of these nine, USACE maintains six of them - Cedar Ridge, Crabtree Cove, Hawker Point, Orleans Trail (North and South), Ruark Bluff East and Ruark Bluff West. One of the remaining 3 campgrounds, is at Stockton State Park operated by Missouri Department of Natural Resources. The final 2 campgrounds are components of privately-owned marinas – Mutton Creek and Orleans Trail.

The lake personnel maintain a list of the 174 camp sites and associated elevations. These camp sites are located within the six campgrounds maintained by USACE. There are no recorded elevations for the campsites in the state park or the privately-owned marinas. The analysis for the campgrounds is based upon high water elevations. When the lake elevation increases, water begins to cover some of the campsites or their electrical connection boxes necessitating

closing the affected campsite. Low lake levels do not impact campsites other than people who are camping may have to walk further in order to reach the lake's edge. Unlike boat ramps that are open year-round, campgrounds like beaches are only open during the recreation season which runs from April through September.

For the analysis of impacts to campgrounds, elevations beginning at 872.5 feet NGVD29 (the first elevation that causes camp sites to be closed) and rising to 889.0 feet NGVD29 (highest elevation impacting camp sites) in half foot increments were used. For each elevation analyzed, any campgrounds at that elevation or below were counted as being closed for every day the recreation season period of record data showed the lake elevation at that particular elevation. This provides the period of record counts. Dividing this number by 63 provides the average annual counts. Since the analysis looks at camp sites with an elevation at or below a specific lake elevation the analysis is cumulative. For example, the count of sites that are closed at 873.0 feet also include the sites that are closed at 872.5 feet. Table 6-11 presents the detailed closure analysis. The average annual days difference columns provide the difference between a specific alternative and the base condition. Negative numbers in these columns indicate there are fewer days that campsites are closed with that reallocation alternative. Table 6-12 displays the number of campsites located within each half-foot elevation range as well as a cumulative campsite total.

Table 6-11. Campsite Closure Analysis During the Recreation Season – Number of Cumulative and Average Annual Days Above Thresholds

Elevation (ft) NGVD 29	Base condition POR Rec Season days	Base condition Average Annual Days	Alt 5 POR Season days	Alt 5 Average Annual Days	Alt 5 Average Annual Days Difference from Base condition	Alt 7 POR Season days	Alt 7 Average Annual Days	Alt 7 Average Annual Days Difference from Base condition
872.5	1608	26	1388	22	-3	1504	24	-2
873.0	2363	38	2045	32	-5	2212	35	-2
873.5	3100	49	2686	43	-7	2905	46	-3
874.0	8542	136	7373	117	-19	8076	128	-7
874.5	9177	146	7918	126	-20	8696	138	-8
875.0	11903	189	10419	165	-24	11590	184	-5
875.5	14338	228	12695	202	-26	14278	227	-1
876.0	17832	283	15938	253	-30	18013	286	3
876.5	19010	302	17044	271	-31	19276	306	4
877.0	20717	329	18632	296	-33	21121	335	6
877.5	21958	349	19789	314	-34	22447	356	8
878.0	24455	388	22153	352	-37	25121	399	11
878.5	26411	419	23961	380	-39	27193	432	12
879.0	27911	443	25338	402	-41	28832	458	15
879.5	29207	464	26440	420	-44	30255	480	17
880.0	30569	485	27585	438	-47	31922	507	21
880.5	31681	503	28602	454	-49	33328	529	26
881.0	32437	515	29299	465	-50	34221	543	28
881.5	32918	523	29734	472	-51	34710	551	28

Elevation (ft) NGVD 29	Base condition POR Rec Season days	Base condition Average Annual Days	Alt 5 POR Season days	Alt 5 Average Annual Days	Alt 5 Average Annual Days Difference from Base condition	Alt 7 POR Season days	Alt 7 Average Annual Days	Alt 7 Average Annual Days Difference from Base condition
882.0	33446	531	30207	479	-51	35240	559	28
882.5	34057	541	30802	489	-52	35863	569	29
883.0	34751	552	31484	500	-52	36545	580	28
883.5	35345	561	32066	509	-52	37124	589	28
884.0	35868	569	32572	517	-52	37632	597	28
884.5	36283	576	32975	523	-53	38039	604	28
885.0	36666	582	33352	529	-53	38412	610	28
885.5	36711	583	33397	530	-53	38456	610	28
886.0	36788	584	33472	531	-53	38531	612	28
886.5	36913	586	33597	533	-53	38650	613	28
887.0	36941	586	33627	534	-53	38676	614	28
887.5	36961	587	33646	534	-53	38697	614	28
888.0	36961	587	33646	534	-53	38697	614	28
888.5	36961	587	33646	534	-53	38697	614	28
889.0	36961	587	-	-	-	-	-	-

Table 6-12. Number of Campsites by Elevation Ranges

Elevation (ft) NVGD 29	Campsites Affected	Cumulative Campsites
872.5	2	2
873.0	1	3
873.5	1	4
874.0	8	12
874.5	1	13
875.0	5	18
875.5	5	23
876.0	8	31
876.5	3	34
877.0	5	39
877.5	4	43
878.0	9	52
878.5	8	60
879.0	7	67
879.5	7	74
880.0	9	83
880.5	9	92
881.0	7	99

Elevation (ft) NVGD 29	Campsites Affected	Cumulative Campsites
881.5	6	105
882.0	5	110
882.5	8	118
883.0	10	128
883.5	9	137
884.0	9	146
884.5	8	154
885.0	8	162
885.5	1	163
886.0	2	165
886.5	4	169
887.0	2	171
887.5	2	173
888.0	0	173
888.5	0	173
889.0	1	174

6.4. Road Closures

There are 19 sections of roads in and around the campgrounds that are impacted by high water elevations and have to be closed during some high-water events. As with the campsites, lake personnel maintain a list of roads and the elevations of the lower segments of the roads that are impacted by high water elevations. In a similar fashion to the campsite analysis, the elevations of the low areas in the roads were compared with the daily elevations of the lake for the base condition, multipurpose pool only reallocation alternative and the combination pool reallocation alternative. The following table displays the results of the road closure analysis. The POR column is the cumulative number of days in the recreation season over the POR when the lake elevations are higher than the noted threshold elevation (the elevations of the low areas on roads).The annual average column divides the period of record column by 63 – the number of years in the model's period of record. The table also provides the difference between the annual average number of days above these thresholds for a reallocation alternative compared to the base condition. Like the campground analysis, the road closure analysis is a high lake elevation analysis. Low lake elevations do not impact any roads

Table 6-13: Road Closure Analysis - Number of Cumulative and Average Annual Days Above Closure Thresholds

Road Location	Elev (ft NGVD 29)	Base Condition POR Season Rec Days	Base Condition Average Annual Days	Alt 5 POR Season days	Alt 5 Average Annual Days	Alt 5 Average Annual Days Changed from Base	Alt 7 POR Season days	Alt 7 Average Annual Days	Alt 7 Average Annual Days Changed from Base
Swim Beach Loop, Ruark Bluff	871.8	1189	19	989	16	-3	1222	19	1
East camp loop, Crabtree Cove	873.5	869	14	736	12	-2	895	14	0
Southeast loop, Ruark Bluff	874.9	573	9	524	8	-1	690	11	2
East loop, Hawker Point North	875.3	516	8	472	7	-1	639	10	2
South curve of west loop, Crabtree Cove	876.9	333	5	307	5	0	380	6	1
Loop across from boat ramp, Ruark Bluff	877.4	299	5	284	5	0	342	5	1
Northeast loop, Ruark Bluff	877.8	276	4	264	4	0	310	5	1
Northeast picnic loop, Mutton Creek	878.5	226	4	213	3	0	245	4	0
South camping loop, Cedar Ridge	879.2	198	3	173	3	0	209	3	0
West loop, Crabtree Cove	879.5	175	3	145	2	0	198	3	0
West loop, Hawker Point North	879.6	172	3	136	2	-1	195	3	0
West picnic loop, Mutton Creek North	880.1	129	2	116	2	0	169	3	1
South boat ramp parking lot, Orleans Trail	880.2	125	2	116	2	0	163	3	1
Southwest loop, Ruark Bluff	881.2	98	2	91	1	0	102	2	0
North loop of south loop, Hawker Point	882.3	75	1	73	1	0	77	1	0
Northeast loop, Orleans Trail South	883.2	65	1	64	1	0	64	1	0
North camp loop, Orleans Trail North	883.3	65	1	64	1	0	63	1	0
Shower building loop, Orleans Trail South	883.6	62	1	60	1	0	60	1	0
Road to boat ramp, Mutton Creek North	884.7	48	1	47	1	0	46	1	0

6.5. Beach Closures

Stockton Lake has six beaches. The beaches are Stockton Beach, Orleans Trail Beach, Ruark Bluff East, Cedar Ridge, Masters, and Stockton State Park All of them are impacted by the same high water elevation – 873 feet NGVD 29. The cumulative and average annual number of days when the lake elevations are above the threshold high water elevation that would force the closure of the beaches during recreation season was assessed for the base condition, multipurpose pool only reallocation alternative (Alternative 5) and the combination pool reallocation alternative (Alternative 7). Table 6-14 displays the results of the beach closure analysis. All of the swim beaches may experience 12 days of closure on average during the recreation season during high water when lake elevations are greater than 873 feet NGVD 29. Under the multipurpose only reallocation, lower water elevations during drought could expose debris (mostly wood); the six swim beaches are expected to be closed two fewer days as compared to the base condition. Under the combination pool reallocation, the six beaches are estimated to be closed four additional days due to high water. Since all beaches are impacted at the same elevation, only one row is displayed to describe the changes for all beaches. Because the 1.8 foot pool raise is within the normal fluctuations of the lake, the project staff do not believe swim beaches will be significantly impacted, even if some beach sizes are slightly reduced. In order to ensure swim safety, there would be a onetime operations and maintenance (O&M) cost of $25,000 to adjust the swim buoys to account for the pool raise.

Table 6-14: Recreation Season Beach Closure Analysis - Number of Cumulative and Average Annual Days Above High-Water Thresholds for all Beaches.

Elev (ft NGVD 29)	Base condition POR Season Rec Days	Base condition Average Annual Days	Alt 5 POR Season days	Alt 5 Average Annual Days	Alt 5 Average Annual Days Changed from Base	Alt 7 POR Season days	Alt 7 Average Annual Days	Alt 7 Average Annual Days Changed from Base
873	755	12	657	10	-2	990	16	4

6.6. Picnic Facility Impacts

Stockton Lake has a total of 90 picnic and grill sites. In order to evaluate the potential impacts of either alternative during recreation season, the PDT performed a survey during a site visit and collected the GPS coordinates including elevations of all the picnic tables and grills in the recreation areas. Some of the permanent picnic structures – the covered pavilions on concrete foundations are sufficiently far from the lake and sufficiently high in elevation as to not be affected by the combination pool reallocation alternative. There are several picnic tables that are near the water's edge that would be impacted by increases in the water surface elevations. Under the base condition, approximately 87 picnic tables are inundated between one and ten days. When compared to the multipurpose pool only reallocation (Alternative 5), there were no additional days of inundation. Instead 13 picnic tables are estimated to be inundated one to two days less. When compared against the combination pool reallocation (Alternative 7), four grills are estimated to be inundated one additional day and eight picnic tables are estimated to be inundated one additional day during the recreation season. These tables are made of aluminum and are lightweight and can easily be moved to a higher elevation to avoid inundation. Given the negligible impact of one additional day of inundation, the PDT concluded there is no impact to picnic facilities.

6.7. Summary of Recreation Impacts

While there are several components to recreation, individual components are not impacted equally by a reallocation. Table 6-15 helps provide a comparison of impacts to individual recreation features across each of the reallocation alternatives.

Table 6-15: Summary of Impacts 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
Base condition	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 from very low water elevations and may be closed between 12 – 30 days on average per year	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
Alt 5-All MP	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 from very low water elevations 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
Alt 7-1.8 ft pool raise	Approximately 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 from very low water elevations could be closed up to an additional 30 days on average per year compared to the base condition	Approximately. 8 picnic tables and 4 grills are inundated one additional day on average during the recreation season as compared to the base condition	Approximately 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 relocate the swim buoys.

7.0 Updated Cost of Storage for Reallocation Alternatives

Engineer Regulation 1105-2-100 outlines that the non-Federal 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 non-federal entity shall also be responsible for an appropriate share of the annual costs that include specific and joint-use operation, maintenance, repair, replacement and rehabilitation (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 (FY19 price level, annualized over 50 years at Federal interest rate of 2.875%), 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 due to 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 to determine 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 Corps of Engineers Civil Works Construction Cost Index System (CWCCIS). This index is maintained in Engineering 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 (FY67). 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 less 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, and joint-use costs of $59,724,456 in FY67 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, non-specific, as-built costs were updated from the mid-point of construction, November, 1966 (FY1967) to October 2019 (FY2020) (USACE 1993). Table 7-1 displays the updated cost of construction, which is estimated to be approximately $542 million.

Table 7-1 Updated Joint-Use Construction Costs

Permanent Features	CWCCIS Account	As-built Joint-Use Costs (FY67)	Weighted Average	FY67 CWCCIS Index (October 1966)	FY2 CWCCIS Index (October 2019)	CWCCIS Index Factor	Updated FY20 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**

*Costs are displayed in FY67 and updated to FY20 price level

Based on the updated FY20 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 acre-feet and 645,575, respectively. Table 7-2 displays the cost to the user for each alternative. Annual operations and maintenance (O&M) and repair, replacement and rehabilitation (RR&R) costs are included. The O&M and RR&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% of the annual O&M and RR&R costs and under Alternative 7, they would be responsible for 6.60% of the costs. The O&M costs were based off of actual FY19 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 cost of storage is $34.1 million for Alternative 5 and $35.8 million for Alternative 7.

Table 7-2 FY20 Updated Cost of Storage

FY20 Updated Joint-Use Construction Cost	Usable Storage (Acre-feet)	Alt	Flood Pool Storage (Acre-feet)	Multipurpose Pool Storage (Acre-feet	Percent of Usable Storage	FY20 Updated Cost of Storage
$542,029,600	1,435,389	Alt 5	0	90,200	6.28%	$34,100,000
		Alt 7	49,000	45,750	6.60%	$35,800,000

Note: Price level is FY20

Table 7-3 Annual Operations, Maintenance, Repair, Replacement and Rehabilitation Costs

Alternative	Estimated O&M based on Actual FY19 Expenditures	User's O&M Responsibility based on % of Usable Storage	Estimated RR&R based on Actual FY19 Expenditures	User's RR&R Responsibility baed on % 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 five years per Sect. 1046(b) Water Resources Development Act to develop five year OMRR&R projections

8.0 National Economic Development (NED) Analysis and Screening of Final Array of Alternatives.

Per ER 1105-2-100, the National Economic Development (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 9.0).

Table 8-1 displays the annualized cost of the non-Federal FWOP condition (construction of a new reservoir), which is Alternative 2(in the main report) 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, 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 $240,000.

The main report discusses other various costs that are taken into consideration. It was determined that additional real estate costs will not be necessary under Alternative 5 or 7. Another cost identified by the PDT in Section 6-5, Beach Closures, include 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 the main report in Section 5.8. Since there is uncertainty regarding the outcome of the FY24 Periodic Assessment and the associated Dam Safety Action Classification (DSAC) rating, a placeholder has been identified in Table 8-1.

Environment impacts were determined to be negligible and mitigation unnecessary; however due to 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 8-1 for comparison of plans. Further details can found in Section 6.7 of the main report.

Lastly, annual operations and maintenance (O&M) and repair, replacement and rehabilitation (RR&R) costs are included. The O&M and RR&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% of the annual O&M and RR&R costs and under Alternative 7, they would be responsible for 6.60% of the costs. The O&M costs were based off of actual FY19 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 provide 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 is the NED plan. While Alternative 5 does have slight 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 case conditions. The selection is further detailed in Section 10.0.

Table 8-1. National Economic Development Analysis, Screening of Alternative 2, 5 and 7.

Cost or Forgone Benefit for Authorized Purpose	Alternative 2 (Nonfederal Action)	Alternative 5	Alternative 7
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

Cost or Forgone Benefit for Authorized Purpose	Alternative 2 (Nonfederal Action)	Alternative 5	Alternative 7
Capital Costs–Transmission and Treatment*	--	--	--
TOTAL COSTS	$296,000,000	$34,100,000	$38,600,000
O&M Costs	$500,000	$180,000	$190,000
RR&R Costs	--	--	-
I&A Factor	0.03704	0.03704	0.03704
Total Average Annual Costs	**$11,464,000**	**$1,450,000**	**$1,620,000**
Net Benefits		**$10,014,000**	**$9,844,000**
Benefit/Cost Ratio		**6.9**	**6.1**

Note: FY20 price level and FY20 Fed discount rate of 2.75% for all categories, expect for Hydropower Benefits Forgone, which were calculated in FY19 dollar and FY19 Fed discount rate of 2.875 and 50-year period of analysis.

9.0 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 feet NGVD 29 to 868.8 feet NGVD 29. Even though it's not the least costly alternative, it still 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. By recommending Alternative 7, the reservoir is projected to maintain elevation ranges that closely align with the current base condition.

Table 9-1 and Table 9-2 summarize the changes in the number of days the reservoir is projected to spend within specified elevation ranges and further breaks out the normal pool elevation range, which spans approximately six feet, that was described in Tables 6-5 and 6-6. It is important to note that lake levels fluctuate on a daily basis. Overall, on an average annual basis, the lake spends approximately 43% of the time between elevations 865 ft to 870.9 ft NGVD 29. Under Alternative 5 it spends approximately 30% of its time in that range and Alternative 5 spends 45% within that range. The normal operating range was broken into mid-normal operating range or elevations 867 ft to 868.9 ft NGVD 29 and low-normal 865 ft to 866.9 ft NGVD 29. Alternative 7 reduces the days that that lake elevation spends at low-normal by 57 days and is projected to spend 60 additional days within the mid-normal range. The results are similar for the recreation season in that the lake is projected to spend more days 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 displayed in Section 5.3 Hydrologic Analysis of Impacts to Water Elevations, in the main report. 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 also making changes during high water 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's 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 compared to the current condition when comparing the tables and graphs presented in Section 5-3 of the main report. 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.

Table 9-1. Elevation Comparisons - Average Annual Days and Percentage of Time at Lake Condition

Lake Condition	Elevation (ft) NGVD 29	Base Condition % of Time	Base Condition Days/Year	Alt 5 % of Time	Alt 5 Days/Year	Alt 5 Difference from Base	Alt 7 % of Time	Alt 7 Days/Year	Alt 7 Difference from Base
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

Table 9-2. Elevation Comparison - Recreation Season Average Annual Days and Percentage of Time at Lake Condition

Lake Condition	Elevation (ft) NGVD 29	Base Condition % of Time	Base Condition Days/Year	Alt 5 % of Time	Alt 5 Days/Year	Alt 5 Difference from Base	Alt 7 % of Time	Alt 7 Days/Year	Alt 7 Difference from Base
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

10.0 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 7.0) 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 nonfederal FWOP 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, pre-construction, 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 FY19 joint-use expenditures and the associated percentage that the water supply user will be responsible for as described in Section 8.0. Repair, replacement, and rehabilitation (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 7.0, 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 10-1. The NED Plan is Alternative 7.

Table 10-1. Test of Financial Feasibility.

Cost or Forgone Benefit for Authorized Purpose	No Action FWOP Nonfederal Action	1.8-foot Pool Raise (45,750 AF MP/49,000 AF FP)
Estimated Yield from Storage (MGD)	**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.

11.0 Repayment Cost for the User

Costs allocated to storage is 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 FY20 Water Supply interest rate of 2.875 percent over 30 years (Table 11-1). In accordance with Section 932 of the Water Resources Development Act of 1986, this interest rate will be adjusted at five-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 Headquarters USACE Economic Guidance Memorandum (EGM). 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 11-1 outlines the parameters used to calculate the repayment cost to the user, and Table 11-2 displays the total annual repayment costs of approximately $2 million.

Table 11-1 Parameter used to calculate Repayment Costs for Tri-State Water Resources (SWMO Regional Water).

Parameter	Item
Total water supply storage required under TSP (acre-feet)	94,750
Water supply yield (mgd)	39
Interest rate	2.875%
Repayment period	30
Flood control storage	789,814
Multipurpose storage (830 feet to 867 feet NGVD 29)	645,575
Inactive storage (Below 830 feet NGVD 29)	171,267
Usable Storage	1,435,389
Storage required as percent of useable storage	6.60%

Table 11-2 Updated Cost of Storage for Tri-State Water Resources (SWMO Regional Water).

Costs (FY20$)	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 FY19 O&M expenditures)	$2,860,000	$188,789
Estimated RR&R (based on projected RR&R expeditures)	$0	$0
Total Annual Repayment		**$1,985,890**

Note: Interest rate is based on USACE Economic Guidance Memorandum (EGM) 20-01

Stockton Lake Reallocation Study

Draft Integrated Water Supply Storage Reallocation Report and Environmental Assessment

Appendix C-Hydrology and Hydraulics

June 2020

US Army Corps of Engineers ®
Kansas City District

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1.0 Purpose of Study

This study investigated the feasibility of storage reallocations in Stockton Lake for water supply that would provide a firm yield (or dependable yield) of 39 MGD for the Tri-State Water Resources Coalition (Tri-State). The coalition is seeking a regional solution for future water supply needs in the area.

2.0 Pertinent Lake Data

2.1 Basin Conditions

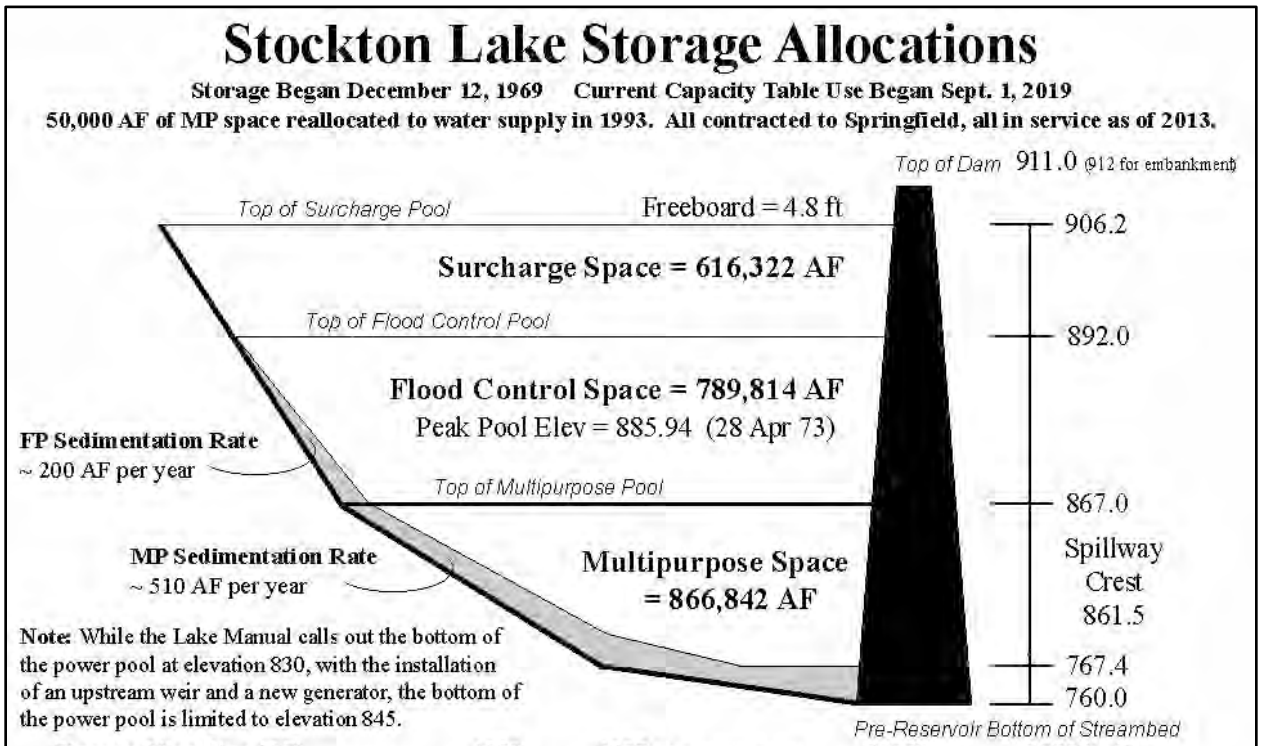
Stockton Lake was constructed and operated by the Kansas City District of the Corps of Engineers. It is located in southwest Missouri on the Sac River which is a right bank tributary of the Osage River, as indicated in Figure 2-1. Harry S Truman Reservoir is a hydropower and flood control reservoir downstream of Stockton which is also constructed and operated by the Kansas City District. Four other Kansas City District flood control reservoirs in the Osage River Basin are operated in parallel with Stockton and feed directly into Harry S Truman Reservoir; these are Melvern, Pomona, and Hillsdale Reservoirs in Kansas and Pomme de Terre Reservoir in Missouri. Lake of the Ozarks is a privately owned power reservoir that is located downstream of Harry S. Truman Reservoir on the lower Osage River.

Figure 2-1. Osage Basin Watershed Map.

Construction of Stockton Dam began in 1963, with closure of the structure occurring on September 23, 1968. The lake first filled to the top of the multipurpose zone (867.0 ft. NGVD29) on December 18, 1971. The drainage area upstream of the dam is about 1,160 square miles. The lake is operated for flood control, hydropower, water quality, recreation, fish & wildlife and water supply. The lake was not originally authorized for water supply; however, 50,000 acre-feet (AF) of storage was reallocated for that purpose in 1993. The City of Springfield holds contract number DACW41-94-L-0001 for the 50,000 acre-feet of storage. The historic, current, and estimated future Stockton Lake storage allocations are provided in Figure 2-2.

All elevations referenced in this report are referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29) because the public is most familiar with the Stockton pool elevations in this datum. If it is necessary to convert to the North American Vertical Datum of 1988 (NAVD 88), USACE survey results have given the following correlation between the two datum for the Stockton intake tower where the pool elevation gage is located:

NGVD29 + 0.43 = NAVD88



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 2-2. Stockton Lake Historic, Current and Estimated Future Storage Allocation.

2.2 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 Dam's one turbine-generator unit. This unit was upgraded in 2015 and can generate approximately 52 megawatts (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 2-3 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.

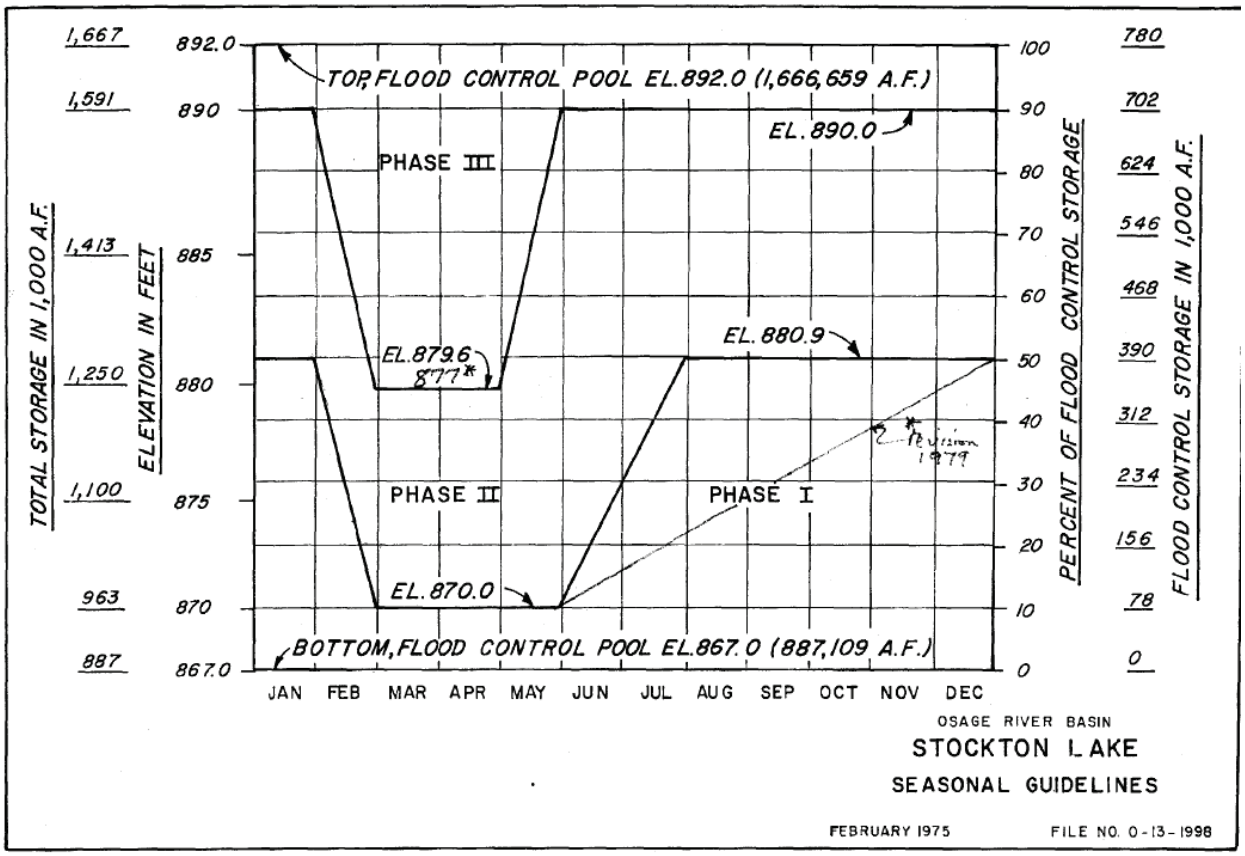


Figure 2-3. Stockton Lake Seasonal Guidelines for Flood Control Release.

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 NGVD29 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.

3.0 Study Methodology

A daily model of the Osage River operation has been prepared using the Hydrologic Engineering Center's Reservoir Simulation Program, Revision 3.4.1.88, Build 3.4.1.88R, May 2019 (HEC-ResSim). The HEC-ResSim software performs hydrologic routing and determines reservoir releases based on a guide curve approach plus user-specified operation rules. The rules provide for lake operation in accordance with the current lake Water Control Manuals. The period of the study is January 1, 1950 through January 1, 2013 (63 years).

The entire Osage River Basin is included in this model to allow evaluation of impacts to the reservoir system. All seven reservoir in the basin are included in the model. However, the detailed model setup (and this report) are focused on Stockton Lake. The Model is run multiple times for a specific water supply yield value with varying account storage amounts. Using this method, the minimum storage required for a specific yield value (firm yield) is determined.

3.1 Data Inputs

Input data for the Model has been developed in accordance with Engineering and Construction Bulletin (ECB) 2019-13 "Methods for Storage/Yield Analysis". When possible, data was constructed from the historic record, but during those times when a record did not exist, it was simulated using standard practices. The available record and simulation methods are described below. This section looks specifically at data inputs for Stockton Lake. Similar methods were used to develop evaporation and precipitation records for the remaining six reservoirs in the Osage River Basin that are included in the model.

3.1.1 Evaporation and Precipitation

Daily evaporation data at the Stockton dam site is available electronically since January 1, 1980. To supplement this data, the Pomme de Terre evaporation data from March 6, 1961 through December 31, 1979 has been used for Stockton Lake. The evaporation is determined in inches using a Class A evaporation pan. During the winter the evaporation pan is not used due to freezing and therefore estimated values have been taken from the District database. The pan evaporation has been converted to lake evaporation using the pan coefficients in Table 3-1. These are the coefficients used by the District for processing real time lake information for both Pomme de Terre and Stockton Lakes.

Table 3-1. Pan Evaporation Coefficients

January	1.00
February	0.64
March	0.42
April	0.46
May	0.53
June	0.61
July	0.61
August	0.78
September	1.04
October	1.24
November	1.79
December	1.82

Prior to March 6, 1961, the daily evaporation values have been estimated using the available information. Monthly average evaporation was determined for the existing record (March 1961 through December 2012). The monthly values were converted to daily evaporation and applied to the study period from January 1929 through February 1961.

Precipitation for Stockton Lake was compiled previously by the Kansas City District for the period beginning January 1898 with data compiled from the National Climatic Data Center and actual lake data.

Reservoir evaporation and precipitation were combined into a single input time series for the HEC-ResSim model. Evaporation was included as a positive value (water leaving the lake) and precipitation was a negative value (water entering the lake) to provide a representation of the meteorological conditions on the lake.

3.1.2 Reservoir Inflows

The Kansas City District inflow record for Stockton Lake begins on September 23, 1968. The record provides mean daily flow but includes the amount of inflow caused by precipitation on the pool. During most of the period, the data is midnight to midnight. However, from September 23, 1968 until January 1, 1976, the data was stored in a 8:00 am to 8:00 pm daily time step. For input to the Model, the inflow was adjusted to remove the precipitation on pool and to adjust the time step to midnight to midnight for the entire period of the record. The rain was separately input into the Model to preserve the total water volume in the system. ResSim does not have a separate parameter for inputting daily precipitation values. Therefore, the daily precipitation was subtracted from the daily evaporation before input to the Model as net evaporation.

Simulation of inflow data prior to September 23, 1968 was completed using a USGS gaging station. A USGS gage for the Sac River near Stockton, Missouri (USGS 06919000) provided daily mean flow data from July 21, 1921 through October 18, 1989. The gage is located just downstream of the current Stockton Dam location and has the same watershed area as the dam. The drainage area upstream of Stockton Dam is 1,160 square miles.

3.1.3 Storage

The most recent area-capacity table for Stockton Lake was completed in 2019. This survey was a compilation of 2009 bathymetry for the multi-purpose pool and 2018 LiDAR for the flood control pool. The Water Management Section began using this storage curve operationally in January 2019. This table was used for the full period of the study without adjustment for past or future trends in sedimentation.

3.1.4 Ungaged Flow

The Model includes control points downstream of Stockton Lake at Highway J and near Caplinger Mills on the Sac River. Flood control operation requires that the ungaged intervening flow upstream of these gages be represented. The lake releases would be reduced during those times that the intervening

(ungaged) flow, added to the lake release, exceeded the control point criteria as defined in the Water Control Manuals.

The Highway J gage (USGS 06919020) is located at river mile 44.9 on the Sac River, 6.3 mile downstream of Stockton Dam and 4.5 miles downstream of the Bear Creek confluence. The total drainage area upstream of Highway J is 1,292 square miles and the Stockton Lake drainage area is 1,160 square miles. The ungaged flow between the dam and gage is estimated by the drainage basin area ratio. The Stockton Lake inflow (calculation method described in an earlier paragraph) is multiplied by the intervening drainage area divided by the Stockton Lake drainage area.

Highway J ungaged = Stockton Inflow * (1,292 - 1,160) / 1,160

The Caplinger Mills gage (USGS 06919900) is located at the State Highway W bridge, 1.5 miles downstream of the Cedar Creek confluence and 5.0 miles north of Caplinger Mills, Missouri. Cedar Creek flow has been recorded by a gage at Pleasant View (USGS 06919500) since October 1, 1948. The Caplinger Mills gage record began October 1, 1974. The Highway J gage record of Sac River flow began October 1, 1973.

To estimate the intervening flow to the Sac River between the Highway J and Caplinger Mills a relationship was determined between the intervening flow, and the flow at the Pleasant View gage. The ungaged flow from October 1974 to March 2013 was estimated by subtracting the daily Highway J flow from the daily Caplinger Mills flow, assuming a 12 hour travel time between the gages. The result is the daily ungaged flow that enters the Sac River between the gages. A cumulative total of the daily ungaged flow was then plotted with a cumulative total of the daily Pleasant View flow for the same period. The plot is provided in Figure 3-1.

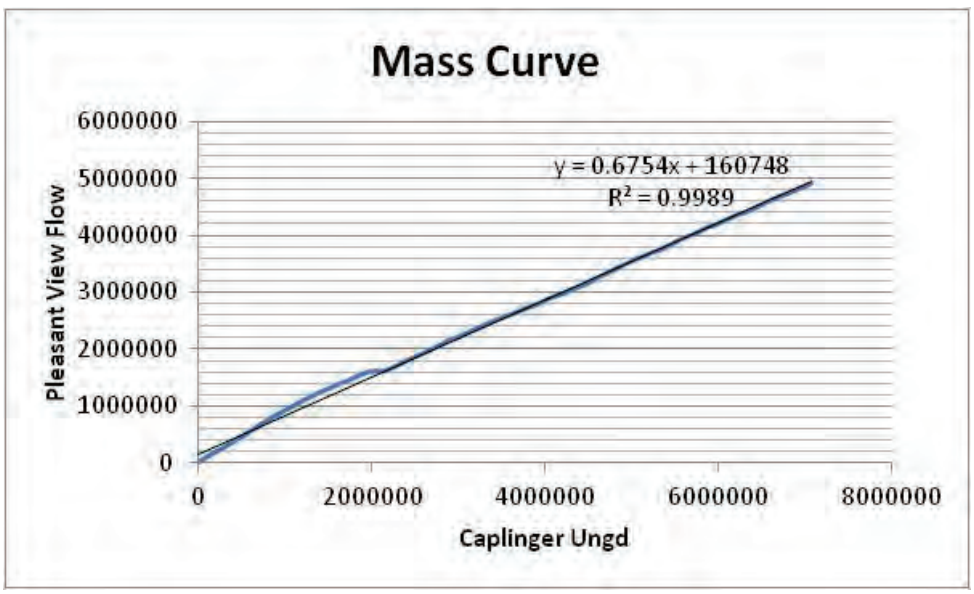


Figure 3-1. Mass Curve Correlation Between the Sac River at Caplinger Mills and Cedar Creek at Pleasant View.

*Notes: Values are in second-day feet. One second-day foot is 1.98 acre-feet of water.

A trend line drawn on the plot has a slope of 0.6754, and provides a strong correlation between the two parameters (R^2 = 0.9989). Therefore, the Caplinger Mills ungaged flow is estimated during the period from October 1, 1948 through the end of the study as:

Caplinger Mills ungaged = Pleasant View flow * (1/0.6754)

4.0 Model Structure

The Model for Stockton Lake includes the entire Osage Basin and operates on a daily time step, representing the period 1950 through 2012 (63 years of record). The Model incorporates the current operation criteria defined within each lake's Water Control Manual. A screen capture of the Model is

provided as Figure 4-1. As can be seen, a small portion of the Missouri River is included in the model, in order to incorporate downstream flood control rules for Harry S Truman operation.

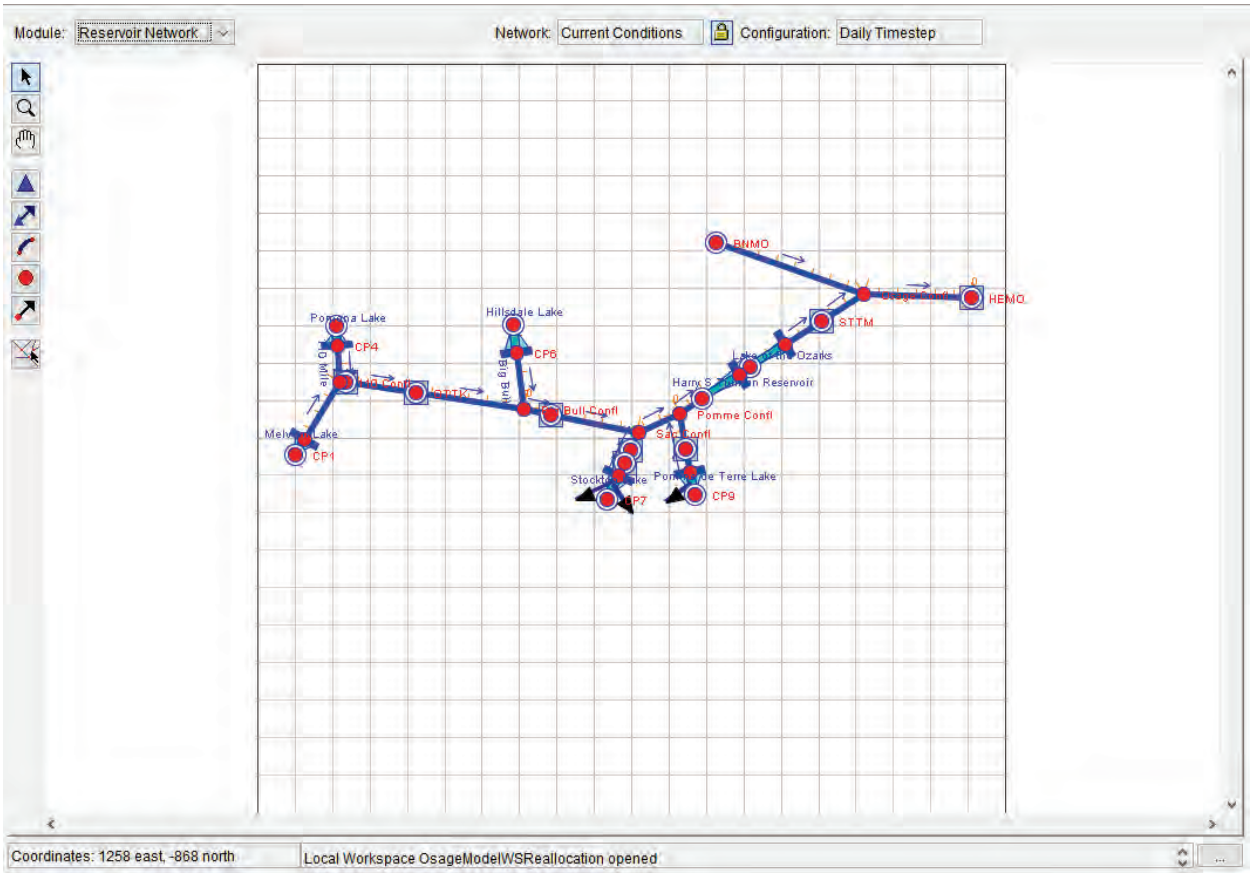


Figure 4-1. HEC-ResSim Osage River Model Network.

Routing between reaches in the model use coefficient routing. However, since the model is a daily time step, many of the shorter reaches employ null routing, a simpler approach that assumes no attenuation of the inflow hydrograph through the reach. One longer reach, the Osage Confluence to the Missouri River at Hermann (HEMO), used null routing to simplify the interaction between the Osage and Missouri Rivers. More detailed routing could be employed in this reach if the model were to be used to analyze the Osage River as it relates to the Missouri River in flood control operations. However, since this study is centered on the Sac River and Stockton Lake operations specifically, the simplified null routing can be used with no impact to the study objectives.

Stockton Lake is operated for flood control, water quality, recreation, fish and wildlife, hydropower, and water supply. The methods for incorporating each of these purposes into the Model is discussed below.

4.1 Flood Control

Stockton Lake is operated for downstream control points and in tandem with Harry S Truman Reservoir. Balancing Stockton with Truman is common during flood water evacuation operation. Simple tandem balance rules are included in the model, but some improvements could be made to the tandem rule operation if the model were to be fine-tuned for flood operations. Water supply studies are dependent on the sequence of inflows, particularly through extended drought periods, rather than times of high flows. The effect of Harry S Truman's flood control operations and infrequent tandem balance requirements throughout the 63 year period of analysis has little influence on Stockton's reservoir accounting through

periods of drought. Table 4-1 provides the Stockton control point flows used by the model for flood control operations.

Table 4-1.
Table 4-1. Stockton Control Point Flows (cfs).

Gage	Phase I	Phase II	Phase III
Highway J	3,500	5,500	6,750
Caplinger Mills	5,000	8,400	12,000

4.2 Water Quality

Stockton Lake maintains minimum flow rates to support downstream water quality within the Sac River. The minimum flow maintained downstream of Stockton is 40 cfs. This low flow release from Stockton is discontinued during times of hydropower generation as unnecessary, because the turbine discharge throughout a 24 hour period far exceeds a steady state release of 40 cfs. To simulate the effect of reducing the release during generation, the low flow release from Stockton is defined by relating the release to the energy production. Figure 4-2 illustrates the relationship; as can be seen, any hydropower generation discontinues the low flow release.

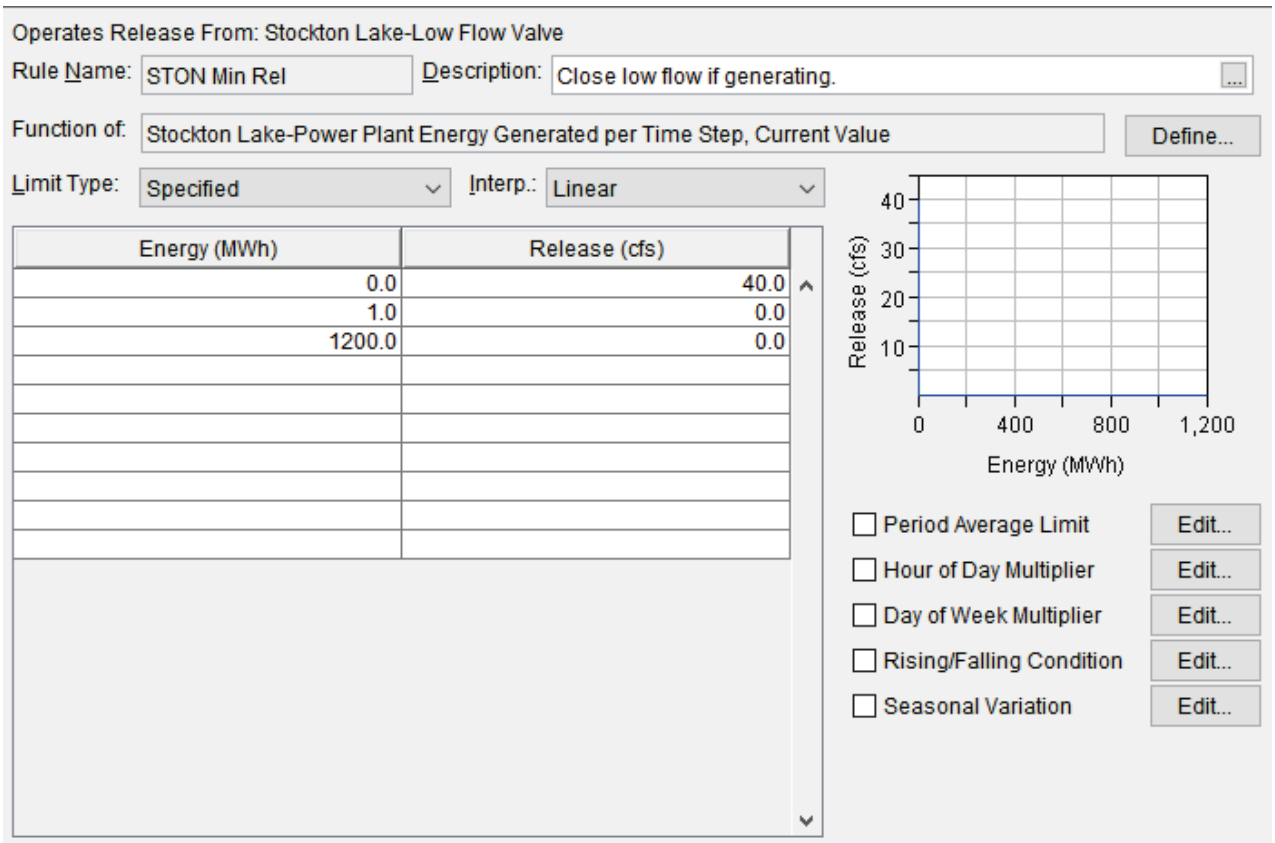


Figure 4-2. Stockton Low Flow Release Rule.

4.3 Recreation and Fish and Wildlife

Operation of Stockton for recreation and fish and wildlife is provided by maintaining the lake elevation as close as possible to the top of the multipurpose pool zone. HEC-ResSim models the reservoir to follow a guide curve which is set to the top of the multi-purpose pool if higher priorities will allow.

4.4 Hydropower

Stockton Lake is operated to provide hydropower for distribution by the Southwestern Power Administration (SWPA), a sub-agency of the Department of Energy. During the design of the generation equipment, a minimum desirable generation schedule was assumed. The schedule was for 3.8 MW generation in June and September, and 7.4 MW generation in July and August. Essentially, these values would be the average hourly energy production during these months for every year. No generation from the multipurpose zone would be required during the remaining months. During discussions with the SWPA it was determined that a more representative power generation requirement could be used. The SWPA provided monthly generation values for the period from 1929 through 2008 for both Truman and Stockton Reservoirs. These monthly requirements were converted to daily values and used in the Model. For the period from 2009 through 2012 the monthly design generation values were used. The resultant daily power requirement time series are provided in Figure 4-3 for Truman and Figure 4-4 for Stockton. As can be seen in the datasets, during historic dry periods of the 1950s, 1980s and early 2000s, the power requirement decreases because of lack of water.

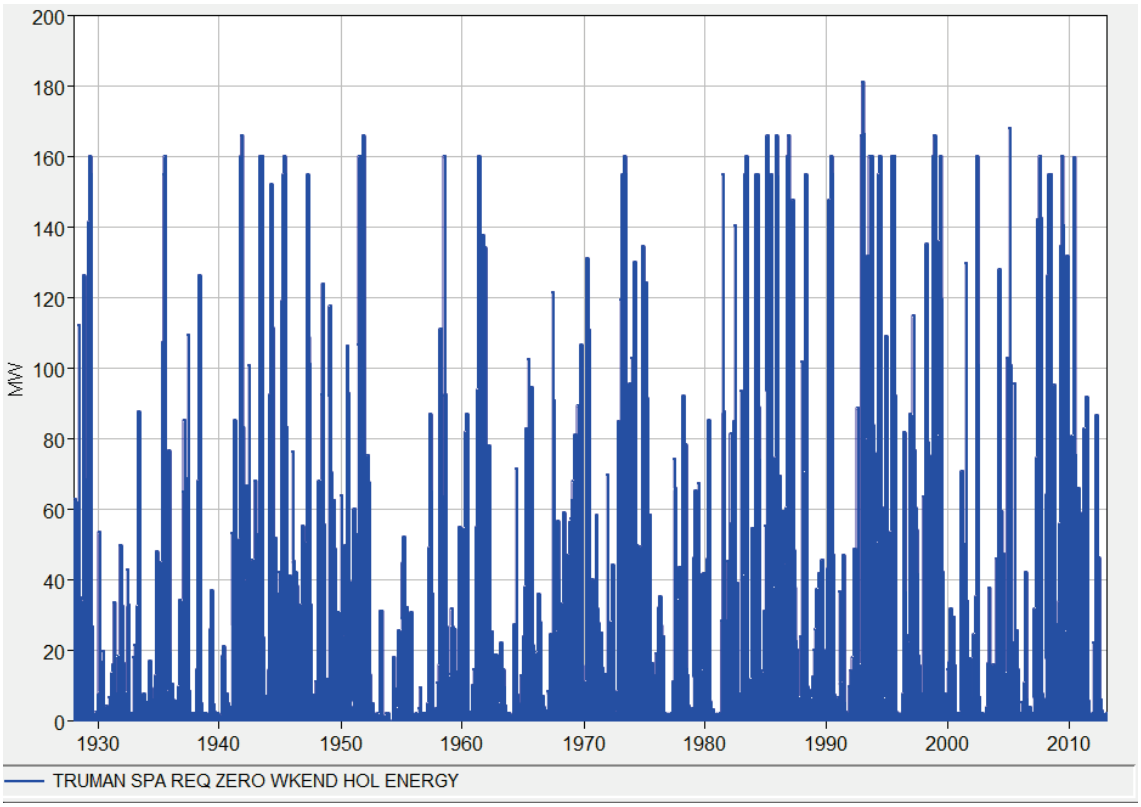


Figure 4-3. Truman Daily Power Requirement Used for Input to HEC-ResSim Power Rules.

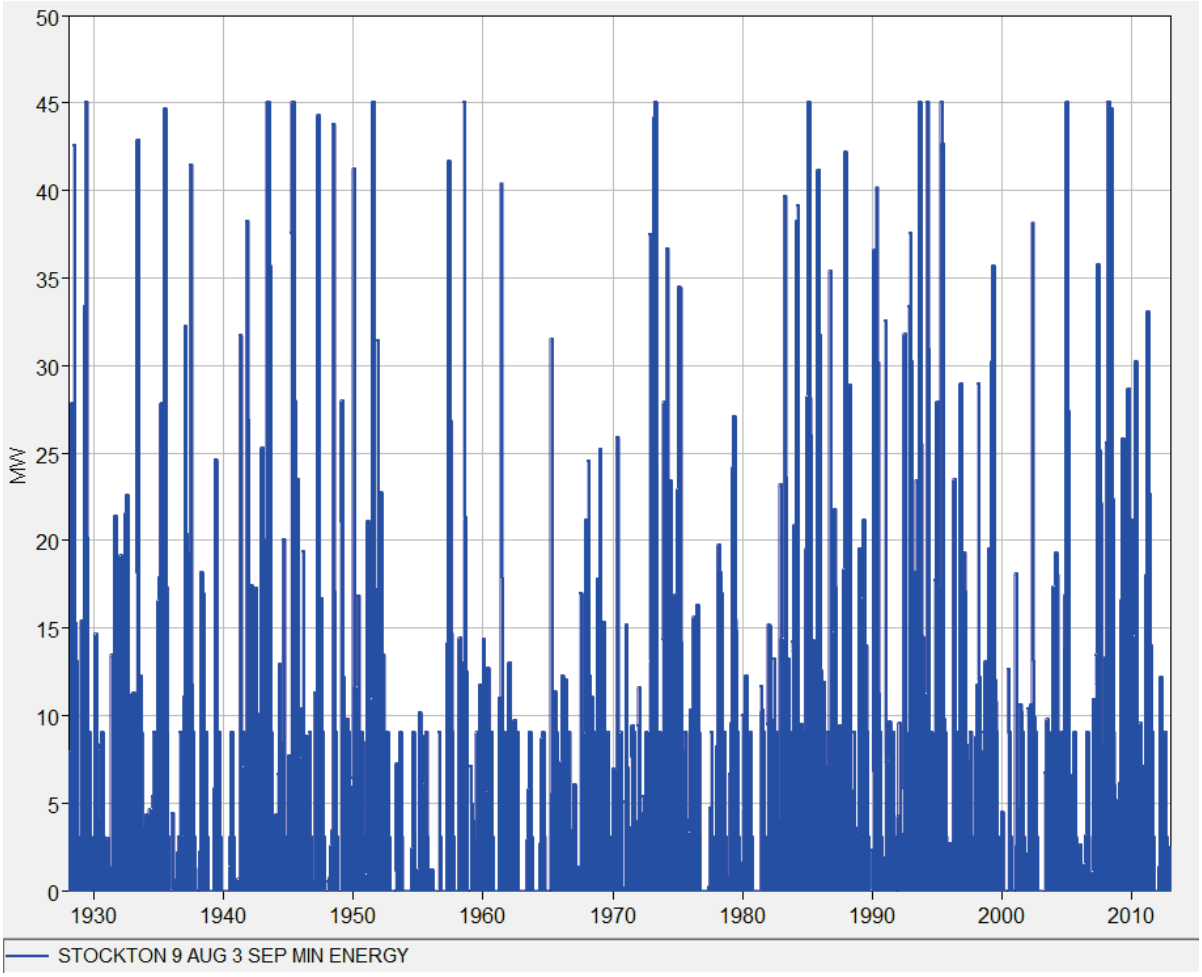


Figure 4-4. Stockton Daily Power Requirement Used for Input to the HEC-ResSim Power Rules.

4.5 Water Supply

In 1993, the first Reallocation Study was completed and approved for the City of Springfield, Missouri. City Utilities of Springfield, Missouri executed a water supply storage agreement at Stockton Lake for 50,000 AF, following the approval of the 1993 Reallocation Study. The City anticipates using 30 MGD from the storage once the need is fully developed. This is the anticipated future daily demand rate. For this study, as part of the base condition, the Springfield water supply storage account has been established for 50,000 AF, and the anticipated future average daily demand of 30 MGD (based on the 1993 Reallocation Study) was assumed. The model input uses 46.416859 cfs which is equivalent with 30 MGD. For modeling purposes, if the storage is depleted, the water supply releases will cease, and no seasonal factors have been applied to the water supply storage used. As stated in Section 2, Pertinent Lake Data, water supply storage was not utilized until 1993. Since that time, actual water usage has been much lower than the maximum of 46 cfs. However, the maximum potential release was modeled to assess the assurance of firm yield for water supply storage.

5.0 Model Validation

Two model scenarios were developed to represent the historical lake conditions. The first is the "pre-reallocation" scenario which uses all the current lake regulation rules, as described in Section 4, Model Structure, with the exception of the Springfield water supply storage amount of 50,000 AF and withdrawal. This is comparable to the observed period of record from the pool's first fill in late 1971 until 1993 when the Springfield water supply contract came online. The second historical scenario is the "base

condition" for the current lake operation which includes operation for all the project purposes including Springfield's 50,000 AF of water supply storage and withdrawal. Figure 5-1 shows a comparison of the modeled pre-reallocation and base condition with the observed data for 1971 (first fill of the reservoir) to 1991. Figure 5-2 shows a comparison of the modeled pre-reallocation and base condition with the observed data for 1992 through 2012 (end of simulation).

The HEC-ResSim model performed reasonably well through the period of observed data. Discrepancy between modeled and observed in the low pool elevations are especially evident through 1976 and 1977. A study of the gate orders indicates that a test release was conducted at that time and the model appears to be more accurate for directly following the water control manual. Periods of maintenance drawdowns would also show discrepancy in between observed and modeled data. Discrepancy also exists in flood control operations. Small rises into the flood pool in the observed data record can be explained by seasonal water level management plans that will allow the pool to rise up to pool elevation 870 feet during certain times of the year to benefit fish and wildlife. Although these plans are allowed by the water control manual, they are not modeled because they are temporary in nature and the drought conditions are more pertinent to the firm yield analysis. HEC-ResSim also uses a simpler approach to tandem balance between Stockton and Truman, so at times Stockton may have needed to store water because of tandem balance but the model did not account for that. A screening level review of model output during flood control operations at Stockton and Truman indicated proper adherence to control point criteria. Again, because the emphasis of this modeling effort is on firm yield calculation, application of the ResSim tandem balance feature was not closely reviewed.

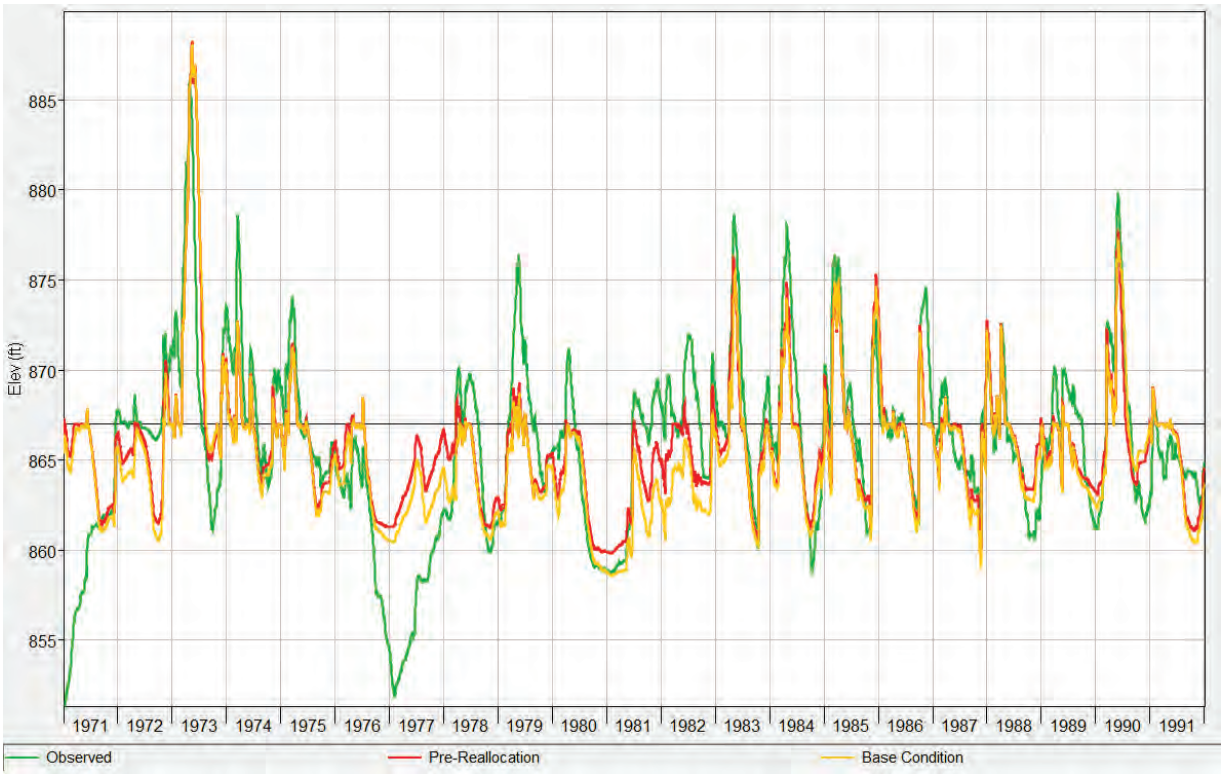


Figure 5-1. Stockton Observed Data Compared to Model Output 1971-1991.

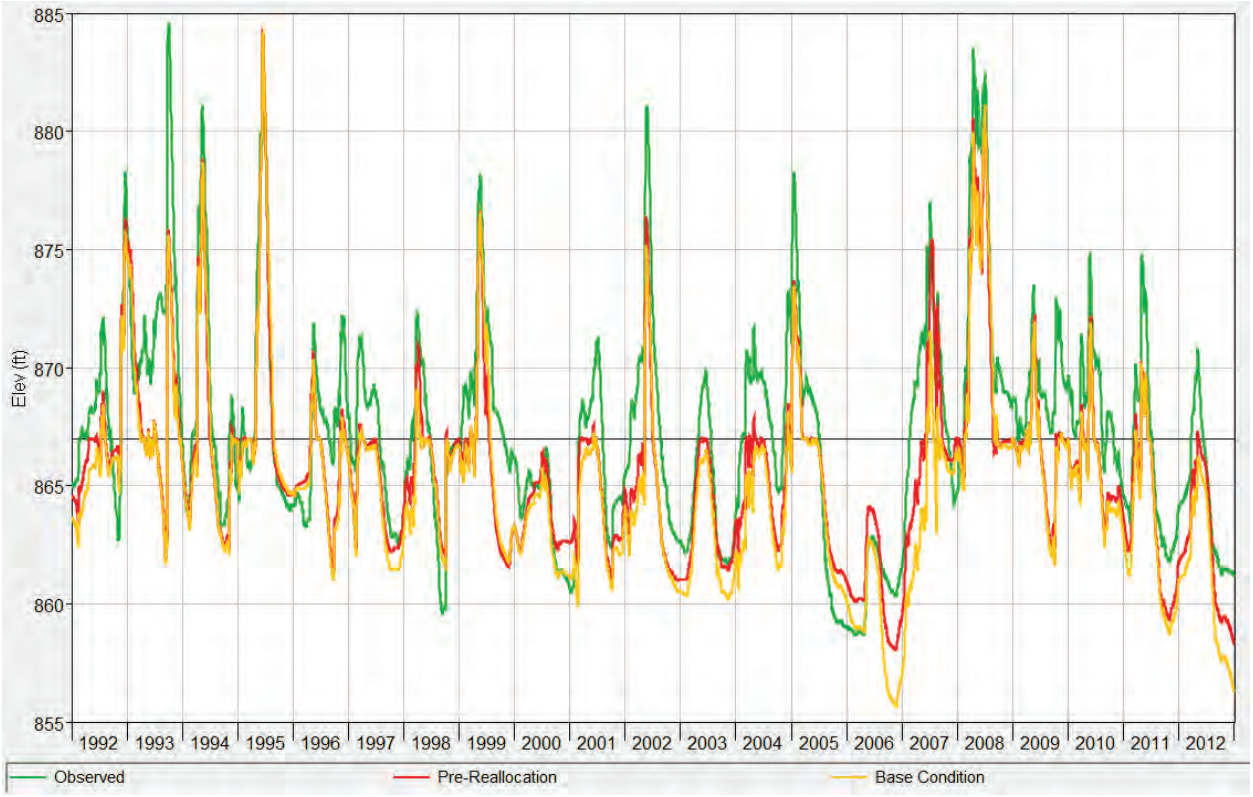


Figure 5-2. Stockton Observed Data Compared to Modeled Output 1992-2012.

Another source of discrepancy between observed pool elevations and the base condition model output, is that the model employs a constant release of 46.416859 cfs from the Springfield water supply storage account. As stated in Section 4.5 this was done to evaluate and assure sufficient volume of storage for the Springfield water supply account throughout the modeled period, and provide some assurance against future drought that may be more severe than these study assumptions. A review of observed data since 1993 shows that Springfield has used much less water supply storage than allocated as evidenced by monthly withdrawal rates much smaller than the anticipated future daily demand. A sensitivity analysis was conducted to quantify how much of an impact this would make on pool elevation. Figure 5-3 documents the HEC-ResSim rule that incorporates actual monthly usage andthat tests the sensitivity of this usage through the 63 year analysis period. Since signing the water supply contract in 1993, the monthly average water use ranged from 2 cfs to just over 10 cfs. By applying those monthly average usage values to the entire 1950 through 2012 period of record, the resulting pool elevations are more closely aligned to the pre-reallocation alternative, as documented in Figure 5-4. Figures 5-1, 5-2 and Figure 5-4 demonstrate that during times of drought the Springfield water usage can result in several feet of additional depletion of the pool, particularly as withdrawal rates trend toward the anticipated future daily demand of 46.416859 cfs as shown in the Base Condition. It is possible that in the future Springfield will begin to use more of their allocation as demand increases and as their water transmission infrastructure continues to be developed.

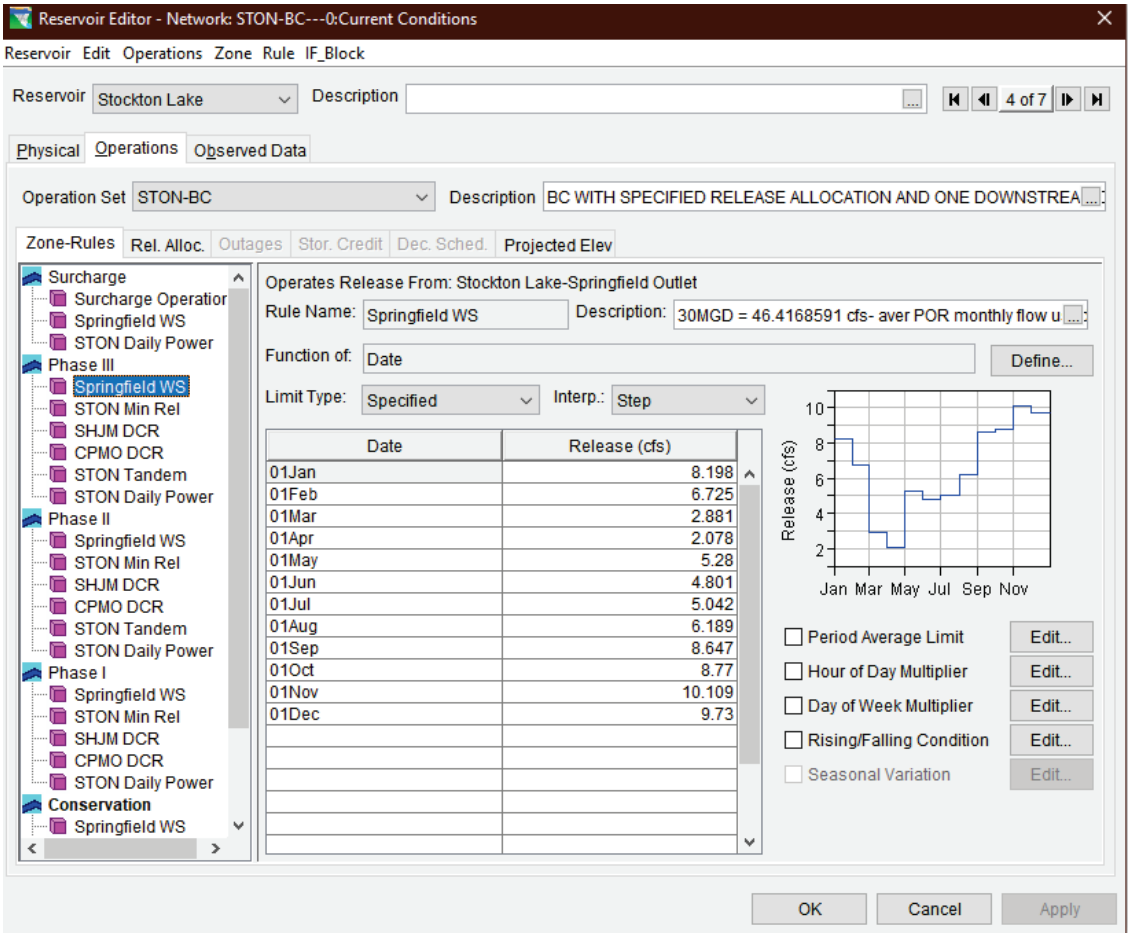


Figure 5-3. HEC-ResSim Rule Incorporating Average Monthly Water Usage.

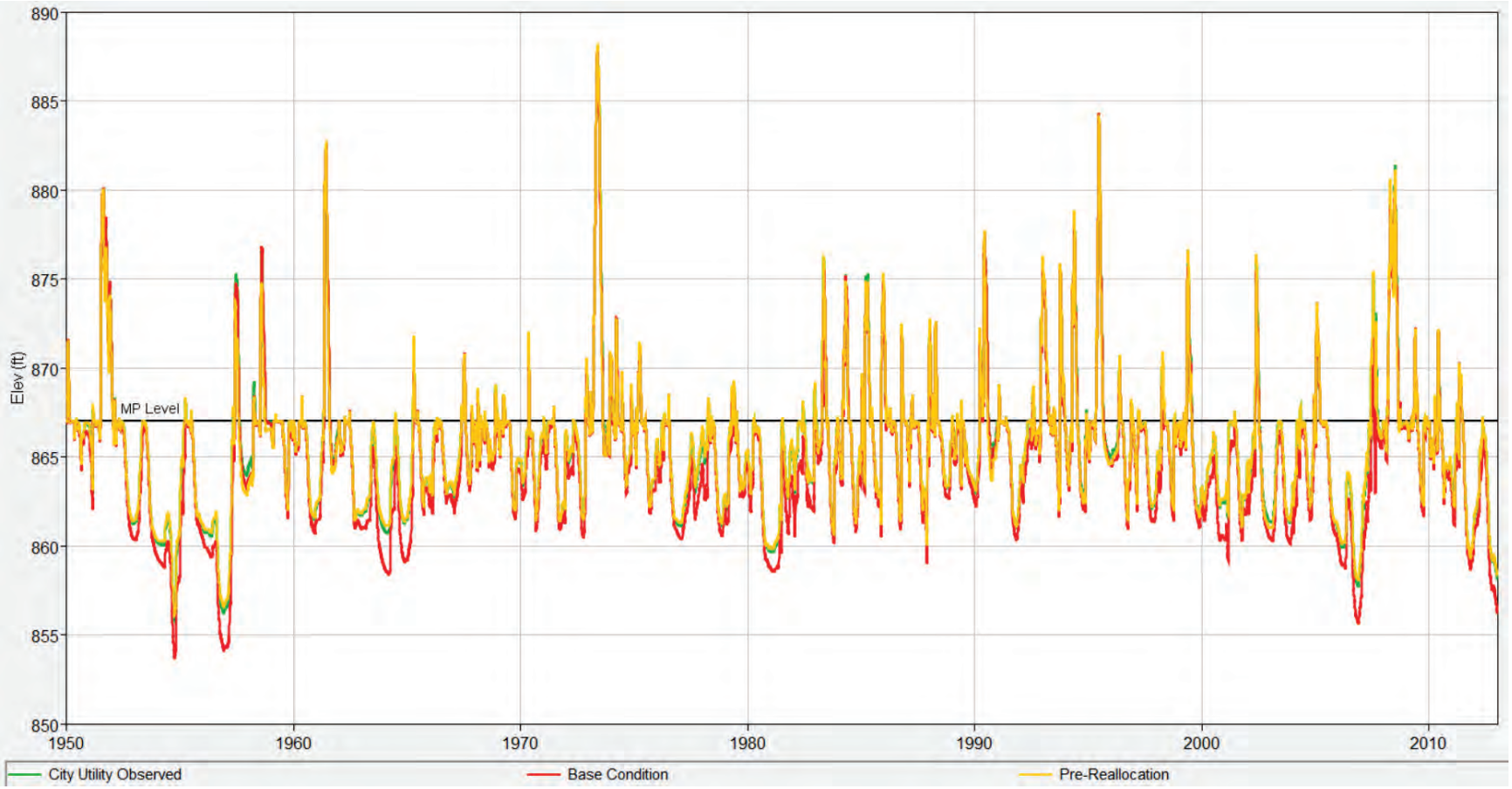


Figure 5-4. City Utility Observed, Base Condition, and Pre-Reallocation Modeled Stockton Pool Elevation.

6.0 Modeled Results

Two modeled alternatives (in addition to the pre-reallocation and the base condition) were developed, evaluated and carried forward for full analysis in this report. Both alternatives provide sufficient storage for a yield of 39 MGD, which is what the Coalition has requested. They are as follows:

- Alternative 5: 90,200 acre-feet of storage re-allocated to Tri-State from the existing multi-purpose pool.
- Alternative 7: 94,750 acre-feet of storage re-allocated to Tri-State concurrent with a 1.8 ft pool raise. 45,750 acre-feet provided from the multi-purpose pool and 49,000 acre-feet from the flood pool. Also referenced as Alternative 7 pre-DYMS.
    - Alternative 7 DYMS: Used to iterate on the storage necessary to re-establish City of Springfield's yield in Section 6.4.
    - Alternative 7 non-DYMS (atypical): Used to investigate an alternate means of re-establishing City of Springfield's yield (see Section 6.4) by returning a sufficient amount of Tri-State's 94,750 acre-feet of storage to Springfield.

The analyses assess the impacts which result from an assumed daily water usage equal to the anticipated future average daily demand. This conservative assumption is consistent with industry practices and Engineering and Construction Bulletin (ECB) 2019-13, Methods for Storage/Yield Analysis, and guards against the uncertainty of future drought. Water supply storage alternatives were sized and evaluated through a 63 year period of record in order to be just sufficient to sustain the anticipated future water supply demand through the recurrence of the 2% drought of the 1950's.

Figure 6-1 shows the Stockton pool elevation comparison between the base condition and alternatives 5 and 7. HEC-ResSim uses storage accounting calculations that apportions inflows and evaporation as a percent of available storage for all water supply accounts. Each alternative is analyzed to ensure the proper amount of storage was allocated to provide 39 MGD (60.3 cfs) of continuous water supply withdrawal. Alternative 5 was able to deliver the 39 MGD using 90,200 acre-feet. As can be seen in Figure 6-1, this alterative leads to the lowest pool elevations during the regional record 1950's drought. Of note, none of the alternatives results in the pool elevation dropping below 845 feet which would result in hydropower generation being unobtainable.

In Alternative 7, the multi-purpose pool is raised 1.8 feet to elevation 868.8 feet. This pool raise is to convert 49,000 acre feet of storage from the current flood control pool to the multi-purpose pool. The actual pool raise would need to be between 868.8 and 868.9 feet NGVD 29 to give the full additional 49,000 acre feet to the expanded multi-purpose pool. Exceeding a 0.1 foot accuracy within pool elevations is within the data collection error of the LiDAR that was used to compute storage in this range.

The pool raise allows additional storage to be utilized in the multipurpose pool for water supply while mitigating negative effects of drought on the multipurpose pool. The pool raise also provides additional head for hydropower generation. The higher multipurpose pool elevation may lead to marginally earlier and increased chances of phase II flood control releases as suggested in the Stockton pool elevation frequency analysis in Figure 6-2, but the increased chances are mainly offset by the increased consumptive water supply usage. Notably, the pool raise generates no significant increase in the simulated maximum flood pool.

Figure 6-1 summarizes the results of the modeling. Under alternative 5, during extended drought conditions, such as the 1950s and 1980s, the consumptive water usage results in pool elevations that decline too much lower elevations as compared to the base condition. For example, around 1957 the pool elevation under Alternative 5 would have declined to 846 ft NGVD 29, almost ten feet lower than the base condition. Around 1983, under Alternative 5, the change in elevation could be as much as 15 feet lower, a decrease from approximately 862 ft NGVD 29 to 847 ft NGVD 29. Under alternative 7, during

the same extended drought conditions (19050s and 1980s), the consumptive water usage results in the pool declining below the base condition, but not as low as Alternative 5. For example during 1957, under Alternative 7 the pool elevation would decline to 850 ft NGVD 29 and in 1983 to 854 ft NGVD 29. Alternative 7 requires more storage (94,750 acre-feet) than alternative 5 (90,200 acre-feet) because the multi-purpose pool of Alternative 7 is larger after the re-allocation, consequently a smaller apportionment of the inflows are provided directly to the Tri-State water account as yield per acre foot of storage declines.

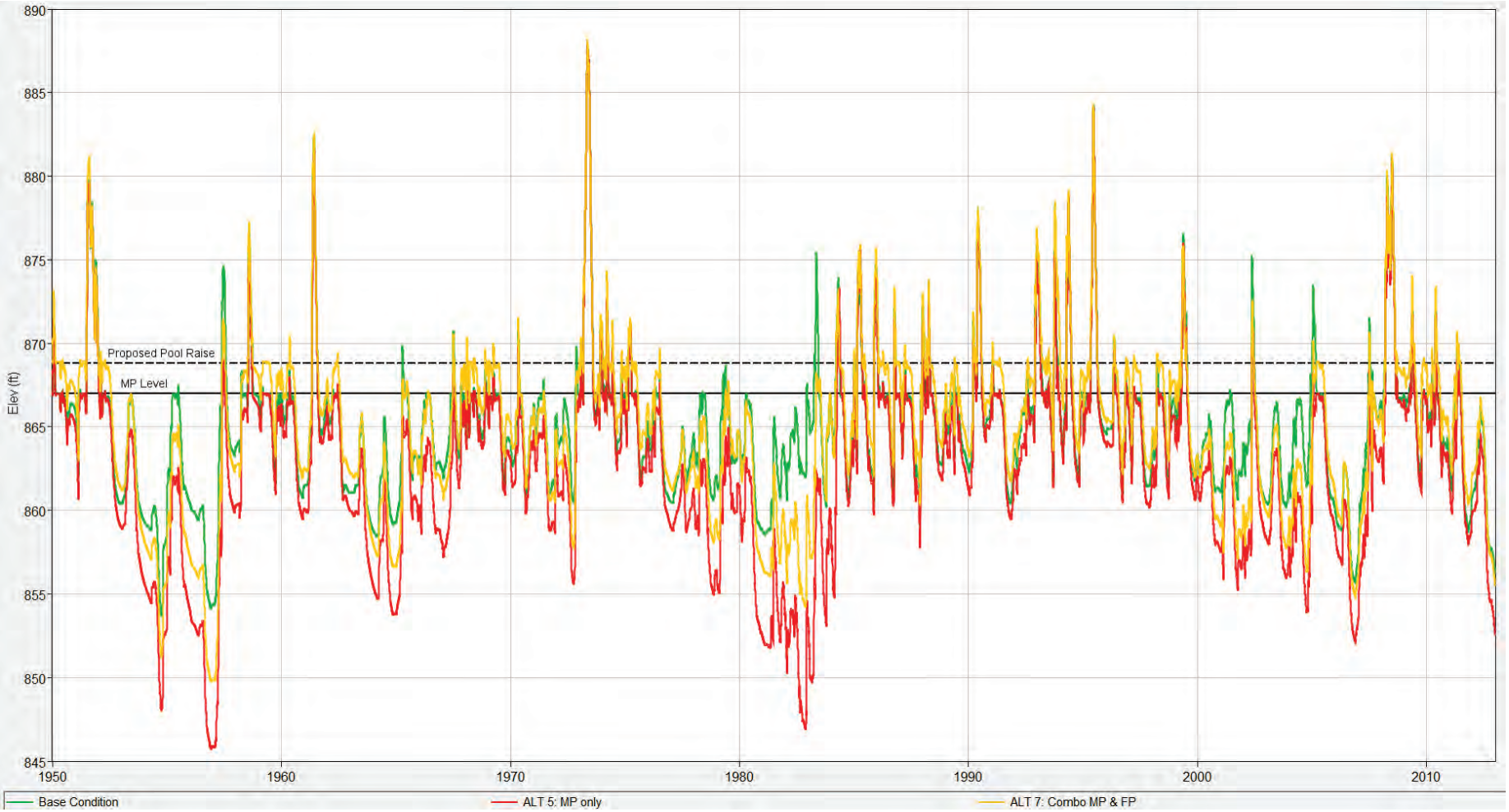


Figure 6-1. Stockton Reservoir Modeled Pool Elevation for the Base Condition and Alternatives 5 and 7.

As mentioned earlier, Figure 6-2 displays the Stockton pool elevation frequency analysis. The frequency analysis compares the pre-reallocation, base condition and alternatives 5 and 7. Starting from the bottom left of the graph, 98 percent of the time under the base condition the pool elevation is at or above elevation 860 ft NGVD 29. Under alternative 5, the elevation of the pool is at or above 854 ft NGVD 29 and under alternative 7, the elevation of the pool is at or above 857 ft NGVD 29, 98 percent of the time. As the annual chance of exceedance decreases to 50 percent of the time, the base condition pool elevation is approximately at or above elevation 869.9 ft NGVD 29, alternative 5 is approximately at or above elevation 867 ft NGVD 29, and alternative 7 is approximately at or above 870.0 ft NGVD 29. Note that at the 50 percent chance exceedance, alternative 7 closely aligns with the base condition scenario. Moving further to the right on the graph, when the annual chance of exceedance is reduced to 10 percent of the time, all three alternatives are in within the range of 878 ft. NGVD 29 to 879 ft NGVD 29 with alternative 7 being approximately at or above 879 ft NGVD 29 10 percent of the time and alternative 5 being approximately at or above 878 ft NGVD 29 10 percent of the time and the base condition line lies between the two alternatives. This demonstrates and reinforces what was discussed previously in the section, that the higher multipurpose pool elevation may lead to marginally earlier and increased chances of phase II flood control releases: Phase II releases occur between elevation 870 ft NGVD 29 and 880.9 ft NGVD29 depending on the time of year, but the increased chances are mainly offset by the increased consumptive water supply usage. By the time the lines reach the 3 percent annual chance of exceedance, all alternative lines are on top of each other. This demonstrates that the pool raise generates no significant increase in the simulated maximum flood pool.

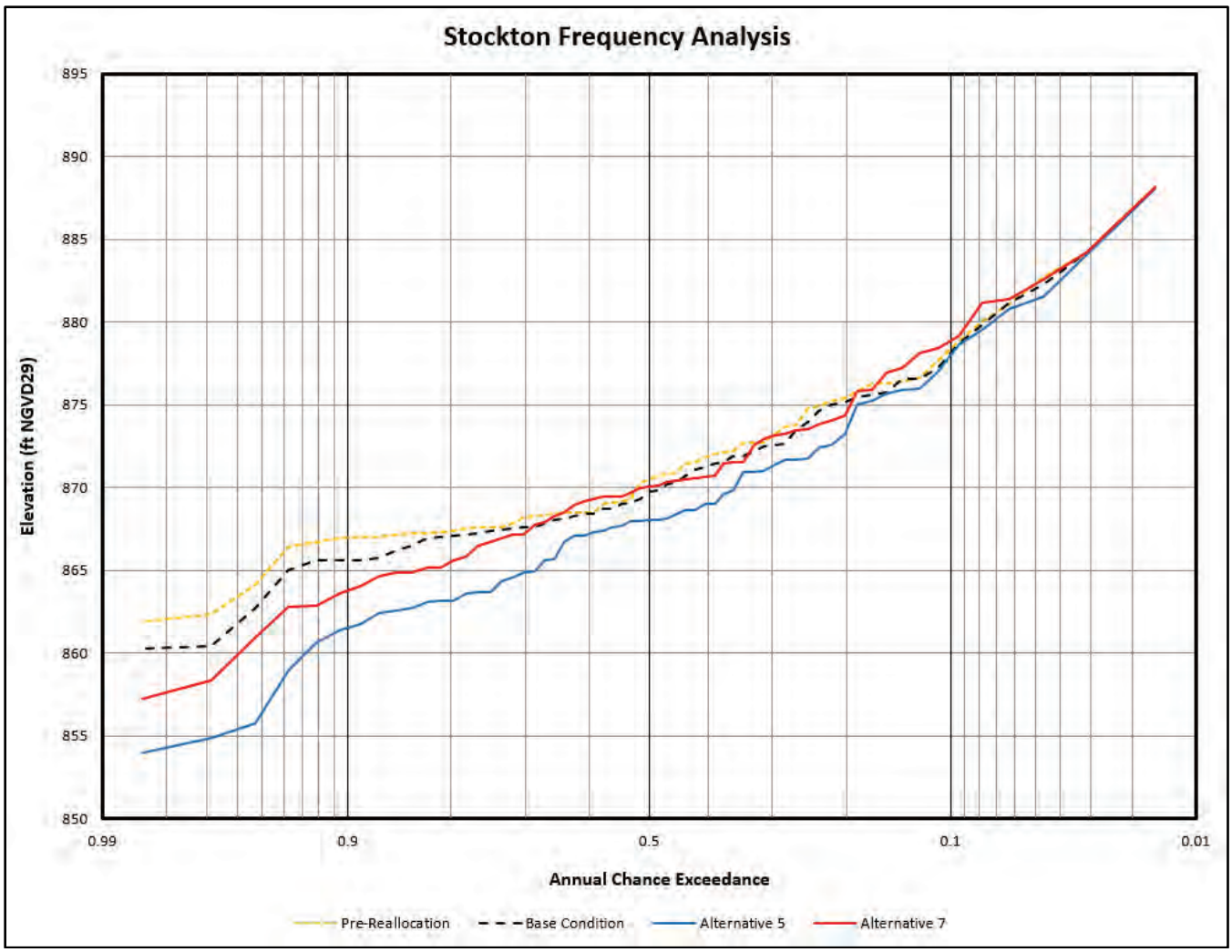


Figure 6-2. Stockton Pool Elevation Frequency Analysis.

6.1 Stockton Lake Downstream Gage Analysis

Another evaluation that can be conducted using the ResSim output is changes to downstream flows based on the two alternatives as compared to the base condition. Figures 6-3 and 6-4 display the 10th percentile monthly maximum discharge at the Sac River at Highway J and Caplinger Mills gages. The 10th percentile flows are the maximum flow the gage would report 10 percent of the time, meaning they are abnormally low. The flows range from 50 to 1,000 cfs at both gages and there is no discernable change between the three alternatives. Figure 6-3 displays the Highway J downstream changes. During the months of January, February, March April, October, November and December the flows at the gage are less than 100 cfs and there is no discernable change between the base case condition and the two alternatives. In the months of May and June the flows are slightly more than 100 cfs and there is no discernable change among the alternatives for May and only about a 10 cfs decline in June when comparing the base condition to the two alternatives. During the months of July and August the flows increase to 500 cfs and 900 cfs respectively and in the month of September flows are around 300 cfs.

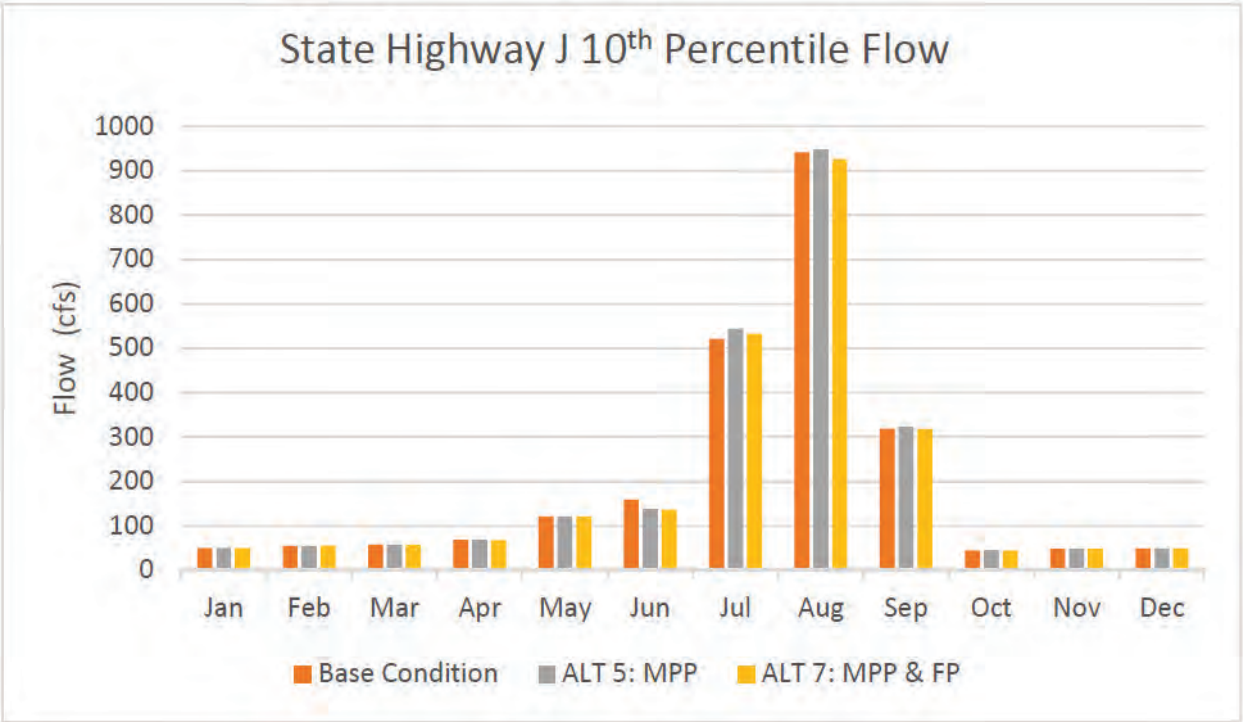


Figure 6-3. 10th Percentile Flow Past the Sac River at Highway J for All Model Alternatives.

Figure 6-4 displays the 10th percentile Caplinger Mills changes. During the months of January, February, March April, October, November and December the flows at the gage are less than 100 cfs and there is no discernable change between the base case condition and the two alternatives. In the months of May and June the flows are between 200 and 300 cfs and there is no discernable change among the alternatives. During the months of July and August the flows for all alternatives increase to almost 600 cfs and 900 cfs, respectively, and in the month of September flows are around 300 cfs for all alternatives. However, even in the higher flow months there is very little change among alternatives.

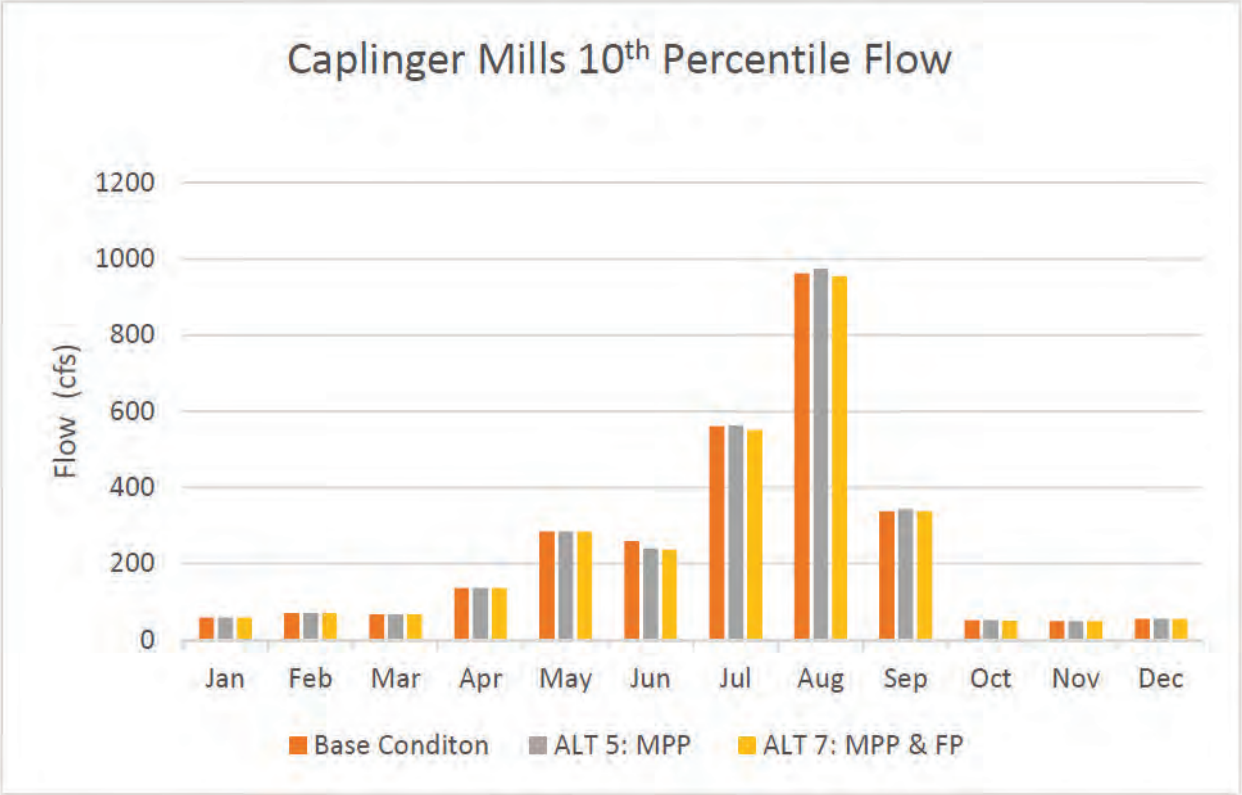


Figure 6-4. 10th Percentile Flow Past the Sac River at Caplinger Mills for All Model Alternatives.

Figures 6-5 and 6-6 show the median or 50th percentile monthly discharge at the Sac River at Highway J and Caplinger Mills, respectively and there are no significant changes stemming from either alternative 5 or alternative 7 as compared to the base condition. The 50th percentile represents the monthly maximum downstream flows that occur at least 50 percent of the time per month. This is the median discharge. Figure 6-5, at Highway J displays a range of flows from 50 cfs to approximately 1,300 cfs for the year. January, July and August have average flows close to 1,000 cfs. Under alternative 7, in the month of July flows decline slightly by approximately 50 cfs as compared to the base condition, but January and August do not display significant changes among alternatives. February and May have average flows around 800 cfs. There is no significant change between alternatives during February. During May there is a slight decline of approximately 50 cfs for both alternative 5 and 7 as compared to the base condition. April has the highest monthly flows at approximately 1300 cfs and there is not a major change between the alternatives as compared to the base condition. June's flows range between 700 cfs for the base condition and 600 cfs for alternative 5 and 500 cfs for alternative 7 or a 200 cfs difference from the base condition. The average flows from September through December range from 300 cfs to 50 cfs. September has a monthly average of 300 cfs. October and November have a monthly average of 50 cfs and December has an average of about 200 cfs and no significant change between alternatives.

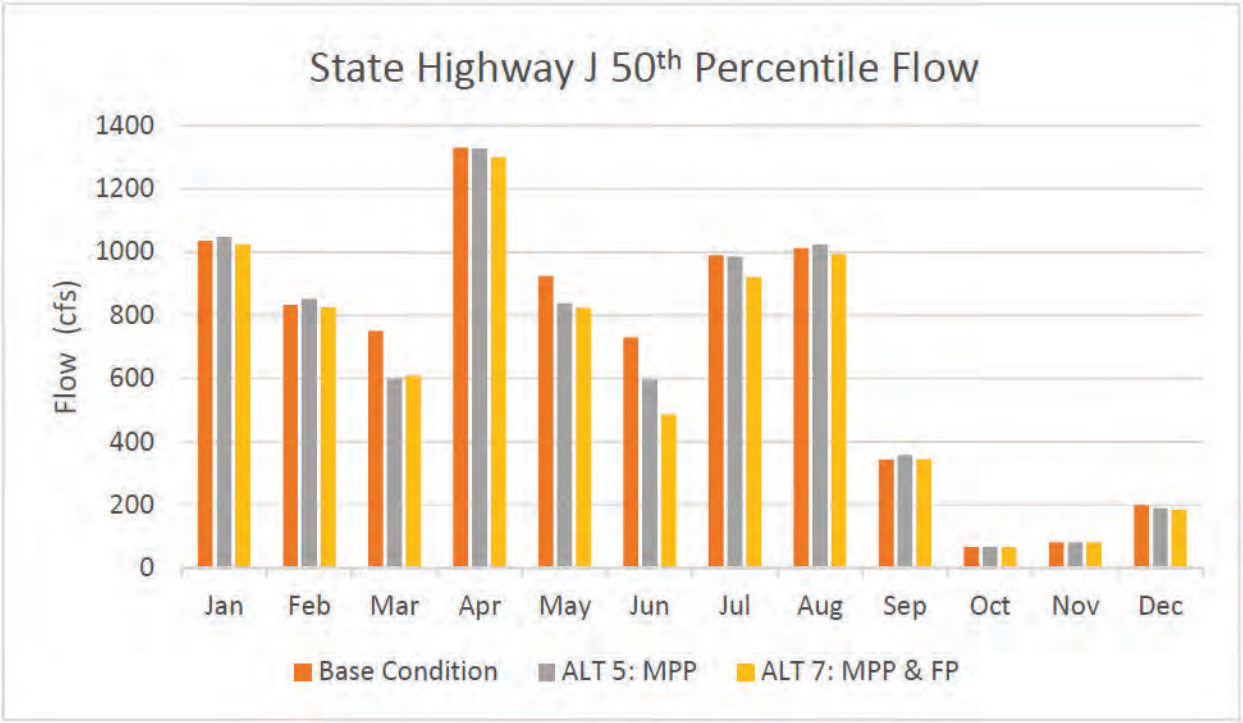


Figure 6-5. Median or 50th Percentile Flow Past the Sac River at Highway J for All Model Alternatives.

Figure 6-6, at Caplinger Mills displays a range of flows from 250 cfs to approximately 2,000 cfs for the year. January, February, March, and May have average flows between 1,000 and 1,500 cfs. There is a slight decline in flows under alternatives 5 and 7 for March and May, but it's not significant. There is a slight decline in flows under alternative 7 as compared to the base condition, but only by about 100 cfs. Average flows are greatest in April, reaching around 2,000 cfs. There are slight declines when compared to both alternative 5 and 7, but not significant. June through August display average flows of about 1,000 cfs and no significant change in flows between alternatives. Flows average between 100 cfs to 400 cfs September through December, but again there is no significant change among alternatives.

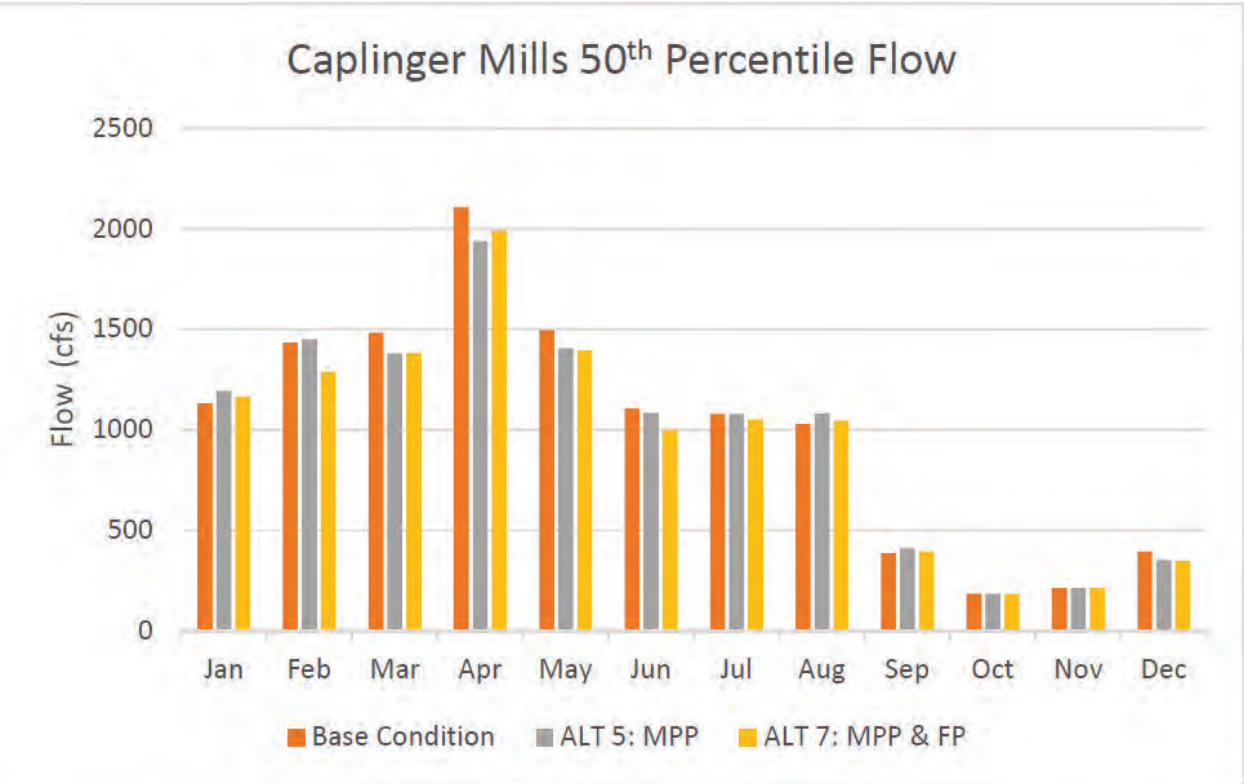


Figure 6-6. Median of 50th Percentile Flow Past the Sac River at Caplinger Mills for All Model Alternatives.

Figures 6-7 and 6-8 display the 90th percentile monthly maximum discharge at the Sac River at Highway J and Caplinger Mills gages. The 90th percentile flows mean that the monthly maximum flows will be at or below these levels 90 percent of the time, meaning that the largest differences will occur between the alternatives because more extreme events are being captured in the results; however, even though 90 percent of the flows are captured between the alternatives the largest discrepancy between both gages occurs at Highway J during the month of April under alternative 7, which displays an approximate 600 cfs decline in flows. Overall, there are no significant changes between the alternatives and the base condition at either the Highway J gage or the Caplinger Mills gage. .

In Figure 6-7, the 90th percentile flows are displayed at Highway J. The flows range from 500 to 3,200 cfs. Average annual flows from January through July are between 2,200 cfs and 3,200 cfs. As compared to the base condition, alternatives 5 and 7 both report lower flows, but not significantly. As stated before, the month of April had the largest difference of 600 cfs. To put 600 cfs into perspective at Highway J gage, when the flow is 2,500 cfs the stage (elevation of water) is 12.28 ft. When the flow is 3,000 cfs the stage of water is 13.11 ft, a change of 0.83 ft or a 6.7% change from the base condition. Average flows for the month of August are approximately 1,500 cfs for the base condition and around 1,200 cfs under alternative 5 and 1,100 cfs under alternative 7. In September and October average flows are 900 cfs and 500 cfs respectively. There is no discernable change between the alternatives as compared to the base condition. November and December have average flows between 2,000 cfs and 2,500 cfs. Under alternative 5, in the month of December, flows are slightly lower by approximately 200 cfs, but otherwise, there is no significant change between the alternatives.

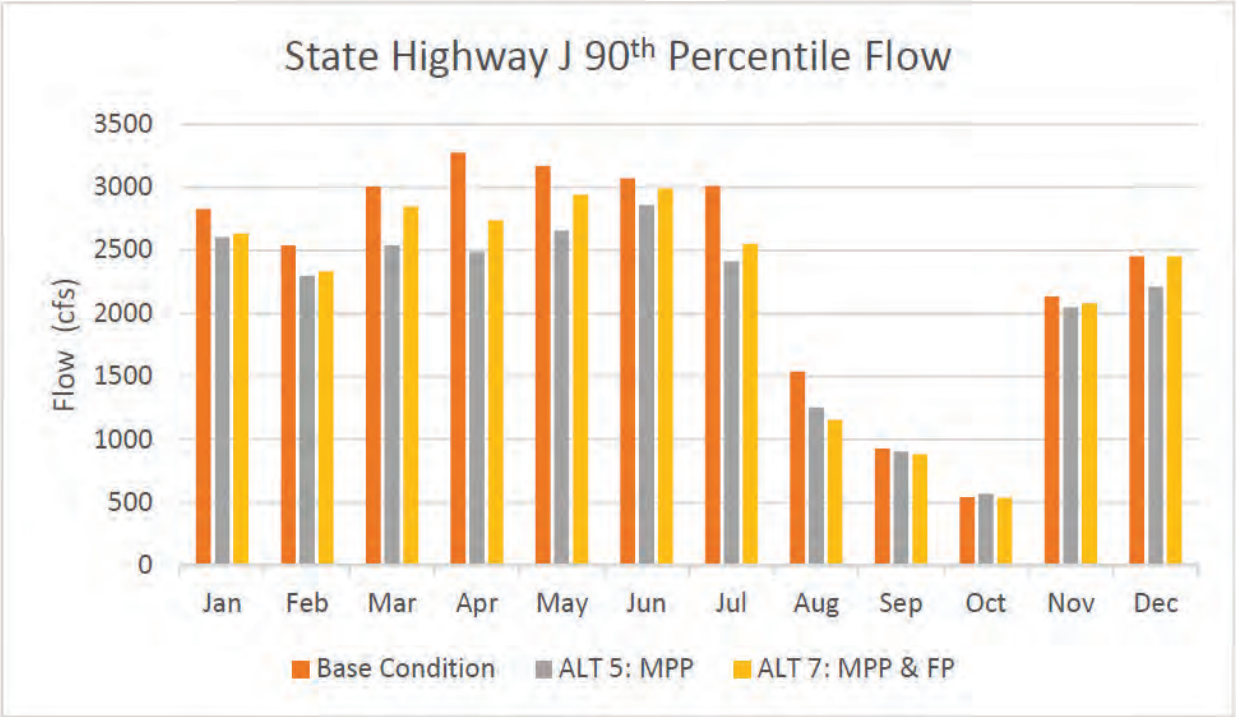


Figure 6-7. 90th Percentile Flow Past the Sac River at Highway J for All Model Alternatives.

In Figure 6-8, the 90th percentile flows are displayed at the Caplinger Mills gage. Average flows range from approximately 1,000 cfs to 5,000 cfs. Average flows for January, February, July and October are approximately 3,500 to almost 4,000 cfs. There is not a significant change between the alternatives. March, April and May have average flows of approximately 5,000 cfs. Under alternatives 5 and 7 for both March and April flows are slightly decreased, but not significantly. In the month of May, flows under alternative 5 are slightly less, while flows under alternative 7 are almost the same as the base condition. Average flows for the month of August are approximately 2,000 cfs and there is no discernable difference between alternatives. September and October have average flows of 1,000 cfs and no change between the alternatives. Lastly, the month of December has average flows of approximately 3,200 cfs under the base condition, 2,900 cfs under alternative 5, and 3,900 cfs under alternative 7, which is an overall change of 500 cfs between the base condition and alternative 7.

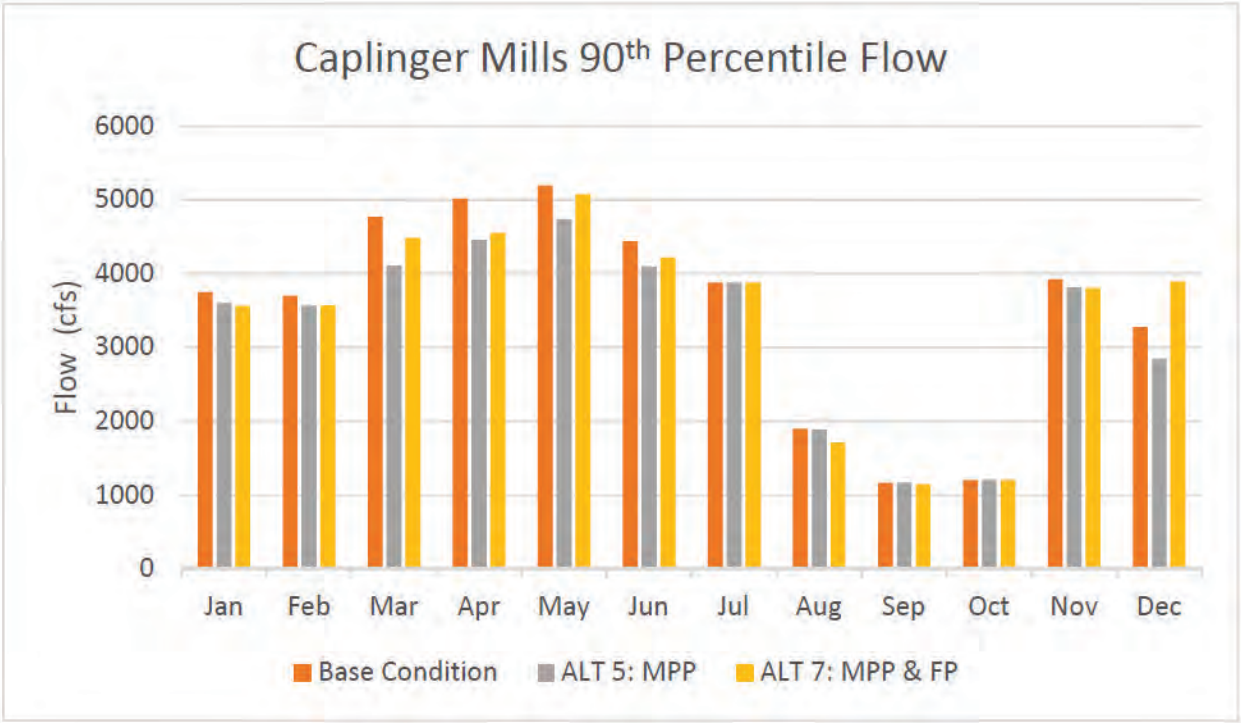


Figure 6-8. 90th Percentile Flow Past the Sac River at Caplinger Mills for All Model Alternatives.

6.2 Downstream Analysis Pertaining to Flood Risk Management

A flood risk management evaluation was only conducted on Alternative 7 since Alternative 5 is not changing the normal pool elevation and thus not changing flood risk and flood risk management. As described in the water control manual, the surcharge operation criteria are understood to stand as documented post-reallocation, meaning the phased released schedule will remain the same. Any time that the elevation and inflow threshold is 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.

Kansas City District Water Control has discretion in the operation of the dam to make non-damaging releases. Considerations for releases include (1) downstream conditions (i.e., flooding) (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 represents stream capacity (meaning bank full). Any release in excess of Phase II will experience out of banks flooding. Phase III release will flood low lying areas but is not expected to impact structures. Therefore, the same non-damaging, non-surcharge operation criteria releases that occur at or below Phase III releases today are 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 6-1 and 6-2 describe the gage location at Caplinger Mills, which is approximately 22 miles downstream of Stockton Dam. Table 6-1 includes information from the National Weather Service (NWS) flood stage data and Table 6-2 describes the water control manual discharges at different phases. For the NWS data in Table 6-1, 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 6-2 displays the various stages of discharges during high water or flood events. Phase 3 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 3 releases under either alternative, there is not an impact to flood risk management.

Table 6-1. National Weather Service Percent Time at Various Flood Stages at 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%
Alt 5 (90,200 MP)	2.23%	1.18%	0.46%	0.04%
Alt 7 (45,750 MP / 49,000 FP)	2.64%	1.25%	0.47%	0.04%

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

Table 6-2. Stockton Lake Water Control Manual Percent Time of Phased Discharges at Caplinger Mills USGS Gage.

Model Simulation	**Action Stage (14') Phase I**	**Flood Stage (16')Phase 2**	**Moderate Flood Stage (19') Phase 3**
Base/Existing Condition	3.94%	1.23%	0.47%
Alt 5 (90,200 MP)	3.49%	1.18%	0.46%
Alt 7 (45,750 MP / 49,000 FP)	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 operation criteria that currently exists 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 condition conditions. While Stockton Lake may reach higher pools slightly more frequently post-reallocation (with a higher multipurpose pool elevation), the District would have discretion to make releases sooner and more frequently because elevation thresholds would be reached sooner.

6.3 Sensitivity Analysis of Water User's Withdrawal Rates

It was described earlier in Section 5.0 that Springfield does not utilize its entire allocation at this point in time. Since storage is sized to meet the needs of a water supply user during drought condition, the same scenario could apply to Tri-State where the withdrawal rate is less than what was modeled assuming there is not a drought every year. To capture this scenario, a sensitivity analysis was conducted to evaluate the impacts to both high pool elevations and drought periods if only half of the Tri-State water allocation was used. For this model run, the constant discharge of 60.3 cfs was reduced to 30.15 cfs and the resultant pool elevations were plotted as shown in Figure 6-9 for Alternative 5 and Figure 6-10 for Alternative 7. The results for both alternatives demonstrate tremendous sensitivity to drought conditions, with almost no demonstrable effect upon flood control storage.

In Figure 6-9, the base condition and the full withdrawal of 60 cfs is the same as displayed earlier in Figure 6-1 which compared all three alternatives. Now, instead of displaying alternative 7, the third line in the graph depicts the withdrawal of 30 cfs. If Tri-State is only withdrawing 30 cfs, the output more closely follows the base condition and during droughts the drawdown effect is significantly less than if the full allotment of 60 cfs is withdrawn.

In Figure 6-10, during drought conditions the results of the reduced withdrawal for alternative 7 are very similar to the base condition, showing that the pool raise coupled with 30.15 cfs of constant release results in pool elevations similar to those obtained under the current reservoir operation rules when analyzing the modeling period.

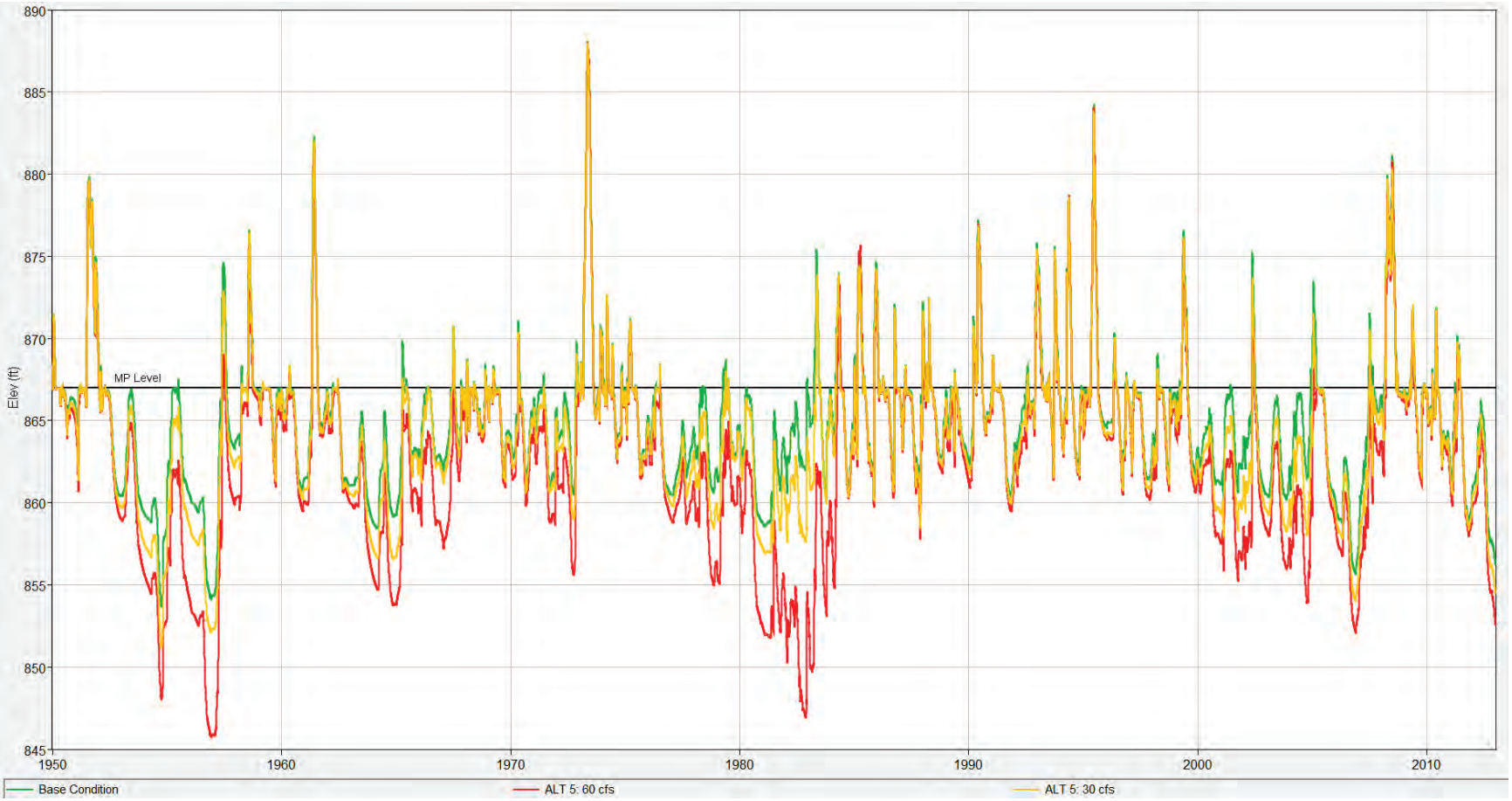


Figure 6-9. Sensitivity Analysis for Alternative 5 Compared with the Base Condition.

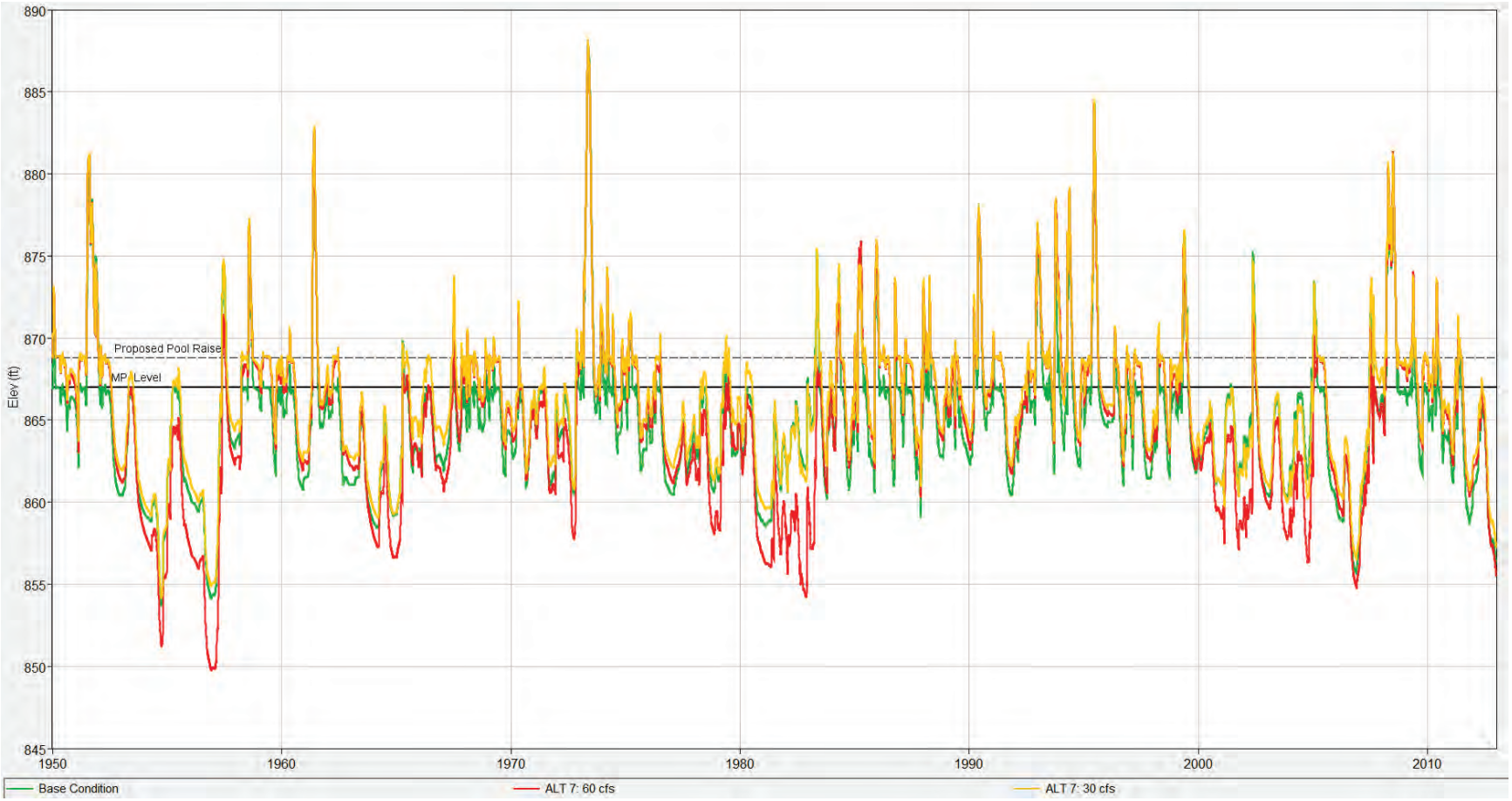


Figure 6-10. Sensitivity Analysis for Alternative 7 Compared with the Base Condition.

6.4 Dependable Yield Mitigation Storage (DYMS) Analysis

A dependable yield mitigation storage (DYMS) analysis was performed to re-establish the pre-reallocation yield of the existing user, the City of Springfield. When storage is taken from the flood control pool by raising the top of the conservation pool 1.8 feet in reallocation, as proposed in Alternative 7, the yield/storage ratio decreases consistent with DYMS guidance in Engineering Regulation (ER)1105-2-100, the Planning Guidance Notebook. Consequently, the amount of storage allocated to the City of Springfield needs to be increased to maintain their yield under their existing contract agreement.

Currently, Springfield is contracted to withdraw at a maximum rate of 46.42 cfs (yield) from 50,000 acre-feet of allocated storage, based upon a sequential mass accumulation analysis from the 1990's. Multiple runs of the base condition ResSim model were performed before alternatives were formulated. In this manner, Springfield's base condition contract storage amount was found insufficient to yield 46.42 cfs. Prior to formulating alternatives to investigate the storage requirement necessary to satisfy the anticipated future demand of Southwest Missouri Regional Water -- and the DYMS increment that follows a pool raise -- it was necessary to refine the yield 50,000 acre feet of storage provides City of Springfield under the base condition. Through iterative ResSim analysis, the yield was refined down to 44.0 cfs and serves as the corrected yield used for the pre-DYMS and DYMS analyses for City of Springfield.

Table 6-3 lists the details of the two simulations in the analysis.

Table 6-3 Comparison of DYMS Simulation and Additional Storage Required for Springfield.

Water Supply User	Alternative 7 Pre-DYMS	Alternative 7 DYMS
Springfield	50,000 acre-feet (green line on Figure 6.11)	69,000 acre-feet (black line on Figure 6.11)
Southwest Missouri Regional Water	94,750 acre-feet (blue line on Figure 6.11)	94,750 acre-feet (red line on Figure 6.11)

Reference Figure 6-11 for the period of record Pre-DYMS versus DYMS analysis. The Pre-DYMS analysis incorporates the 1.8 feet pool raise while introducing Southwest Missouri Regional Water's yield requirement. This analysis solved for the storage necessary to meet that requirement. Next, the DYMS analysis was conducted in order to determine how much additional storage would be required in order to re-establish Springfield's corrected yield of 44.0 cfs.

The bottom half of Figure 6-11 indicates the Stockton reservoir elevation with the new multipurpose level (MPP 868.8 ft) established. The top half of the Figure 6-11 indicates the initial and daily storage volumes remaining for both the City of Springfield and Southwest Missouri Regional Water. The blue and red lines start at 94,750 acre-feet and represent Southwest Missouri Regional Water account for the pre-DYMS and DYMS evaluations, respectively. Note that the green line that starts at 50,000 acre-feet is the current Springfield water storage amount for the pre-DYMS analysis. By raising the multipurpose pool level, and so reducing available flood control storage, 50,000 acre-feet of contract storage proves to be no longer adequate to meet Springfield's refined 44.0 cfs yield requirement in the pre-DYMS analysis. The ResSim model was utilized to conduct an iterative solution for the DYMS storage requirement. In the final DYMS analysis, the black line, which begins at 69,000 acre-feet, was determined to be the appropriate total storage amount necessary to restore the corrected yield of 44.0 cfs for the City of Springfield. This storage volume was determined by iteratively analyzing the capacity of estimated storage allocations to meet the yield, and then assessing how much surplus storage remained through the drought of record. Iterative storage attempts to meet the yield requirement were refined based on minimizing surplus storage through the drought of record. With the final DYMS iteration, the City of Springfield retains approximately 250 acre-feet of storage remaining during the critical drought period. Overall, the results of the two model simulations, pre-DYMS and DYMS, demonstrated very similar accounting trends, except through the drought of 1965 for Southwest Missouri Regional Water, which does nothing to alter the DYMS-critical results obtained for City of Springfield through the 1950's drought of record. This DYMS analysis characterized by the black line in Figure 6-11 demonstrates that City of Springfield needs an additional 19,000 acre-feet of storage (69,000 acre feet minus 50,000 acre

feet) in order to secure a yield of 44.0 cfs. This additional 19,000 acre-feet requirement results from the decrease in "yield per unit storage" when useable multipurpose storage is increased.

The traditional or typical DYMS solution assumes two mutually exclusive water supply users with non-negotiable, firm, yield requirements. Under these circumstances, the new water supply user must acquire the storage necessary to make whole, the yield of the existing water supply user. That "DYMS" quantity must be acquired in addition to the storage necessary to meet the new user's yield. However, given the unique relationship between the existing water supply user, City Utilities of Springfield, and their membership as part of the Southwest Missouri Regional Water Commission (the new water user), a different approach to find the atypical DYMS solution was conducted. In the typical DYMS solution 94,750 acre-feet of storage provides 60.3 cfs yield for the new water supply user, Southwest Missouri Regional Water. As noted in the main report, this yield is estimated to provide 39 MGD, which covers the current membership needs of 30 MGD and allows for a 30% growth contingency for new members. In order to meet the estimated yield of 30 MGD, this equates to a non-negotiable, firm, yield of 42.0 cfs. In the atypical DYMS solution, this reality permits excess storage from the anticipated 94,750 acre-feet of purchased storage to be transferred to the City of Springfield. Consistent with theory, Figure 6-12 demonstrates that 19,000 additional acre-feet are required to make whole, City of Springfield's 44.0 cfs yield, regardless the sub-portion of the multipurpose pool from which it originates. The balance of storage remaining to Southwest Missouri Regional Water in the atypical DYMS solution supports a yield of 48.0 cfs, which is estimated to yield approximately 31 MGD effectively reducing the 30% contingency for future members to approximately 5%.

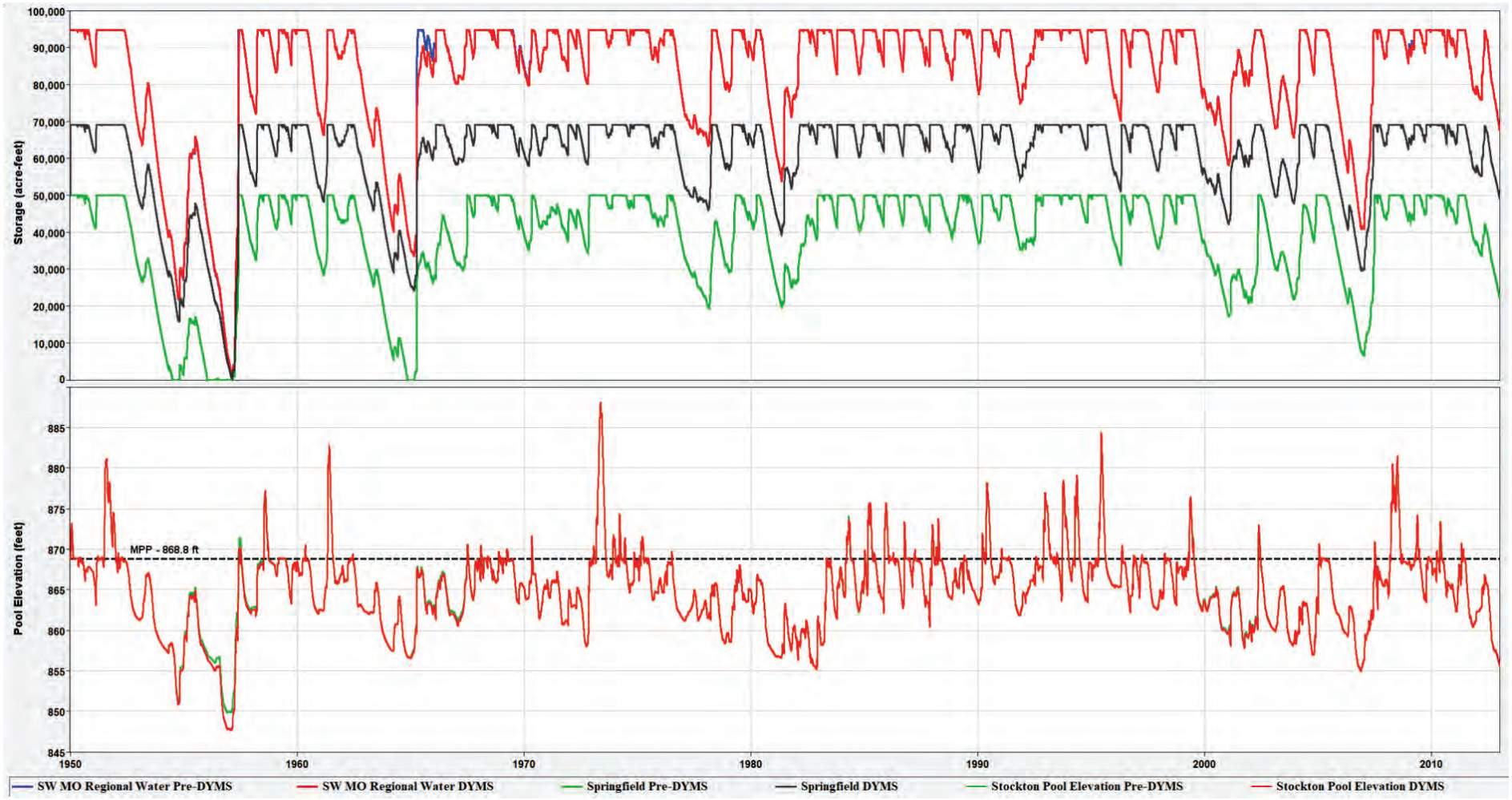


Figure 6-11. Overview of the Pool of Record (1950-2012) and DYMS Analysis.

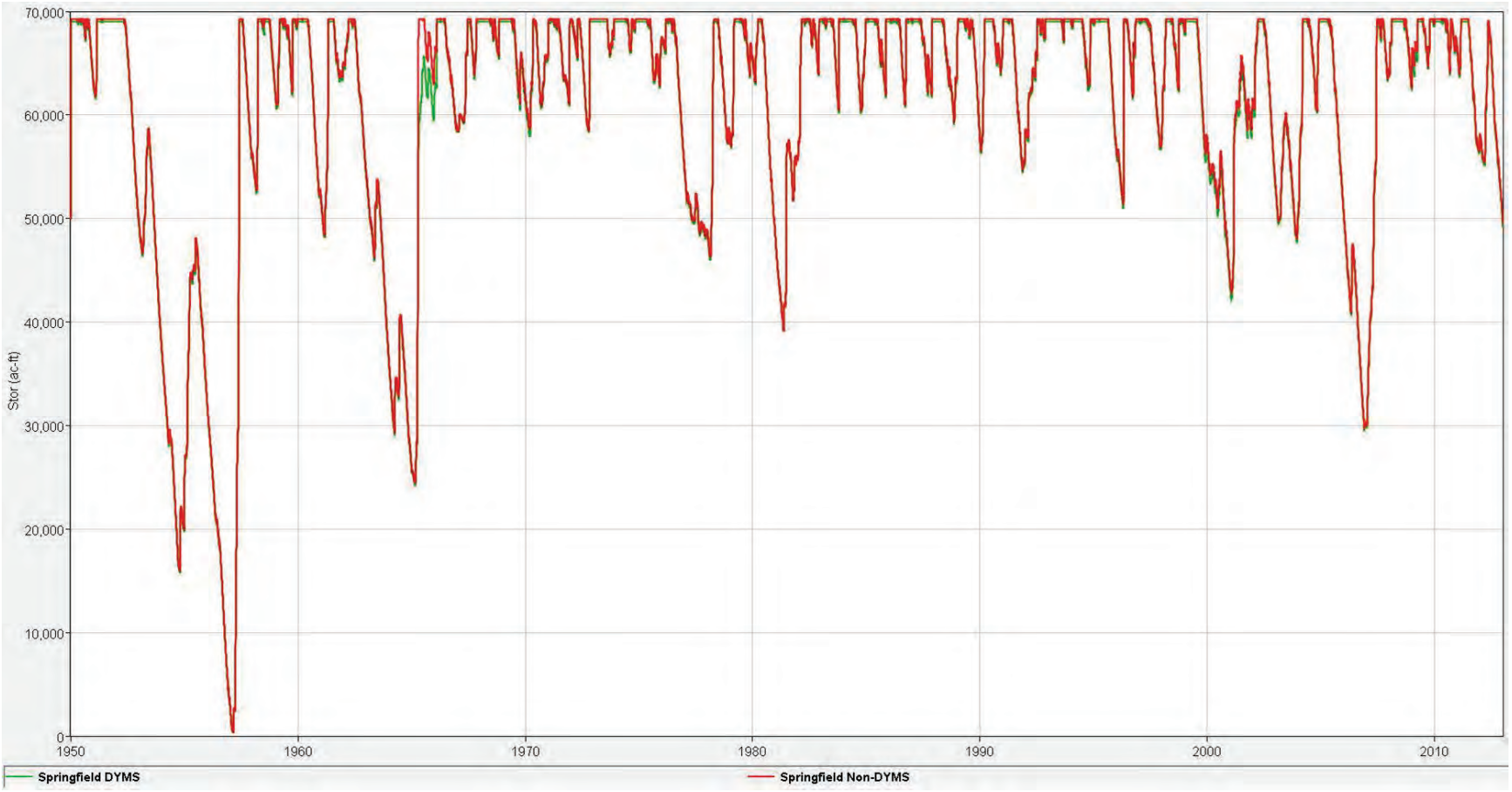


Figure 6-12. Comparison of City of Springfield storage required in traditional DYMS solution versus a non-DYMS (atypical) solution.

7.0 Conclusion

HEC-ResSim was used to evaluate the water supply firm yield of Stockton Lake for the Tri-State reallocation study. A thorough analysis was conducted in accordance with ECB 2019-13 and industry practices.

Two alternative means of satisfying water supply re-allocation for 39 MGD (60.3 cfs) are possible through the drought of record and 2% assurance, without significantly affecting flood control operations while also maintaining a working range of pool elevations for hydropower production above the minimum weir elevation of 845 ft NGVD 29. However, the pool raise incorporated into Alternative 7 is the preferred alternative as it mitigates the negative effects of drought, while benefitting other multi-purpose pool interests with little meaningful risk to flood control operations.

Stockton Lake Reallocation Study

Draft Integrated Water Supply Storage Reallocation Report and Environmental Assessment

Appendix D-Climate Change

June 2020

US Army Corps of Engineers ®
Kansas City District

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Qualitative Assessment of Climate Change Impacts: Stockton Lake Reallocation Study

1. Background

"USACE projects, programs, missions, and operations have generally proven to be robust enough to accommodate the range of natural climate variability over their operating life spans" (USACE, 2017). However, recent scientific evidence shows that in some places and for some impacts relevant to USACE operations, climate change is shifting the climatological baseline about which that natural climate variability occurs, and may be changing the range of that variability as well. This is relevant to the USACE because the assumptions of stationary climatic baselines and a fixed range of natural variability, as captured in the historic hydrologic record, may no longer be appropriate for long-term projections of flood risk (USACE, 2017).

Climate Change impacts on the hydrology of Stockton Lake and the Sac River Basin were considered in accordance to USACE Engineering Construction Bulletin (ECB) 2018-14, *Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs and Projects (USACE, 2018),* as well as USACE Engineering Technical Letter (ETL) 1100-2-3 *Guidance for Detection of Nonstationarities in Annual Maximum Discharges (USACE, 2017).*

Engineering Construction Bulletin (ECB) No. 2018-14 (USACE 2018), "Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects", dated 10 September 2018, and expiration 10 September 2020, provides guidance for incorporating climate change information in hydrologic analyses in accordance with the USACE overarching climate change adaptation policy. The ECB calls for a qualitative analysis. The goal of a qualitative analysis of potential climate threats and impacts to USACE hydrology-related projects and operations is to describe the observed present and possible future climate threats, vulnerabilities, and impacts of climate change specific to the study goals or engineering designs. As seen in Figure 1, qualitative analysis includes consideration of both past (observed) changes as well as potential future (projected) changes to relevant climatic and hydrologic variables.

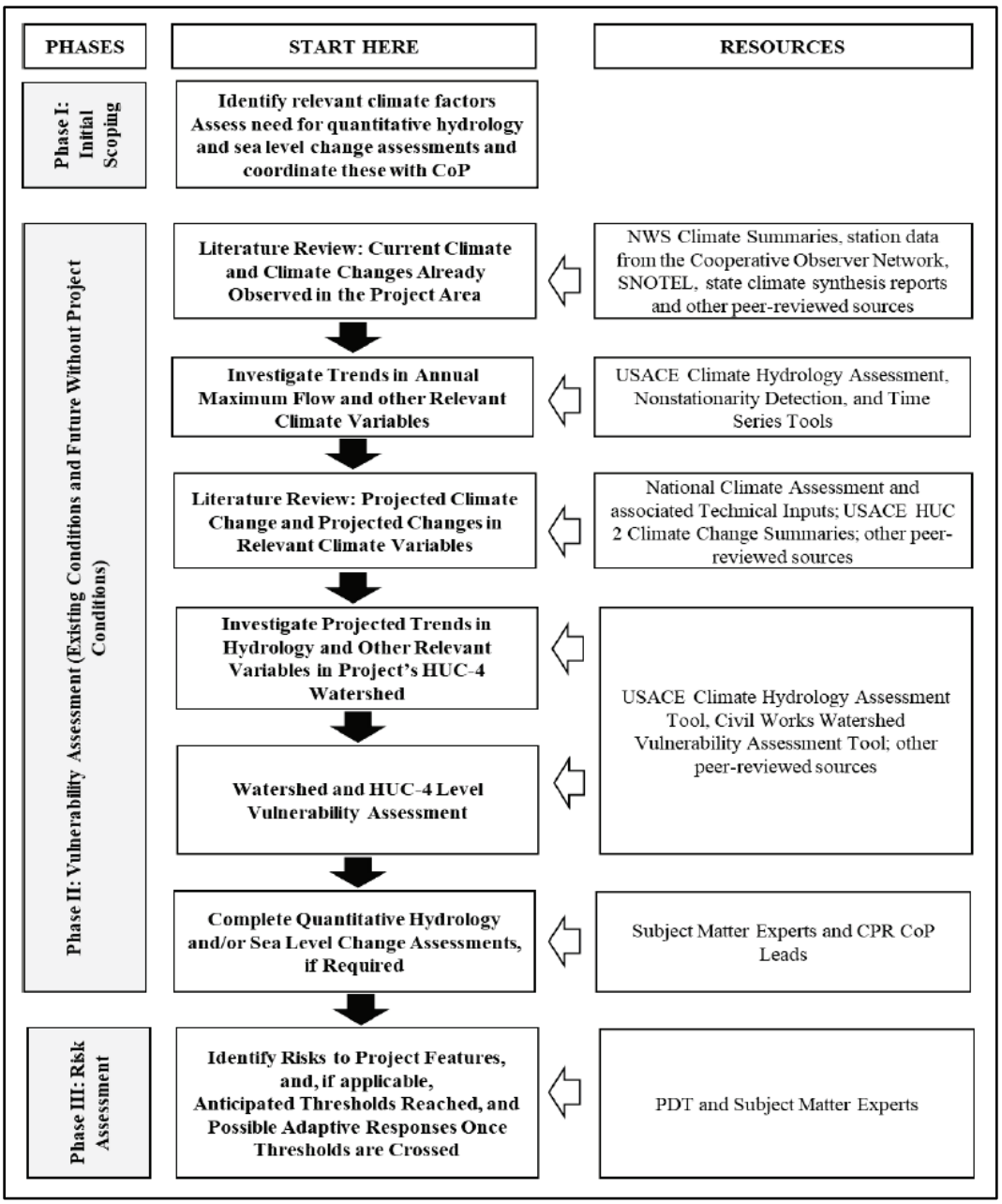


Figure 1. Incorporating Change Impacts to Inland Hydrologic Analysis (ECB 2018-14)

2. Existing Conditions

A brief analysis of existing conditions was conducted for the project area. The analysis included a literature review of current regional climate conditions, identification of relevant climate variables, and analysis of existing trends obtained from observed datasets.

2.1. Literature Review: Current Climate and Climate Changes Observed in the Project Area

A literature synopsis was generated to summarize published conclusion regarding both natural and anthropogenic climate trends in the Sac River Basin established from observed climate changes.

2.1.1. Recent US Climate Change and Hydrology Literature Applicable to US Army Corps of Engineers Missions (USACE, 2015)

This report is 1 of 21 regional climate syntheses prepared at the scale of 2-digit USGS Hydrologic Unit Codes (HUC) across the United States. The area covered by the Region 10 report is shown in Figure 2. The report for the Missouri River Region 10 summarized observed and projected climate trends.

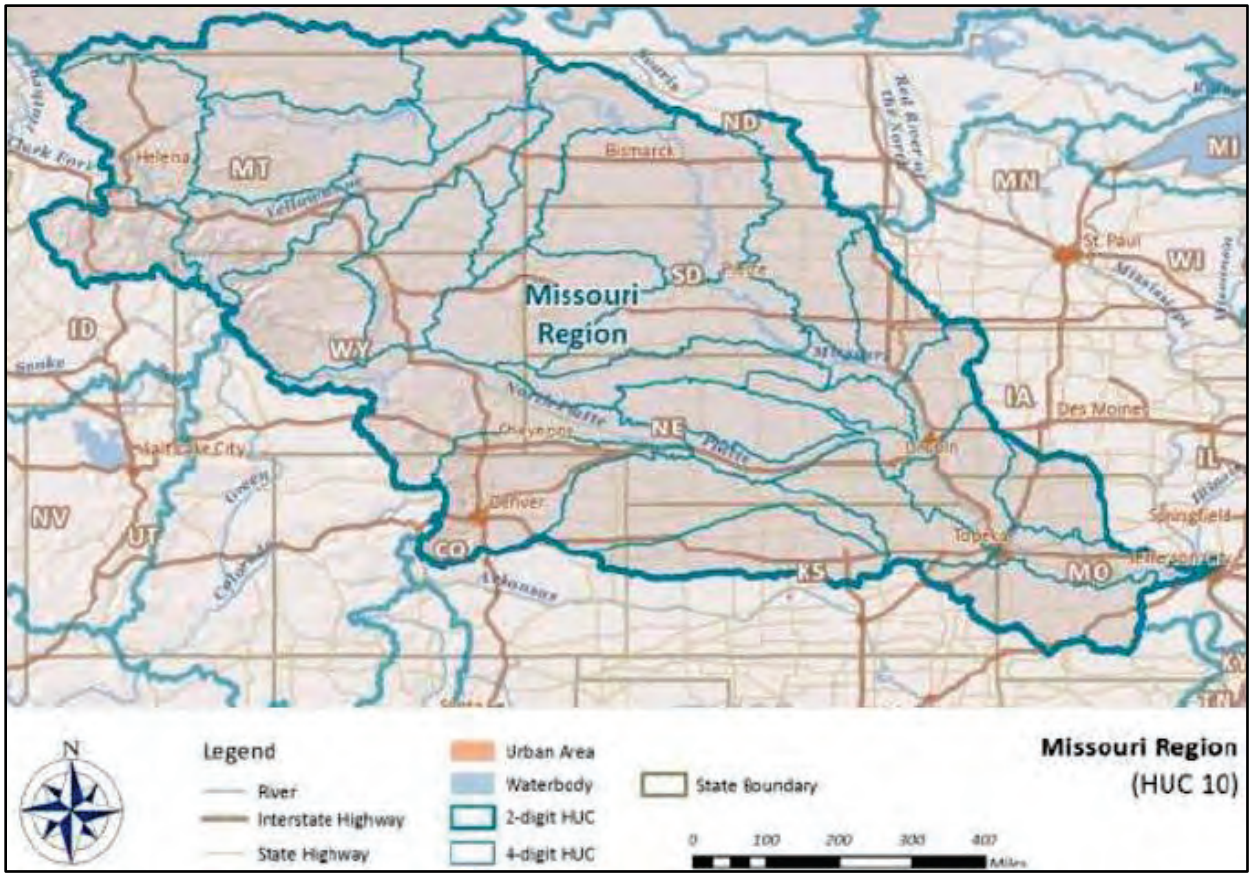


Figure 2: Water Resources Region 10: Missouri River Region Boundary

The general consensus in the literature pointed toward mild increases in average temperature and streamflow in the Missouri River Region over the past century. In some studies, and some locations, statistically significant trends were quantified. In other studies and locales within the region, apparent trends were merely observed graphically but not statistically quantified. There was a clear consensus that the growing season in the Missouri River Region is lengthening; however, there was little evidence of increased extreme temperature in the region. Spatial variability was observed in the literature review for

observed precipitation and precipitation extremes. The lower portion of the region generally showed increasing trends for both observed precipitation and precipitation extremes. There was some evidence of increased frequency in the occurrence of extreme storm events in the lower portion of the region.

2.1.2. USGS Flood Trends Report: Fragmented patterns of flood change across the United States (Archfield, 2016).

The USGS carried out an assessment of whether trends in flood magnitudes were consistent within geographic regions of the United States. Regional trends were assessed in the frequency, duration, peak magnitude, and volume of flood events by 400 km by 400 km grid cells (41 grid cells) across the United States. The study found that although changes in trends in the peak magnitude, frequency, duration, and volume of frequent floods were observed at specific locations throughout the continental U.S, there was not strong geographical cohesion between these site specific observations. The report also noted that within a given region, the changes for watersheds in close proximity can be very different from each other.

The results of this study indicated there are no notable regional trends in flood duration, flood volume, flood frequency, or peak magnitude within the region that encompasses Stockton Lake as shown in Figure 3. However, positive trends were present in the Missouri River Basin for peak magnitude (although not widespread), duration, and volume, while frequency displayed a negative trend.

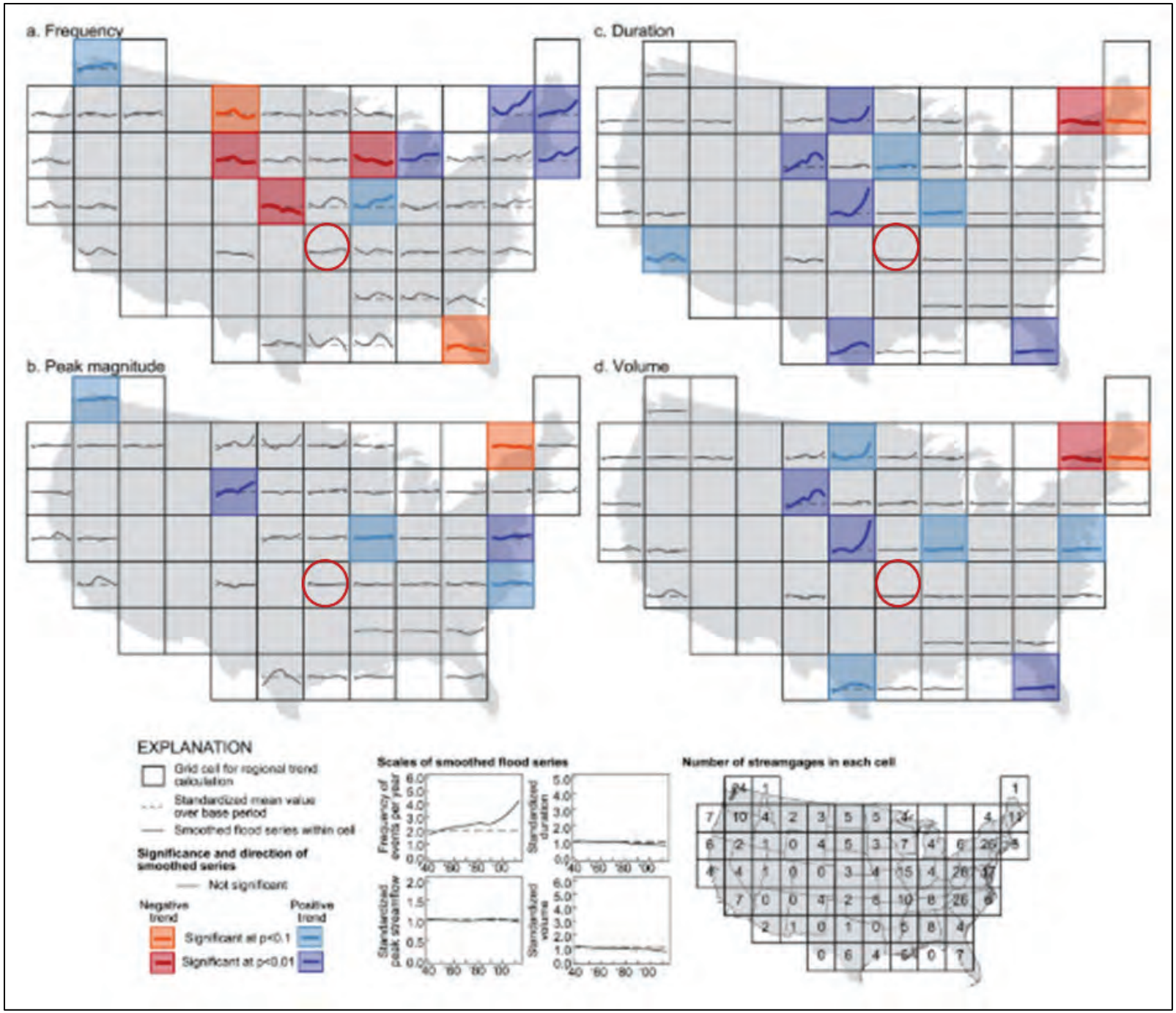


Figure 3. Regional changes in floods across the United States (1940-1969 vs 1970-2013)

2.1.3. Literature Review Summary

The strongest consensus amongst the literature supports the observed trend of increasing temperatures and precipitation in the basin. The literature is conflicted as to the trends associated with flood frequency and the occurrence of extreme storm events.

2.2. Identification of Relevant Climate Variables

The important hydrologic variables affecting the project include water surface elevation (stage) and discharge. Besides fluctuations in climate, stage can be influenced by long-term geomorphic change and gage relocation. Discharge can be influenced by changes in land-use, soil conservation practices, channel realignment, dams, levees, and measurement techniques. These factors can make it difficult to determine the role of climate change in affecting the hydrologic signal at the project scale. The relevant question to answer at the project scale is whether there has been, or will be, a change that affects conditions in the study area and how this change would impact the resilience of the proposed project. Pool elevation and discharges (inflows and outflows) were chosen as the primary hydrologic variables to analyze for this project. While streamflow is not necessarily the hydrologic variable of interest in this ecosystem project, streamflow can be used to indicate nonstationarities in the record, and therefore in the underlying hydrologic processes.

Relevant components of stream discharge include its magnitude, frequency, and duration, as well as the timing of particular discharges, and associated stages/pool elevations. Increased inflows can increase the amount of sediment deposited in the reservoir and decrease the total available storage. Additionally, increased magnitudes and durations contribute to increased water volumes that need to be stored or managed. Contrarily, decreased frequency and duration contribute to long, dry periods between significant rain events that increase the demand for water supply for agriculture and nearby municipalities.

2.3. Site Specific Analysis: Trends in Observed Streamflow Records

This portion of the climate change assessment focuses on carrying out first order statistical analysis using streamflow records observed at USGS gages referenced in Stockton Lake operations.

2.3.1. Nonstationarity and Trend Analyses

The project area, shown in Figure 4 below, is located within the Sac River Basin at Stockton Lake. Multiple USGS gages exist along the rivers upstream and downstream of the project location. Additional gages are located on tributaries which are not suited for this analysis due to short period of records and data gaps. Since the project site is largely influenced by flows from both the Sac and Little Sac rivers, two gages, one on each river, were selected for analysis. Additionally, the pool elevation period of record for Stockton Lake was used in the analysis since pool elevation directly impacts storage and water availability. The nearest downstream control point used for regulating reservoir discharges was also analyzed because the stage of the downstream control point limits reservoir releases. Table 1 summarizes all gages used in the analysis. All locations have a period of record larger than 30 years. Reservoir pool elevations and upstream gage periods of record span approximately 50 years.

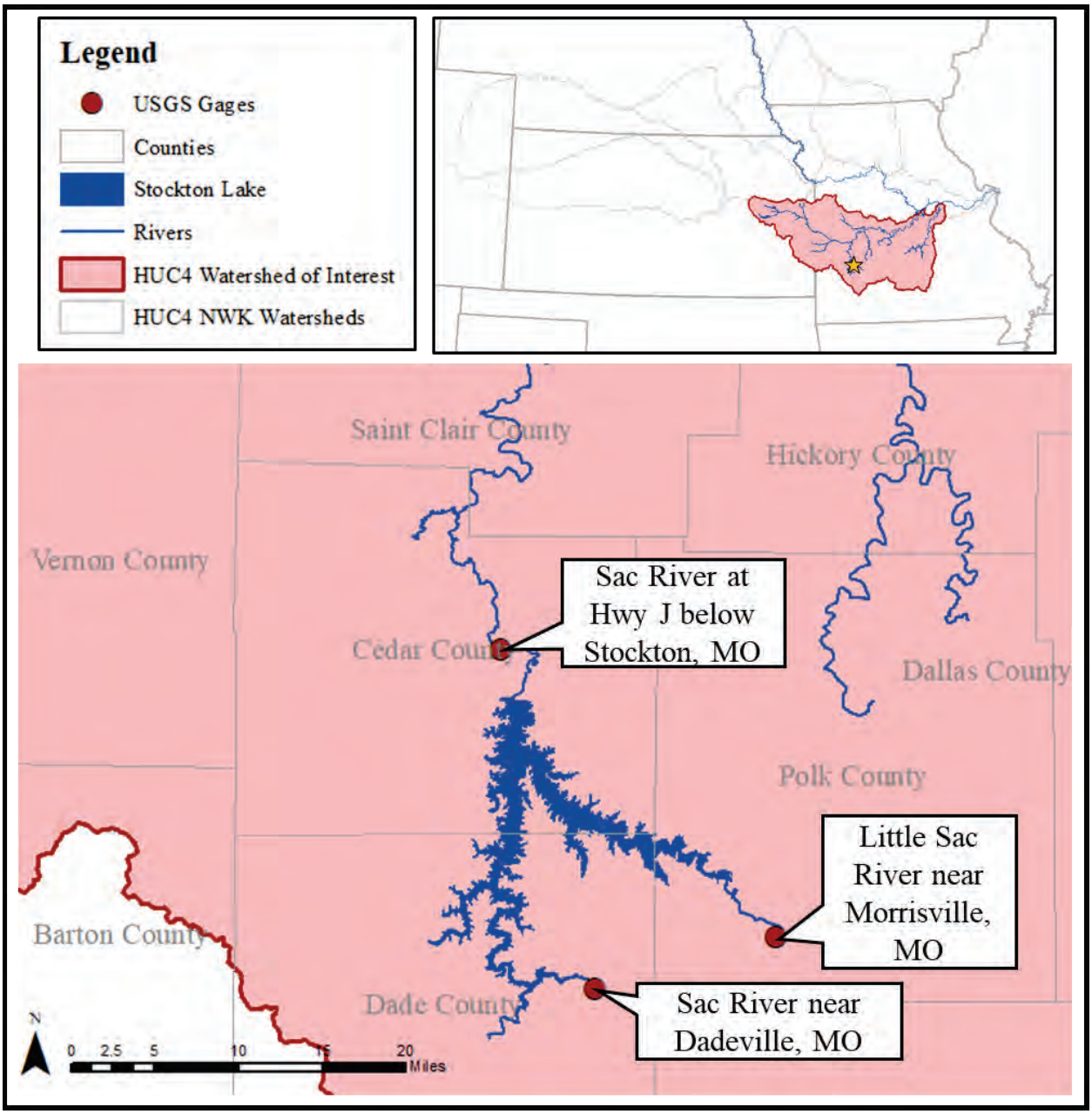


Figure 4. Location of the Project Area within the Kansas City District HUC-4 Watersheds

Table 1. Summary of USGS Gages used for Analysis

USGS Stream Gage	Period Of Record	Drainage Area (mi^2)	Remarks:
06918440 – Sac River near Dadeville, MO	1965-2018	257	1947 and 1960 peak flows and stages occurred prior to reservoir construction. Stockton top of multipurpose pool reached in 1971.
06918740 – Little Sac River near Morrisville, MO	1969-2018	237	All flows and stages occurred after the construction of the Stockton Lake.

USGS Stream Gage	Period Of Record	Drainage Area (mi^2)	Remarks:
06918990 – Stockton Lake near Stockton, MO	1969-2019	1,160	Gage record contains pool elevations based on NGVD29. USGS records available from 1988-2019. Additional data available from Kansas City District (NWK) Water Management pool elevation records. Intentional storage began December 1969 and top of multipurpose pool (867 ft-NGVD29) was reached December 1971.
06919020 – Sac River at Hwy J below Stockton, MO	1974-2018	1,292	Gage location is used as a downstream control point for reservoir releases. Entire period of record is influenced by upstream regulation from Stockton Lake.

The USACE Nonstationarity Detection Tool (NDT) was applied to determine if flows upstream and downstream of the project location and reservoir pool elevations were representative of homogenous (stationary) hydroclimatic conditions. The statistical methods applied by the NDT were applied to water year peak streamflow and pool elevation datasets. The stationarity of the flow and pool elevation records used for Stockton Lake were assessed by applying a series of statistical tests to the observed records at four long-term gage sites on the Sac and Little Sac Rivers. Other gage sites near the project area were not assessed due to data gaps and/or short period of recorded data. Statistical methods abbreviations are provided in Table 2.

Table 2. Statistical Method Abbreviations applied in the Nonstationarity Analyses

Abbreviation	Statistical Method	Abbreviation	Statistical Method
CVM	Cramer-von-Mises	BAY	Bayesian Change Point
KS	Kolmogorov-Smirnov	LM	Lombard Mood
LW	Lombard Wilcoxon	MD	Mood
PT	Pettitt	SLM	Smooth Lombard Mood
MW	Mann-Whitney	SLW	Smooth Lombard Wilcoxon

2.3.1.1. USGS Gage 06918990 Stockton Lake

Initially, the observed, USGS and NWK water management recorded pool elevations were analyzed to identify observed climate change impacts. Then, time periods were refined as needed, for example to show the impacts of upstream regulation. Using the NDT and the adopted default sensitivity parameters (see Table 3), a series of twelve statistical tests were applied to assess the stationarity of the flow record for the USGS gage 06918990, located on Stockton Lake near Stockton, MO. The Stockton Lake gage has a continuous period of record from 1969 to the present year (2019) when USGS and NWK water management data are combined. Initially, both the USGS and NWK data were combined in the Hydrologic Engineering Center Data Storage System Visual Utility Engine (HEC-DSSVue) to create a single, combined record to match the specified period of record for Stockton Lake. NWK data received higher priority and overwrote USGS data when overlapping dates were present. The Time Series Toolbox was then used to import the combined record for use with the web-based tools. The web-based NDT, without using the Time Series Toolbox, would not import data for the Stockton Lake gage. The period of record from 1971 to 2019 was analyzed since multipurpose pool was not reached until December of 1971, resulting in a period of record of 48 years.

Table 3. Default, Minimum, and Maximum Nonstationarity Detection Tool Sensitivity Parameters

Sensitivity Parameters	Default	Min	Max
CPM Methods Burn-In Period	20	5	50
CPM Methods Sensitivity	1,000	500	10,000
Bayesian Posterior Threshold/Sensitivity	0.5	0	1
Energy Divisive Method Sensitivity	0.5	0.1	0.9
Pettitt Sensitivity	0.05	0.01	0.15
Bayesian Prior Likelihood	0.2	0.05	0.95
Lombard Smooth Methods Sensitivity	0.05	0.01	0.15

As can be seen in Figure 5 on the following page, nonstationarities were not detected when the default settings were used. Further investigation was performed on the sensitivity parameters to ensure that slight adjustments to the parameters did not detect additional nonstationarities. Each parameter was adjusted individually while the others remained at the default values. Adjusting the CPM Burn-In Period, CPM Methods Sensitivity, Energy Divisive Method Sensitivity, Pettitt Sensitivity, and Lombard Smooth Methods Sensitivity parameters to the minimum and maximum values produced the same results. When the Bayesian Posterior Threshold was adjusted to 0.34, the Bayesian Change Point method detected a nonstationarity at 1972 as seen in Figure 6. Additionally, adjusting the Bayesian Prior Likelihood to 0.45 produced nonstationarities in 1972. Both nonstationarities occurred shortly after the multipurpose pool was reached. The relative strength of a detected nonstationarity can be determined by looking at the level of consensus between different methods targeted at detecting the same type of nonstationarities (variance/standard deviation, mean, or overall distribution) in a flow data series. Only one method identified the previously mentioned nonstationarities with the adjusted parameters, indicating that there is no consensus between the different methods and, as a result, there are no operationally significant nonstationarities in the pool elevation record at this site (White, 2016).

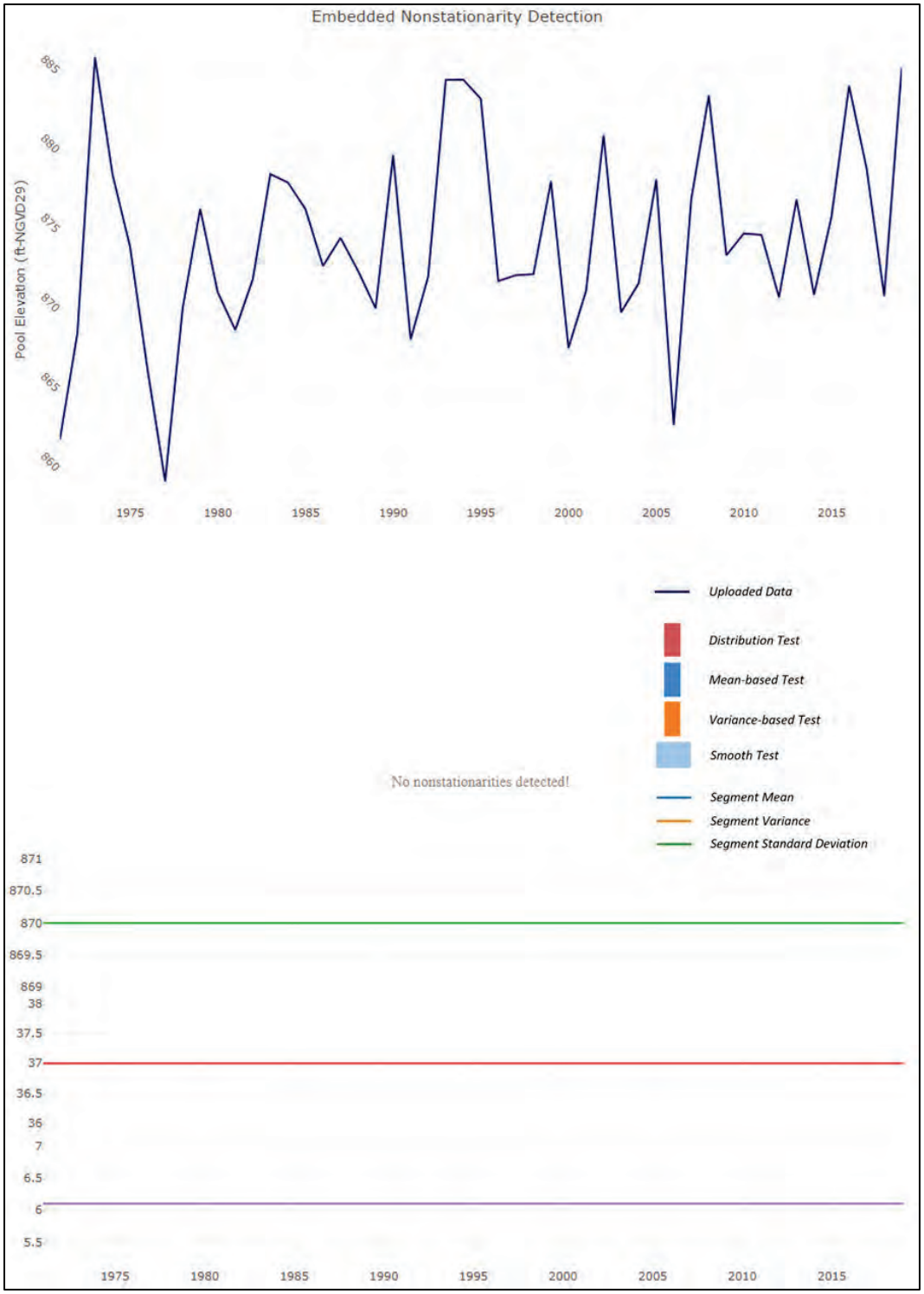


Figure 5. Time Series Toolbox Nonstationarity Detection Analysis of Maximum Daily Annual Pool Elevation, USGS Gage 06918990 – Stockton Lake near Stockton, MO 1971 to 2019 using Default Sensitivity Values

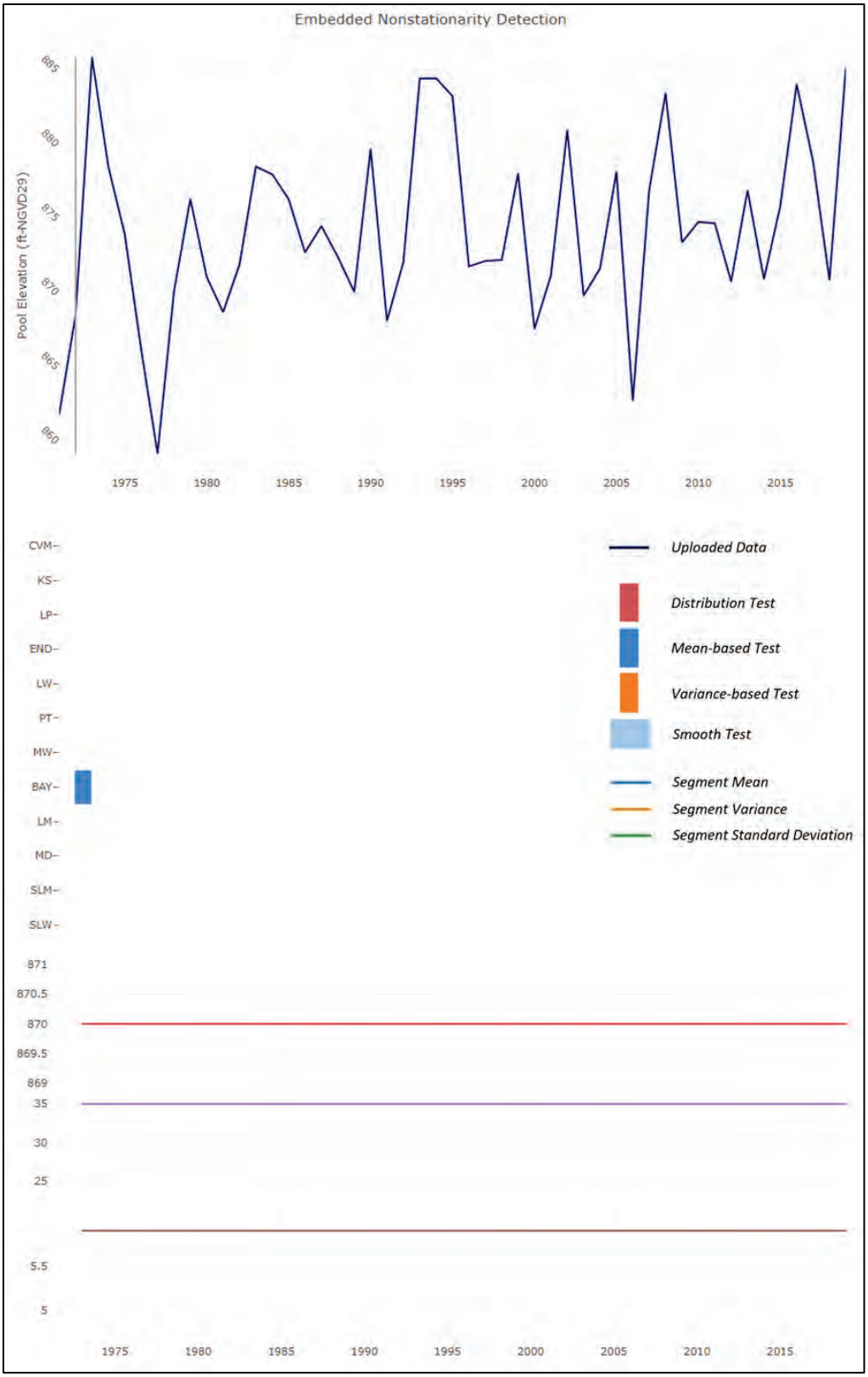


Figure 6. Time Series Toolbox Nonstationarity Detection Analysis of Maximum Annual Daily Pool Elevation, 06918990 – Stockton Lake near Stockton, MO 1971 to 2019, Bayesian Posterior Threshold adjusted to 0.34.

In addition to testing for stationarity, a monotonic trend analysis was carried out using the Mann-Kendall Test and the Spearman Rank Order Test (α =0.05 generally accepted level of significance). The period of record from 1971 to 2019 was analyzed. Although the tests identified an increasing pool elevation trend for 1971 to 2019, the trends are not statistically significant as seen in Figure 7. The computed p values for the t-test, Mann-Kendall, and Spearman Rank-Order were 0.076, 0.117, and 0.113, respectively. Since no statistically significant trends were detected in the observed pool elevation record, pool elevations at Stockton Lake can be analyzed using the assumption of stationarity for the period from 1971 to 2019.

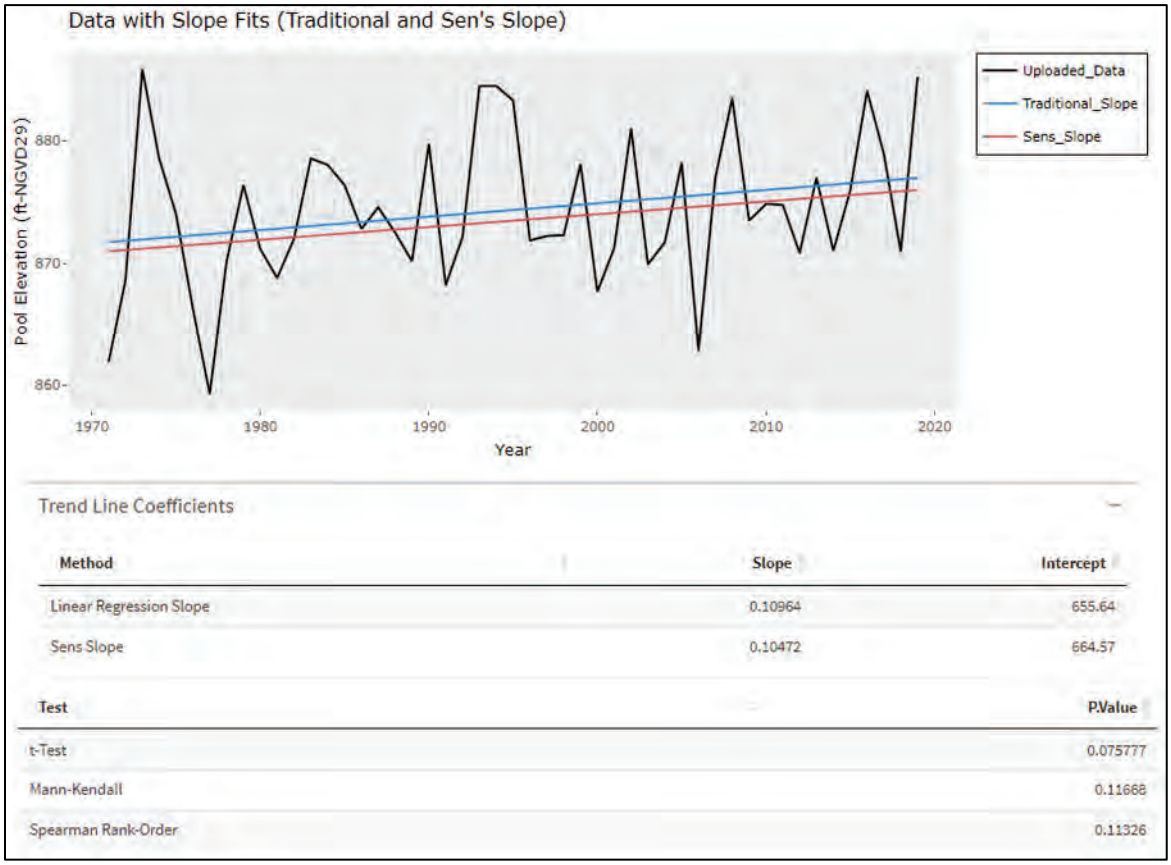


Figure 7. Time Series Toolbox Monotonic Trend Analysis of Peak Annual Pool Elevation at Stockton Lake, USGS Gage 06918990 record from 1971 to 2019

2.3.1.2. USGS Gage 06918440 Sac River near Dadeville, MO

The USGS Gage 06918440 is one of three inflow gages used to monitor inflows into Stockton Lake. The NDT was applied to the period of record from 1965 to 2015 using default sensitivity parameters. The gage has a continuous period of record of 1965 to 2019. The 50-year period of record from 1965 to 2015 was analyzed because the standard NDT imported data directly from USGS through 2015. As seen in Figure 8, several nonstationarities were identified in 1984 when the default sensitivity parameters were used. The CVM, KS, LePage, and MW methods all identified a nonstationarity in 1984 with a segment mean increase from 3,900 cfs to 7,800 cfs. Further investigation was performed on the sensitivity parameters to ensure that slight adjustments to the parameters did not produce additional nonstationarities. Each parameter was adjusted individually while the others remained at the default values. When the CPM Methods Burn-In Period parameter was adjusted to the minimum value, an additional nonstationarity in 1983 was detected by the LM method and when adjusted to 40, all nonstationarities disappeared. A burn-in period of 40 is not recommended to be used on the 50-year period of record because it includes 80% of the dataset. Adjusting the CPM Methods Sensitivity to the minimum value did not change the results;

however, as the parameter was increased to 7,000, the MY nonstationarity disappeared. All nonstationarities were removed when the parameter was adjusted to 30,000.

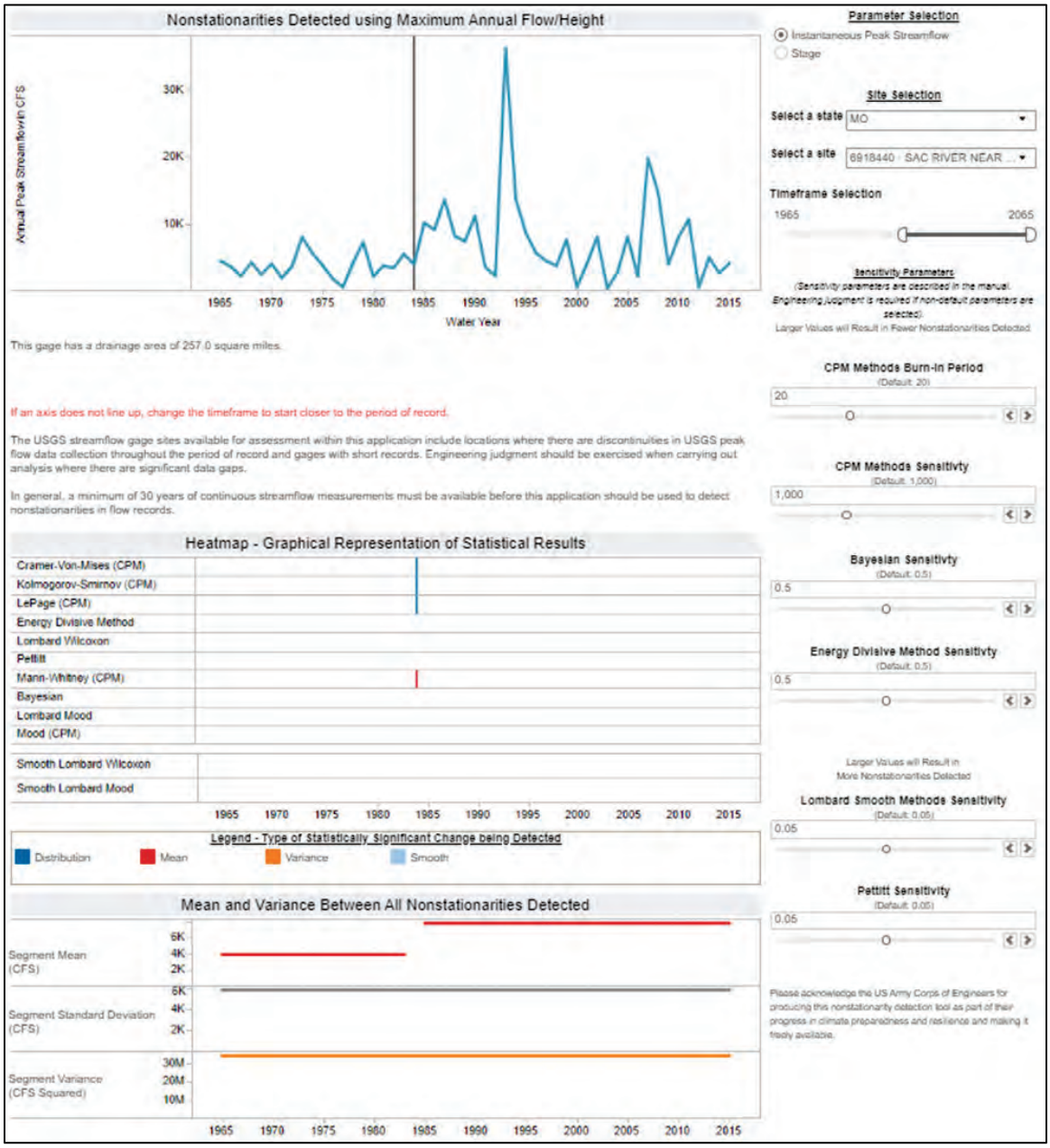


Figure 8. Nonstationarity Detection Analysis of Maximum Annual Flows, USGS Gage 06918440 – Sac River near Dadeville, MO from 1965 to 2015 using Default Sensitivity Values

The time period used for analysis was also adjusted to determine if the construction of the reservoir contributed to the nonstationarity detection. When the period of record was adjusted from 1965 to 1972 (corresponding to the water year that multipurpose pool was initially reached) and default parameters were used, zero nonstationarities were detected (Figure 10). The same holds true even when the sensitivity parameters were adjusted to the minimum and maximum values with the exception of the CPM Methods Sensitivity parameter. An additional nonstationarity was detected in 1984 with the KS method when the CPM Sensitivity parameter was adjusted from 1,000 to 600. Only one method identified the previously mentioned nonstationarities with the adjusted parameters, indicating that there is no consensus

between the different methods and, as a result, there are no operationally significant nonstationarities in the streamflow record from 1972 to 2015 at this site (White, 2016). After review of possible changes in the contributing watershed, no significant changes in land use or implementation of soil conservation practices were noted that would increase the average discharge. However, southwest Missouri experienced an extended dry period in the 1950's through 1970's followed by a wetter period in the 1980's, as seen in Figure 9. Figure 9, taken from Pat Guinan's 2012 Southwest Missouri Weather and Climate Summary, displays the annual average precipitation for Southwest Missouri from 1895 to 2011. Given that the gage period of record starts in the drier period, the initial trend identified by the data may be biased towards lower flows. As such, analysis of the full period of record may be influenced by the prolonged drought identifying a false nonstationarity in 1983. The nonstationarity identified an increase of approximately 4,000 cfs in the average discharge. The Sac River gage near Dadeville, MO may be analyzed using the assumption of stationarity for the reduced period of record of 1972 to 2015. However, reducing the period of record will result in an increase in uncertainty in the study, but the natural variability in the data should still be captured in the 43-year period of reduced data.

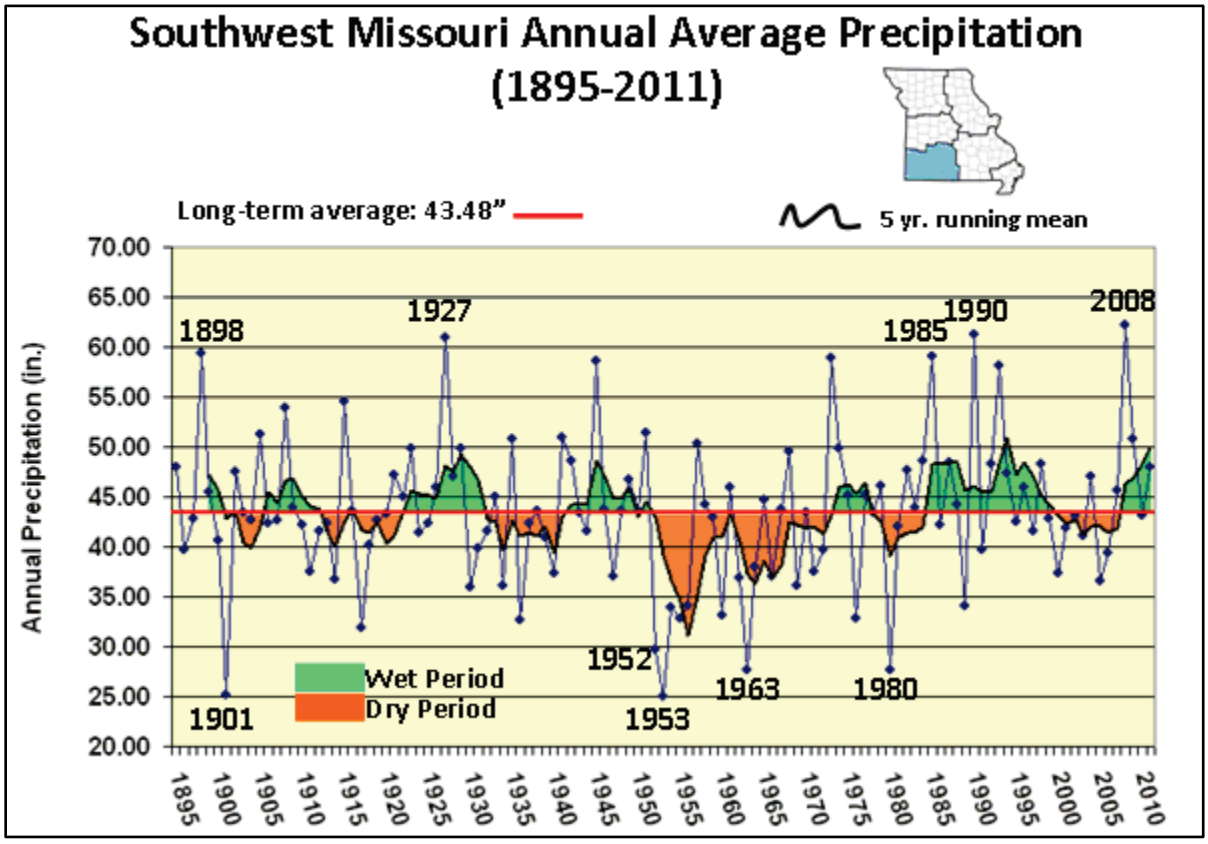


Figure 9. Annual Average Precipiation for Southwest Missouri from 1895 to 2011 (Guinan, 2012)

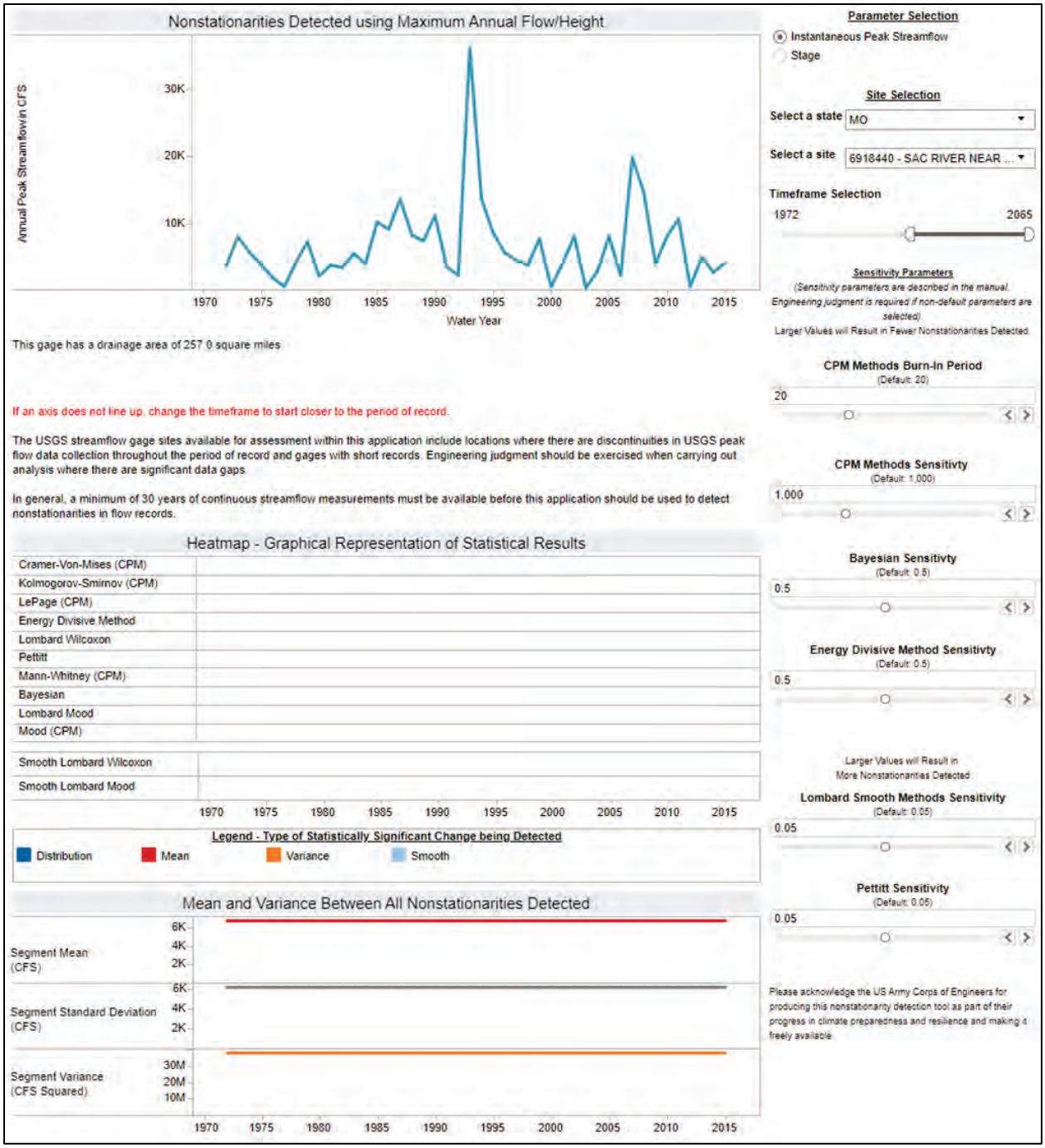


Figure 10. Nonstationarity Detection Analysis of Maximum Annual Flows, USGS Gage 06918440 – Sac River near Dadeville, MO from 1972 to 2015 using Default Sensitivity Values

A monotonic trend analysis was also performed using the Mann-Kendall Test and the Spearman Rank Order Test for both the 1965-2015 and 1972-2015 periods. Both tests did not identify a statistically significant trend for the 1965-2015 or 1972-2015 periods as the p-values for each test (0.208 and 0.203 for 1965-2015, 0.656 and Null for 1972-2015) were larger than the 0.05 generally accepted level of significance. Figure 11 displays the p-values and linear regression parameters for 1965-2015 and Figure 12 displays the p-values for 1972-2015. Since no statistically significant trends were detected in the

annual maximum flow record, Sac River flows near Dadeville, MO can be analyzed using the assumption of stationarity for the period from 1972 through 2015.

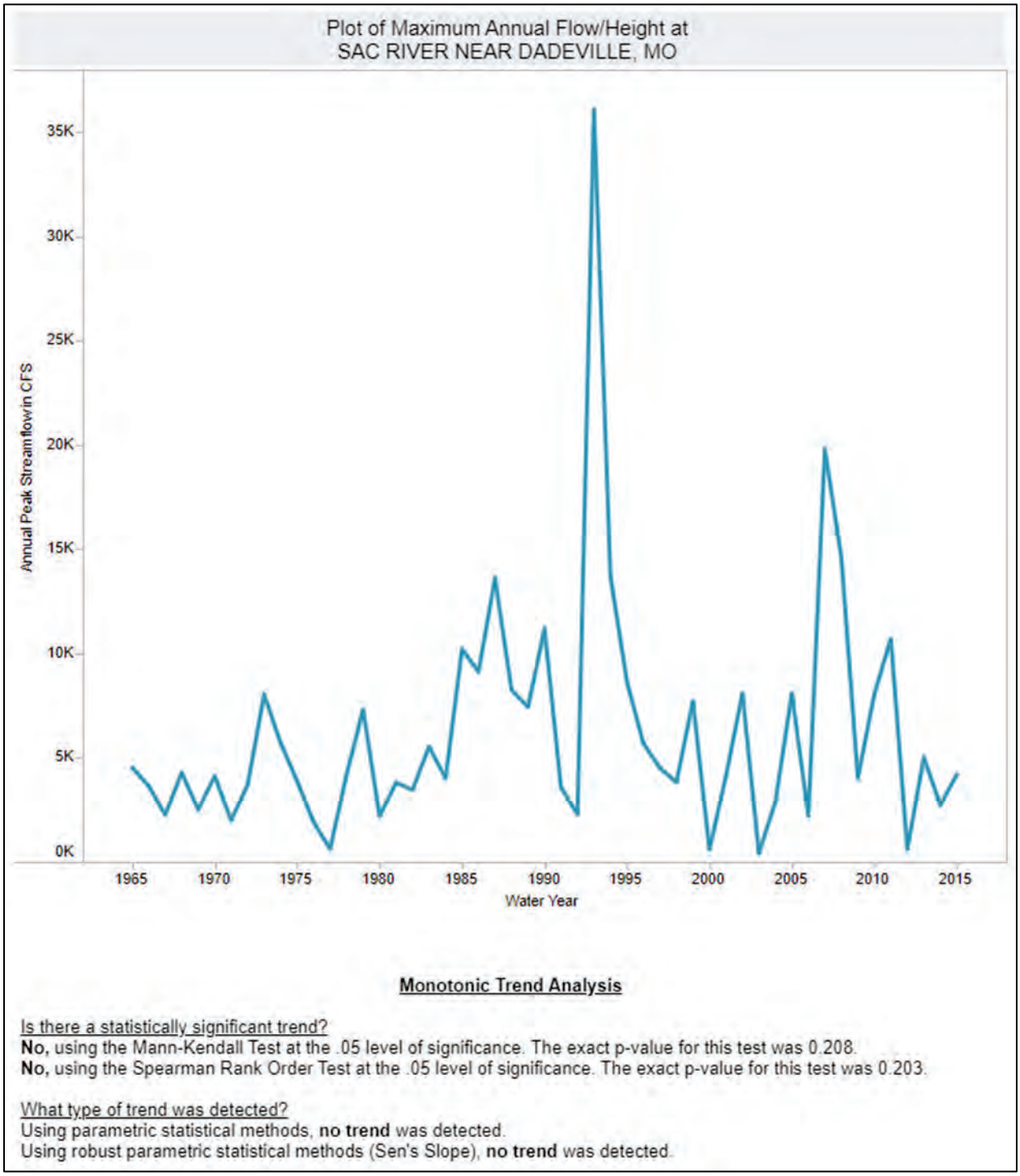
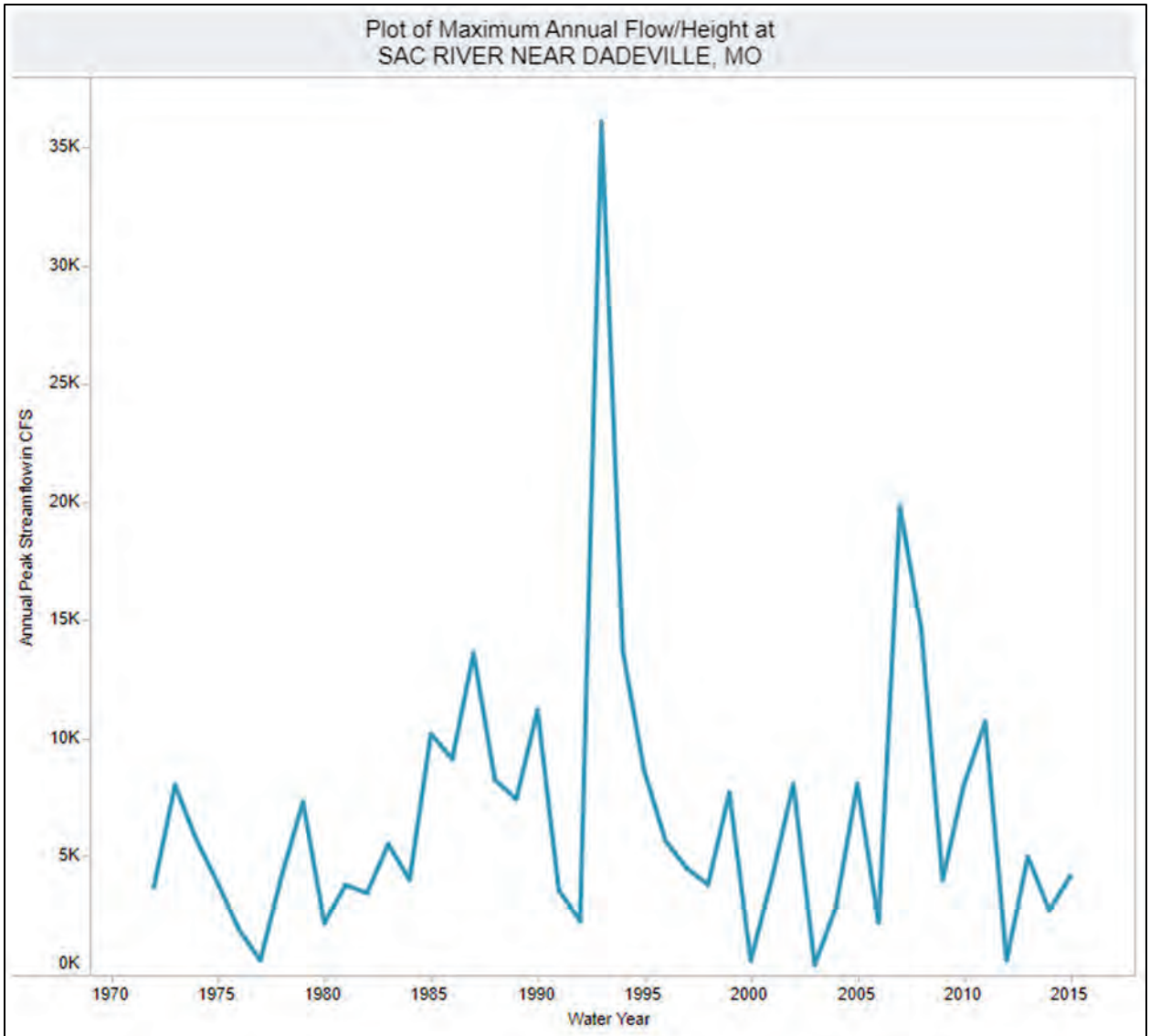


Figure 11. Monotonic Trend Analysis of Maximum Annual Flows, USGS Gage 06918440 – Sac River near Dadeville, MO from 1965 to 2015.



Monotonic Trend Analysis

Is there a statistically significant trend?
No, using the Mann-Kendall Test at the .05 level of significance. The exact p-value for this test was 0.656.
No, using the Spearman Rank Order Test at the .05 level of significance. The exact p-value for this test was Null.

What type of trend was detected?
Using parametric statistical methods, **no trend** was detected.
Using robust parametric statistical methods (Sen's Slope), **no trend** was detected.

Figure 12. Monotonic Trend Analysis of Maximum Annual Flows, USGS Gage 06918440 – Sac River near Dadeville, MO from 1972 to 2015.

2.3.1.3. USGS Gage 06918740 Little Sac River near Morrisville, MO

The USGS Gage 06918740 is one of three inflow gages used to monitor inflows into Stockton Lake. The NDT was applied to the period of record from 1969 to 2015 using default sensitivity parameters. The gage has a continuous period of record from 1969 to 2019. The period of record from 1969 to 2015 was

analyzed because the standard NDT imported data directly from USGS until 2015. As seen in Figure 7, nonstationarities were not identified when the default sensitivity parameters were used. Further investigation was performed on the sensitivity parameters to ensure that slight adjustments to the parameters did not produce additional nonstationarities. Each parameter was adjusted individually while the others remained at the default values. Even when adjusted to minimum and maximum values, zero nonstationarities were detected indicating that the period of record can be evaluated as a stationary time series.

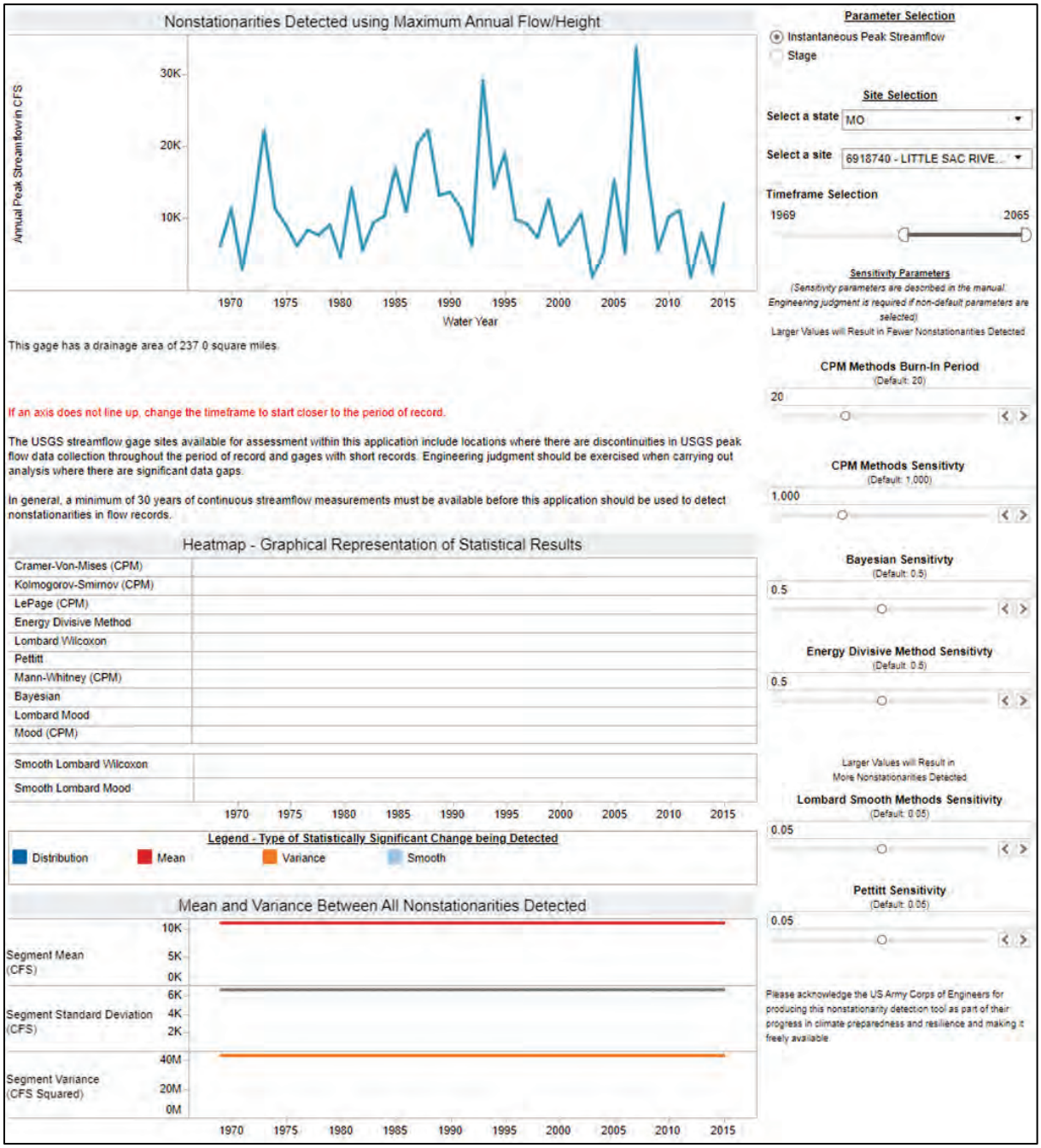


Figure 13. Nonstationarity Detection Analysis of Regulated Maximum Annual Flow, USGS Gage 06918740 – Little Sac River near Morrisville, MO from 1969 to 2015 using Default Sensitivity Values

A monotonic trend analysis was also performed using the Mann-Kendall Test and the Spearman Rank Order Test. Both tests did not identify a statistically significant trend as the p-values for each test were significantly larger than the 0.05 generally accepted level of significance. Figure 14 displays the p-values and linear regression parameters. Since no statistically significant trends were detected in the annual maximum flow record and the nonstationarity identified showed no agreement or robustness between the different methods, Little Sac River flows near Morrisville, MO can be analyzed using the assumption of stationarity for the period from 1969 through 2015.

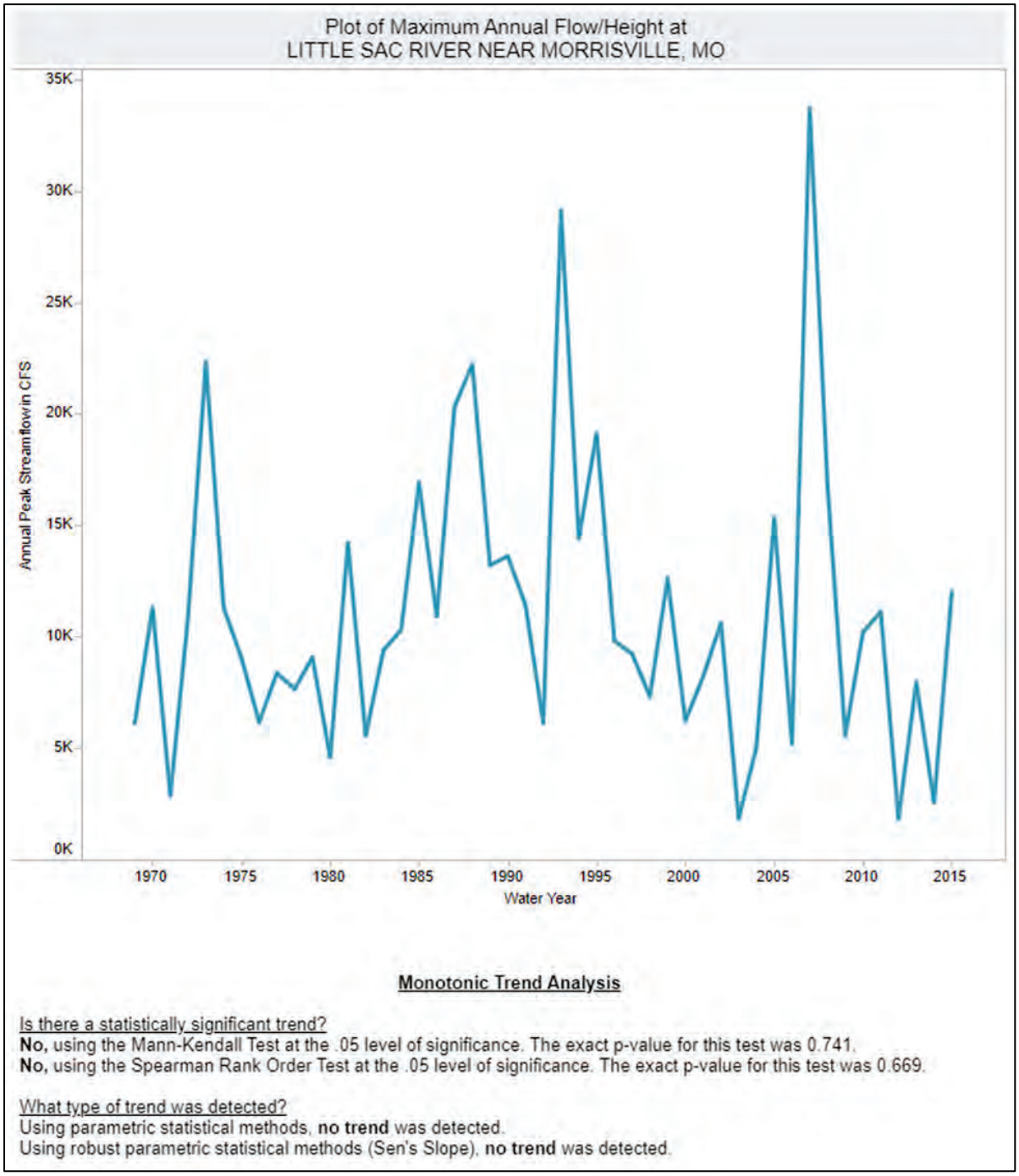


Figure 14. Monotonic Trend Analysis of Peak Annual Discharge at the Little Sac River near Morrisville, MO USGS Gage 06918740 from 1969 to 2015.

2.3.1.4. USGS Gage 06919020 Sac River at Hwy J below Stockton, MO

The observed USGS recorded flows were analyzed to identify observed climate change impacts. The NDT and the adopted default sensitivity parameters were used to assess the stationarity of the flow record for the USGS gage 06919020, located on the Sac River near Stockton, MO. The gage is located downstream of Stockton Lake and is used as a downstream control point for reservoir releases. The available period of record is influenced by upstream regulation from Stockton Lake. The gage has a continuous period of record of 1974 to 2019. The web-based NDT, without using the Time Series Toolbox, imports data from USGS up until 2015 for the Sac River near Stockton, MO gage. As can be seen in Figure 15, nonstationarities were not detected when the default sensitivity parameters were used. Further investigation was performed on the sensitivity parameters to ensure that slight adjustments to the parameters did not produce additional nonstationarities. Each parameter was adjusted individually while the others remained at the default values. Nonstationarities were detected in 1983 with the LW method and 1984 with the PT method when the CPM Burn-In Period was adjusted to 5 (the minimum value) and when the Pettitt Sensitivity parameter was adjusted to 0.1 (the maximum value), respectively. During each of these scenarios, only one method detected a nonstationarity meaning that there was no agreement or robustness between the different methods. With this consideration, nonstationarities were not identified indicating that there is not an operationally significant nonstationarity in the flow record at this site (White, 2016).

In addition to testing for stationarity, a monotonic trend analysis was carried out using the Mann-Kendall Test and the Spearman Rank Order Test (α =.05 level of significance). The entire period of record from 1974 to 2015 was analyzed and produced p-values of 0.119 and 0.099 for the Mann-Kendall Test and Spearman Rank Order Test, respectively. The computed p-values and monotonic trend analysis are provided in Figure 16. Since no statistically significant trends were detected in the observed streamflow period of record and the nonstationarity analysis results were not robust, flows at the Sac River gage near Stockton, MO can be analyzed using the assumption of stationarity for the period selected.

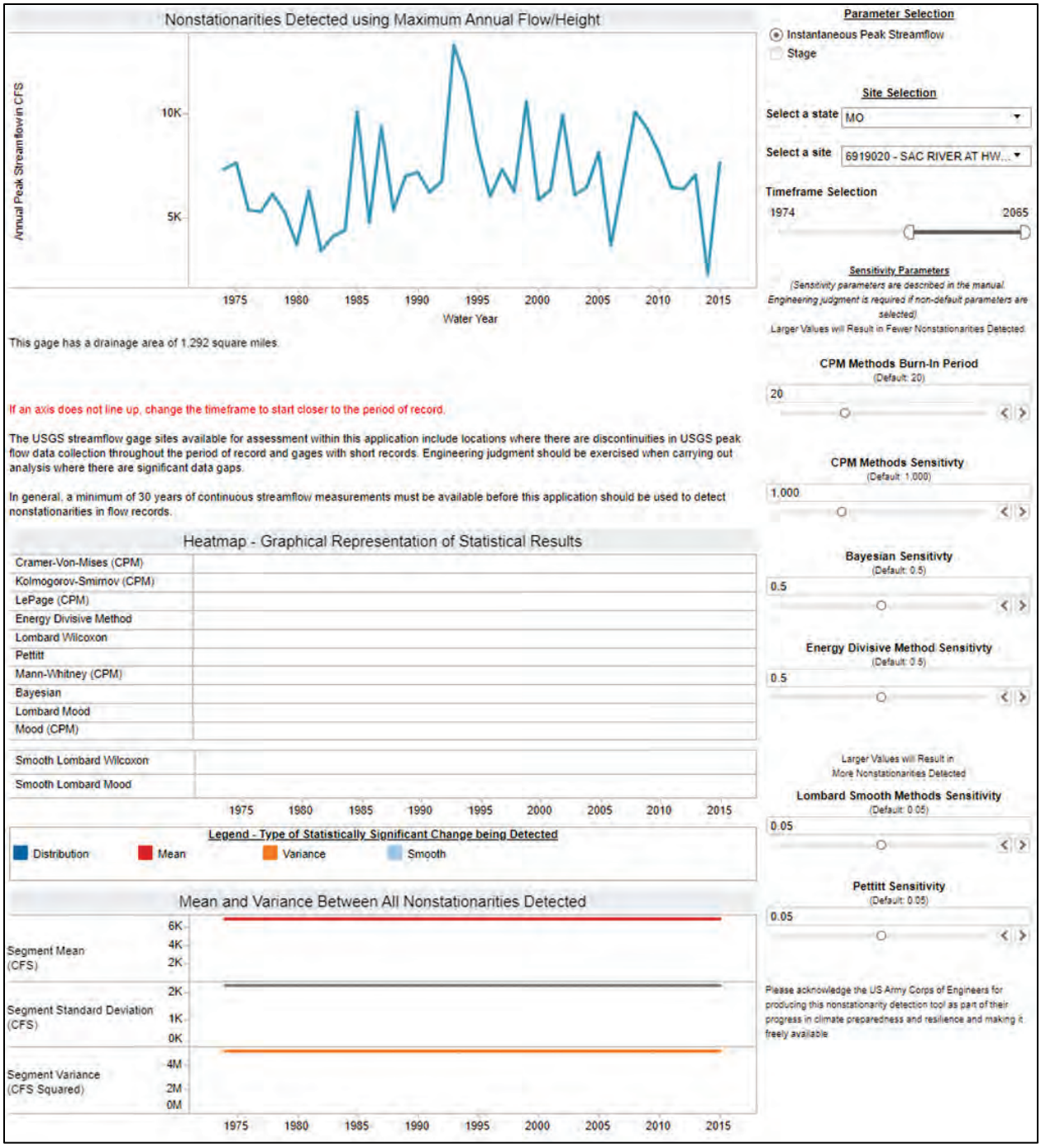
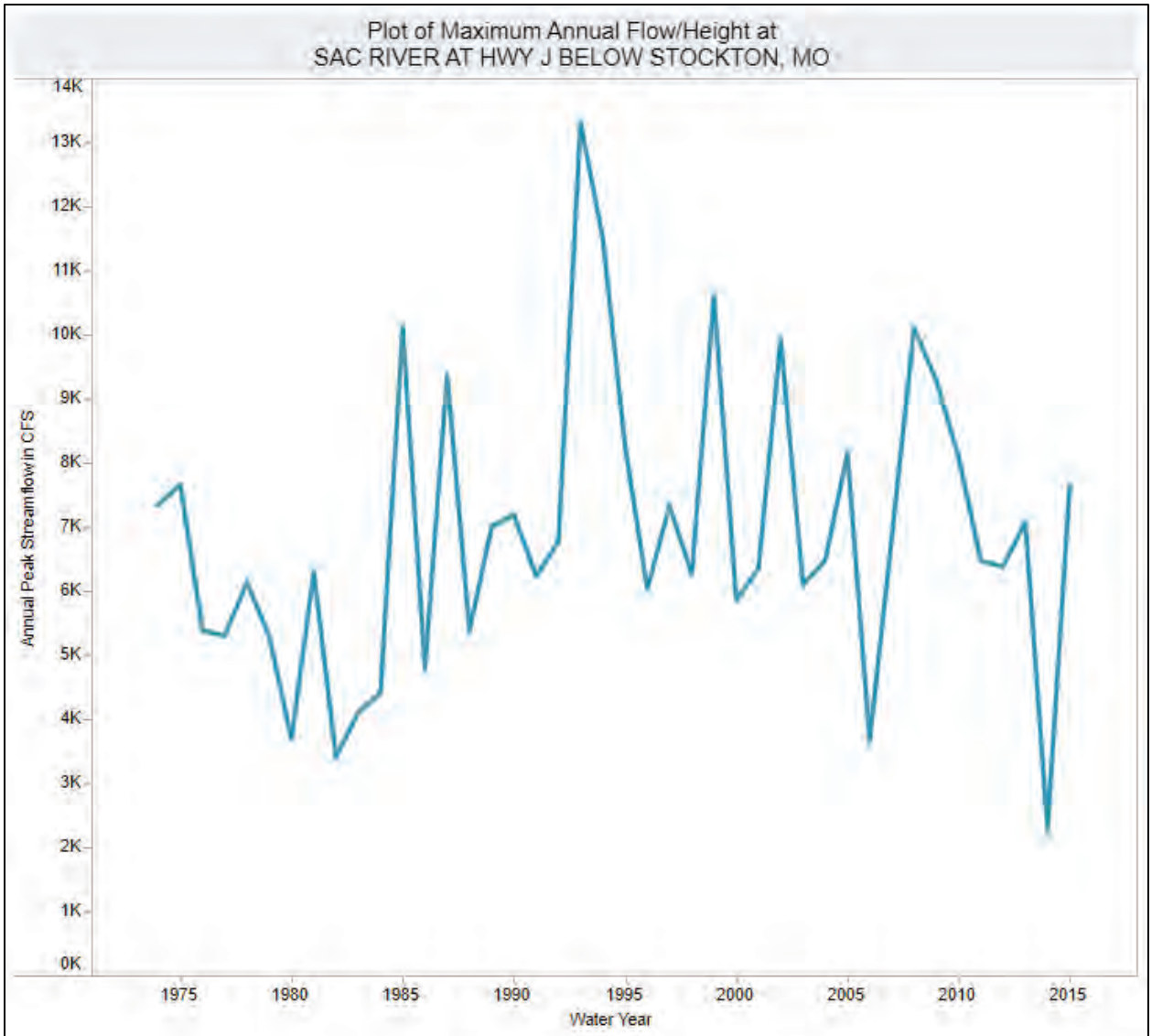


Figure 15. Nonstationarity Analysis of Maximum Annual Flow, USGS Gage 06919020 – Sac River at Hwy J below Stockton, MO from 1974 to 2015 using Default Sensitivity Values



Monotonic Trend Analysis

Is there a statistically significant trend?
No, using the Mann-Kendall Test at the .05 level of significance. The exact p-value for this test was 0.119.
No, using the Spearman Rank Order Test at the .05 level of significance. The exact p-value for this test was 0.099.

What type of trend was detected?
Using parametric statistical methods, **no trend** was detected.
Using robust parametric statistical methods (Sen's Slope), **no trend** was detected.

Figure 16. Monotonic Trend Analysis of Peak Annual Discharge at the Sac River at Hwy J below Stockton, MO USGS Gage (Gage Number 06919020) from 1974 to 2015.

2.3.2. Climate Hydrology Assessment using Observed Data

In addition to applying the statistical tests for nonstationarity, the Climate Hydrology Assessment Tool (CHAT) was used to apply a linear regression to the annual maximum daily discharges and pool elevations reported at the gages on the Sac River near Dadeville, Little Sac River near Morrisville, and

the Sac River at Hwy J below Stockton, MO. The CHAT currently does not have capabilities to analyze user input data. As a result, the Stockton Lake pool elevations could not be analyzed using the same tool; however, a linear regression trendline was fit to the Time Series Toolbox trend analysis results displayed in Figure 7. A quick check of the Little Sac River near Morrisville, MO confirmed that the trendline computed in the Time Series Toolbox is the same as the trendline computed in the (CHAT), and the p-value is the same p-value obtained with the t-test. Figure 17 through Figure 20 display the regression results performed for the Sac River and Little Sac River gages. The results of the regression analysis for all gages are summarized in Table 4.

P-values significantly greater than the generally accepted threshold for significance ($\alpha = 0.05$) indicates that the trend line does not have a statistically significant slope at the 95% level of confidence and thus no changes in mean annual peak flows are evident for the analysis period. A low p-value (less than the accepted threshold for significance of 0.05) would be indicative of a statistically significant increasing or decreasing trend in flow peaks. All gages assessed using the CHAT resulted in p-values larger than 0.05 indicating that there is no significant trend.

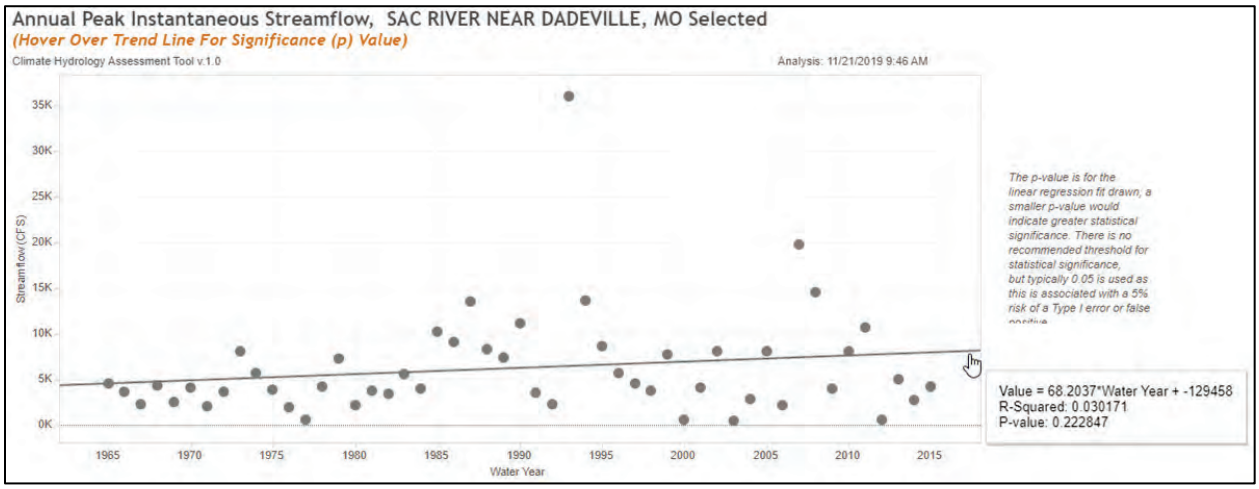


Figure 17. Annual Peak Streamflow Sac River near Dadeville, MO for 1965 to 2015. Trendline Equation: Q = 68.204 * (Water Year) – 129,458, p = 0.223

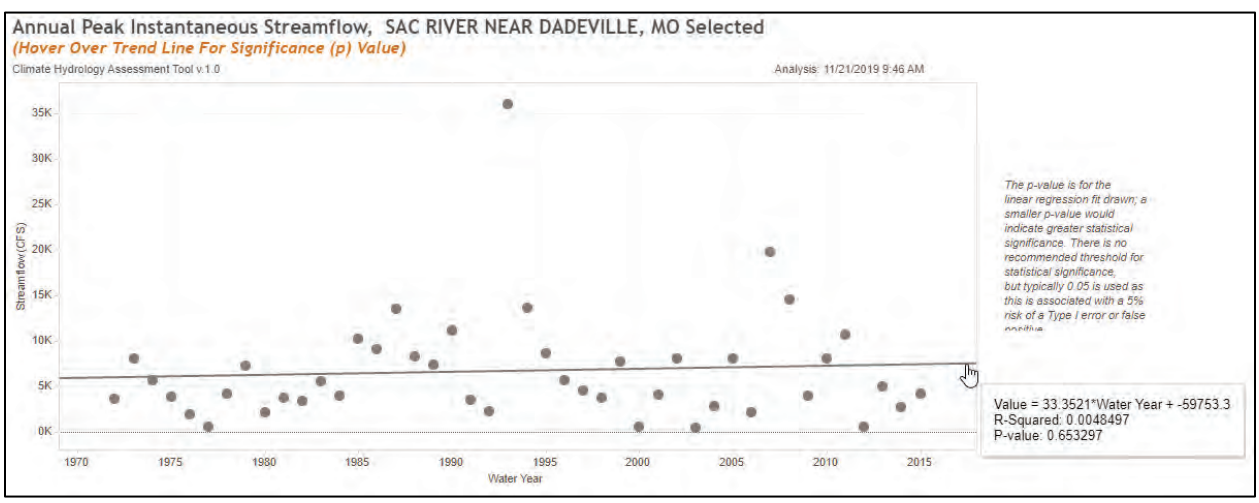


Figure 18. Annual Peak Streamflow Sac River near Dadeville, MO for 1972 to 2015. Trendline Equation: Q = 33.352 * (Water Year) – 59,753, p = 0.653

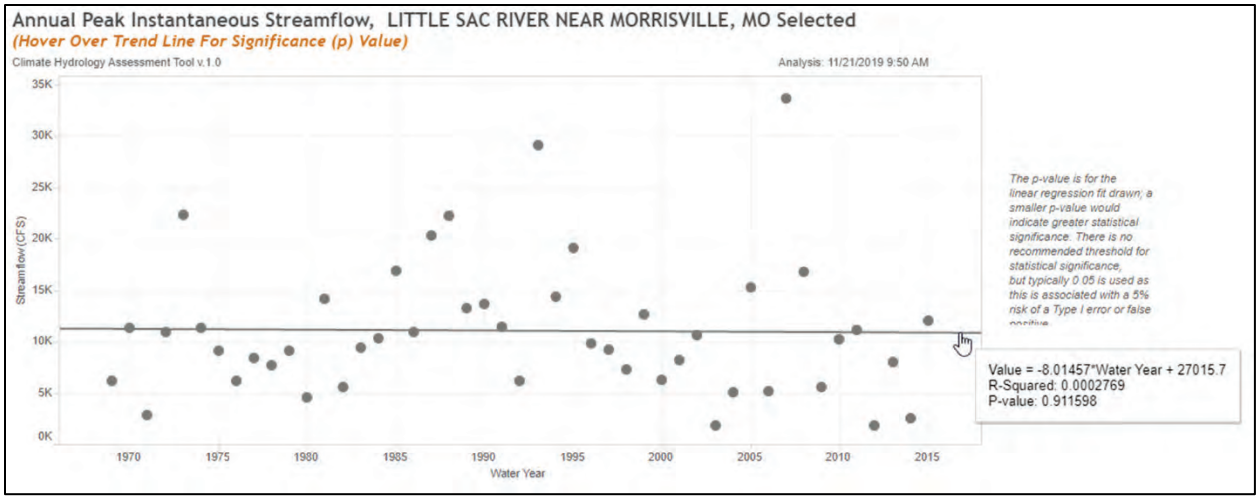


Figure 19. Annual Peak Streamflow Little Sac River near Morrisville, MO from 1969-2015. Trendline Equation: Q = -8.015 * (Water Year) + 27,016, p = 0.912

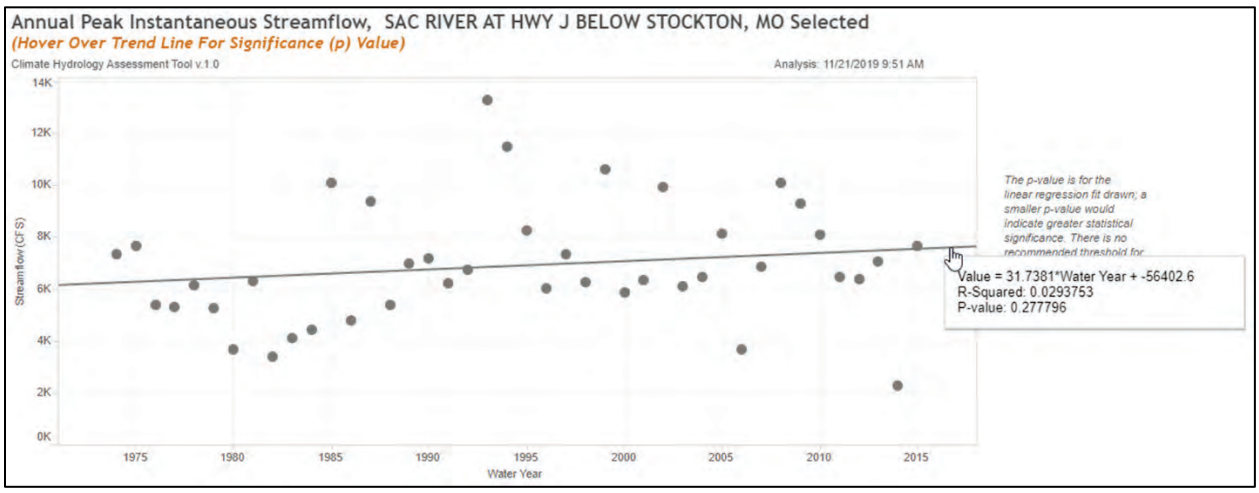


Figure 20. Annual Peak Streamflow Sac River at Hwy J below Stockton, MO from 1974-2015. Trendline Equation: Q = 31.738 * (Water Year) – 56,403, p = 0.278

Table 4. Significance of Linear Regression for the Pool Elevation and Streamflow Gages

Gage	Data Type	Period of Record Assessed	Significance of Trend Line (P-value)	Coefficient of Determination R^2	Significant? (P-value < 0.05)
USGS Gage 06918990 - Stockton Lake	Pool Elevation	1971-2019	0.076	NA	NO
USGS Gage 06918440 – Sac River near Dadeville, MO	Flow	1965-2015	0.223	0.030	NO
USGS Gage 06918440 – Sac River near Dadeville, MO	Flow	1972-2015	0.653	0.005	NO
USGS Gage 06918740 – Little Sac River near Morrisville, MO	Flow	1969-2015	0.912	0.0003	NO
USGS Gage 06919020 – Sac River at Hwy J below Stockton, MO	Flow	1974-2015	0.278	0.029	NO

3. Future Without-Project Condition

An analysis of future without-project conditions was conducted for the project area. The analysis included a literature review of projected regional climate conditions and analysis of projected trends

3.1. Literature Review: Projected Climate Change and Projected Changes in Climate Variables

A literature synopsis was generated to summarize published conclusion regarding both natural and anthropogenic climate trends in the Sac River Basin identified through analysis of future conditions.

3.1.1. Regional Climate Trends and Scenarios for the US National Climate Assessment (NOAA, 2013)

The report outlines effects from different modeled emissions scenarios, including a higher emission scenario and a lower emission scenario. Effects from these two modeled scenarios focus on sociological effects of changes in temperature and precipitation. The report addresses climate change, however, the report does not provide details on effects for specific hydrological/meteorological events. The report concluded rising temperatures in the Midwest will increase the demand for water, which could stress natural resources and increase competition for water among communities. The changes in temperature could also influence crop growth cycles due to warming winters and changes in rainfall patterns which may require new agriculture and livestock management practices. The magnitude of expected changes in climate could exceed the extremes experienced in the last century, rendering existing adaptation, and planning efforts as inadequate for responding to the future impacts from climate change. Extremes in climate will also magnify periods of wet or dry weather resulting in longer, more severe droughts, and larger more extensive flooding.

3.1.2. Recent US Climate Change and Hydrology Literature Applicable to US Army Corps of Engineers Missions (USACE, 2015)

This report is 1 of 21 regional climate syntheses prepared at the scale of 2-digit USGS Hydrologic Unit Codes (HUC) across the United States. The area covered by the Region 10 report is shown in Figure 2. The report for the Missouri River Region 10 summarized observed and projected climate trends.

The general consensus in the literature indicated increasing air temperatures in the Missouri River Region over the next century. Reasonable consensus, regardless of emission scenarios, was seen in the literature with respect to projected increases in extreme temperature events, including more frequent, longer, and more intense summer heat waves in the long term future compared to recent past. Projection of precipitation in the study region was less certain than those associated with air temperature. On the whole, more studies appeared to point toward a wetter, rather than drier, future climate in the Missouri River Region. A majority of the projections reviewed here forecasted an increase in annual precipitation and in the frequency of large storm events. However, statistically significant trends in the projection data were lacking. Similarly, clear consensus was lacking in the hydrologic projection literature. The direction of the streamflow trend appeared to be dependent on modeling assumptions. Of the limited number of studies reviewed here, more results indicated a potential increase in streamflows.

3.1.3. Hydrological Variability and Uncertainty of Lower Missouri River Basin under Changing Climate (Qiao et al, 2013)

The study was conducted on the Lower Missouri River Basin, which was divided into three main watersheds, shown in Figure 21.

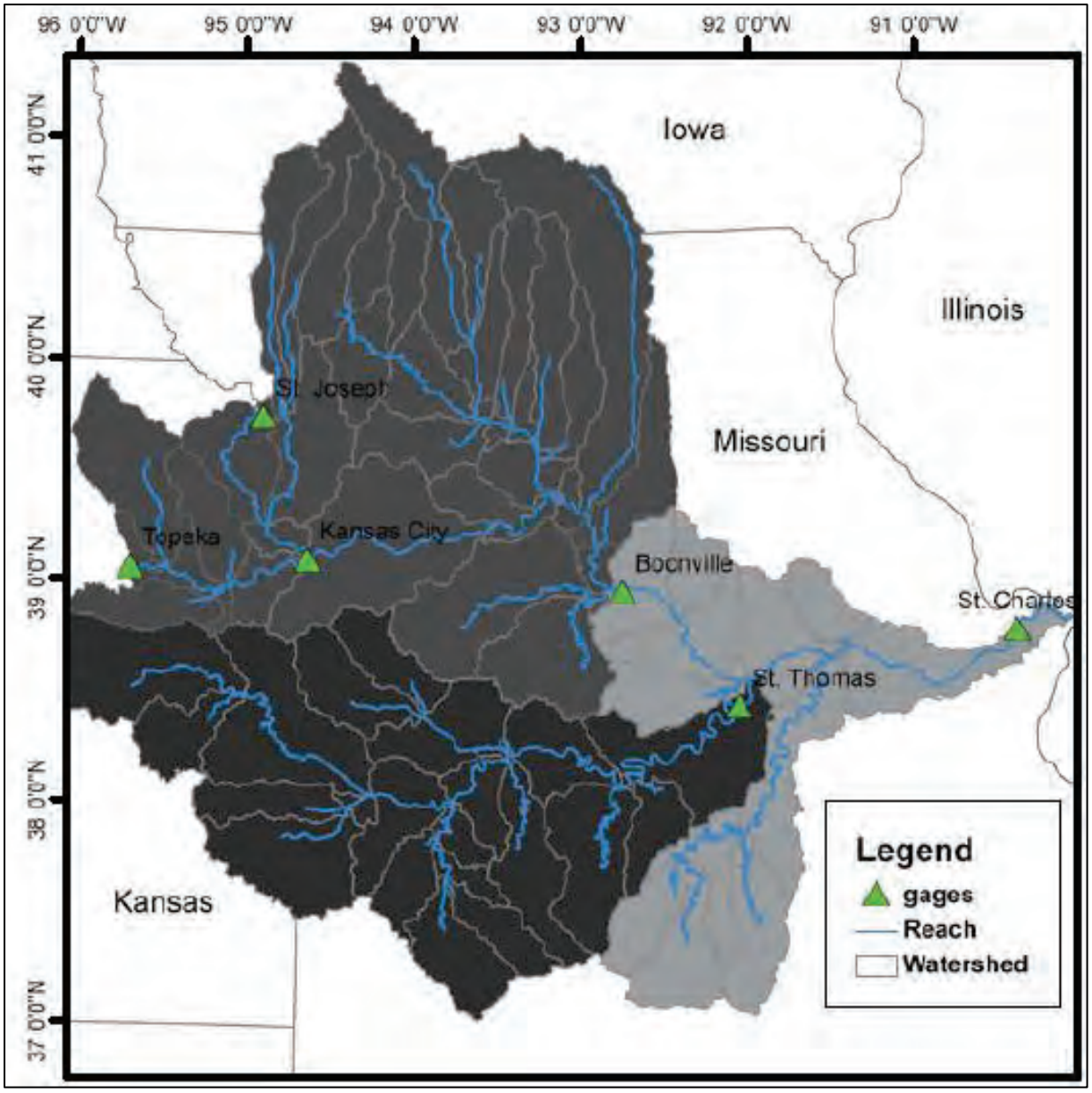


Figure 21: Study Area for the Lower Missouri River Basin with Watershed Features Delineated.

The North American Regional Climate Change Assessment Program (NARCCAP) climate projections were used as atmospheric forcing for the Soil and Water Assessment Tool (SWAT) model which runs with varying potential evapotranspiration (PET) methods to assess the hydrological change and uncertainty of 2040-2069 over 1968-1997 for the Lower Missouri River Basin. The NARCCAP temperature and precipitation predictions were refined using a bias correction method. The results of this study showed that, following the seasonal variability of precipitation, various water fluxes would increase in most seasons except the summer. Expected precipitation typically increased in intensity with little change in frequency, triggering faster surface water concentration to form floods. The study predicted an even wetter environment compared to the historically very wet period, with the possibility of more flooding. However, the uncertainty-specific analysis suggested that the climate models contribute more uncertainty annually. Total uncertainty can be entirely attributed to the uncertainty derived from the climate models for the March to July period (the season with the highest precipitation, greatest number of flooding days, and highest river discharges).

3.1.4. Climate Change Assessment - Missouri River Basin (USACE Omaha District, 2016)

The Omaha District USACE utilized the guidance for Climate Studies (ECB 2016-25) as part of the Missouri River Recovery Management Plan. This report utilized the studies listed above, with additional studies covering the mountainous regions of the Missouri Basin as well as the high plains of the Dakotas, Montana, Wyoming and Colorado to project trends in climate that will affect the Missouri River basin. The study used the HUC2 basin which covers the entire Missouri River from the Continental Divide to the confluence of the Missouri River with the Mississippi River.

The USACE climate guidance and most references from sources for the Missouri River Basin agreed that future climate trends are likely to have increased temperatures and precipitation. The increased temperatures are likely to result in earlier spring snowmelt with a decrease in snowmelt duration and peak snow water equivalence. The increased temperatures could also impact water temperature and water quality, which could greatly impact low summer flows. The study also indicates that rainfall events are likely to become more sporadic for the entire Missouri River Basin and large rain events are likely to become more frequent and interspersed by longer relatively dry periods. Extremes in climate will also magnify periods of wet or dry weather resulting in longer, more severe droughts, and larger more extensive flooding.

3.1.5. Literature Review Summary

The strongest consensus amongst the literature supported the 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 or dry weather resulting in longer more severe droughts and larger more extensive storms. The literature was conflicted as to projected peak magnitude, duration, and volume of extreme events with the uncertainty being attributed to the uncertainty of the climate models themselves.

3.2. Regional Scale Analysis: Trends in Projected Streamflow Records

This portion of the climate change assessment focused on carrying out first order statistical analysis at a HUC-4 watershed scale. The watershed analyzed included HUC 1029 Gasconade and Osage River Basin.

3.2.1. Climate Hydrology Assessment: Projected Trends in Streamflow and Climate Change at a Regional Scale

The USACE CHAT was used to investigate potential future trends in streamflow for HUC 1029, shown in Figure 22 below. Figure 23 displays the range of projected annual maximum monthly streamflows computed from 93 different climate change hydrologic model runs for the period of 1950-2099 for each HUC. Climate changed hydrology output is generated using various greenhouse gas emission scenarios and global circulation models (GCM) to project precipitation and temperature data into the future. These meteorological outputs are spatially downscaled using the Bias Corrected Spatial Disaggregation (BCSD) statistical method and then input in the U.S. Bureau of Reclamation's Variable Infiltration Capacity (VIC) precipitation-runoff model to generate a streamflow response. As expected for this type of analysis, there is considerable, but consistent spread in the projected annual maximum monthly flows for HUC 1029. The spread in the projected annual maximum monthly flows is indicative of the high degree of uncertainty associated with projected climate changed hydrology.

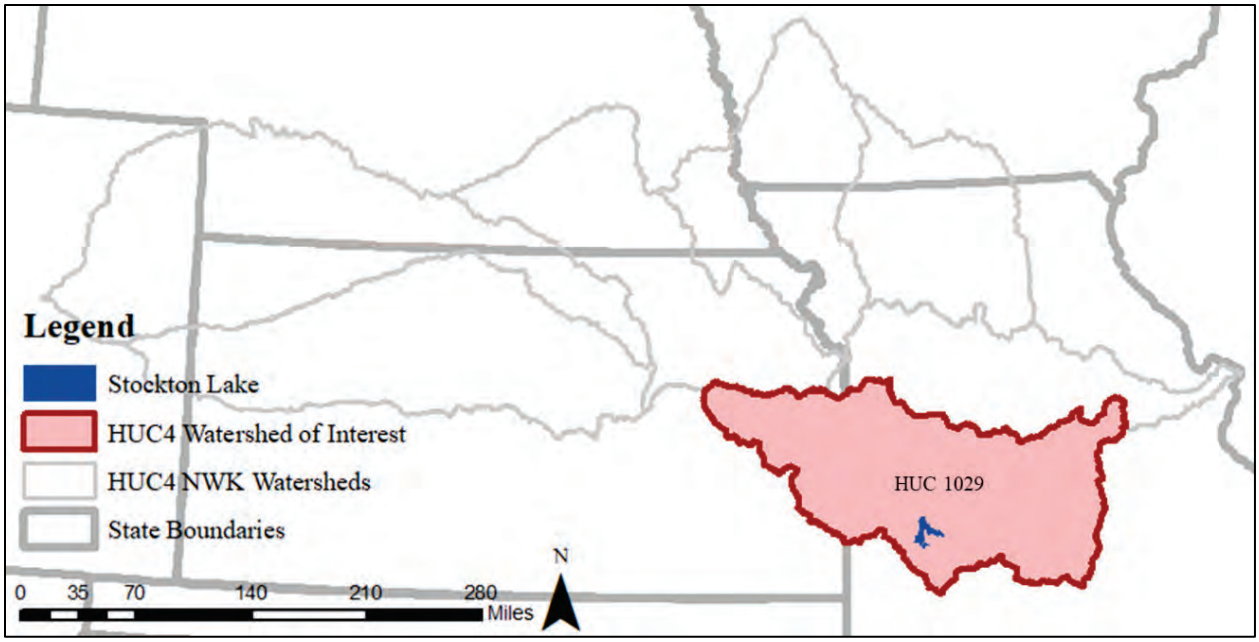


Figure 22. HUC-4 Watershed Analyzed in the Climate Hydrology Assessment Tool

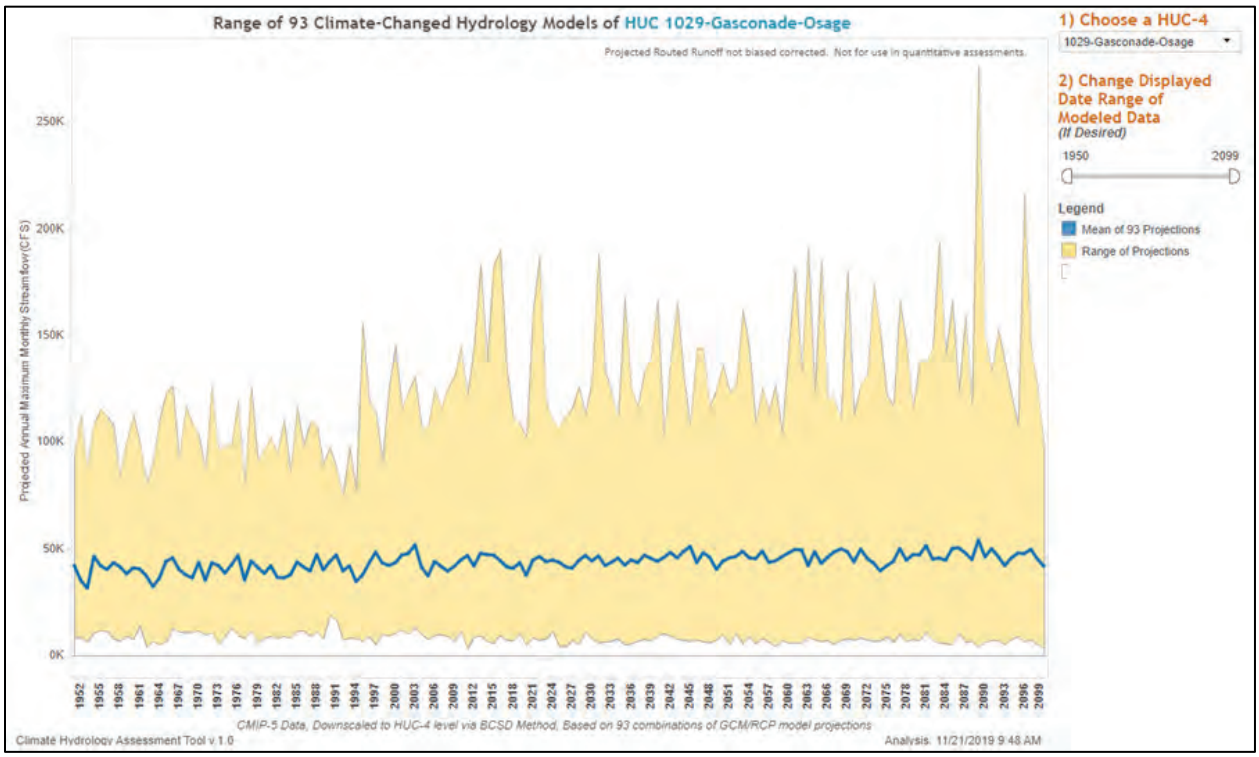


Figure 23. Mean Projected Annual Maximum Monthly Streamflow among Ensemble of 93 Climate-Changed Hydrology Models, HUC-4 1029 Gasconade-Osage.

The overall trend in the mean projected annual maximum monthly streamflow increased over time, as shown in Figure 24. There is a statistically significant increasing trend for the later time period with p-values significantly less than the generally accepted threshold for significance of 0.05 for HUC 1029. These findings, summarized in Table 5, suggest that there is potential for flood risk to increase in the future in the study area, relative to the current conditions. Although the p-values indicate that the trend

magnitudes are different from zero, it does not reveal the magnitude of change. Nevertheless, the most likely value of the trend in the data is the one that is the best fit to the data, which is approximately 38.4 cfs/year for HUC 1029. The trend, while indicative of increasing flows over time, are not relatively large in magnitude. These results are qualitative only.

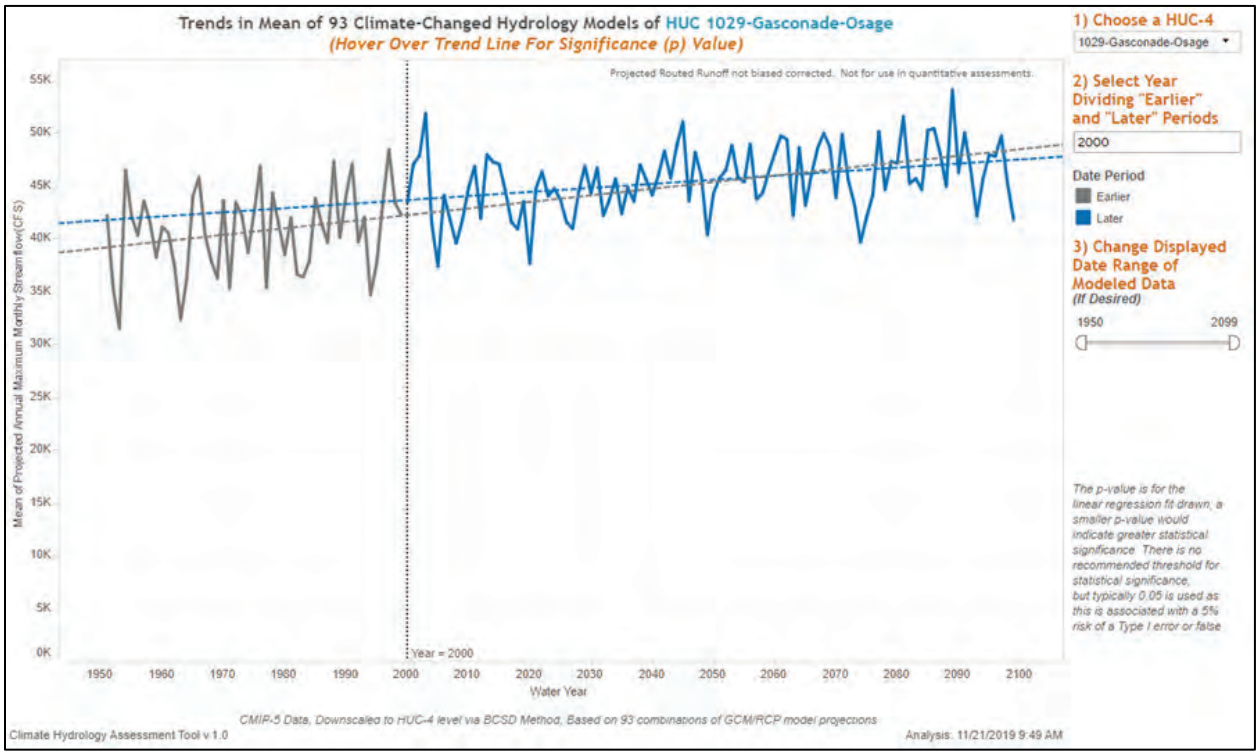


Figure 24. Mean Projected Annual Maximum Monthly Streamflow, HUC 1029 Gasconade-Osage. Earlier Trendline Equation: Q = 62.3374 * (Water Year) – 82,493.4, p-value = 0.120. Later Trendline: Q = 38.395 * (Water Year) – 33,185.8, p-value = 0.0003.

Table 5. Significance of Linear Regression for Mean Projected Annual Maximum Monthly Streamflow for HUC 1029

HUC-4 Watershed	Trendline Period Assessed	Trendline Significance (p-value)	Coefficient of Determination R2	Significant? (P-value < 0.05)
Gasconade-Osage (1029)	Earlier: 1950 - 2000	0.1196	0.0507	NO
	Later: 2000 - 2099	0.0003	0.1251	YES

3.2.2. Screening Level Vulnerability Assessment to Climate Change Impacts

The USACE Watershed Climate Vulnerability Assessment Tool facilitates a screening level, comparative assessment of how vulnerable a given HUC-4 watershed is to the impacts of climate change relative to the other 202 HUC-4 watersheds within the continental United States (CONUS). The tool can be used to assess the vulnerability of a specific USACE business line such as “Water Supply” or “Flood Risk Reduction” to projected climate change impacts. Assessments using this tool help to identify and characterize specific climate threats and particular sensitivities or vulnerabilities, at least in a relative sense, across regions and business lines. The tool uses the Weighted Ordered Weighted Average (WOWA) method to represent a composite index of how vulnerable a given HUC-4 watershed (Vulnerability Score) is to climate change specific to a given business line. The HUC-4 watersheds with

the top 20% of WOWA scores are flagged as being vulnerable. Water Supply is the most relevant business line for the Stockton Lake reallocation study and is the business line analyzed with the USACE Climate Vulnerability Assessment Tool. Indicators considered within the WOWA score for Water Supply include: change in sediment load, short-term variability in hydrology, long-term variability in hydrology, runoff elasticity (ratio of streamflow runoff to precipitation), and drought severity.

When assessing future risk projected by climate change, the USACE Climate Vulnerability Assessment Tool makes an assessment for two 30-year epochs of analysis centered at 2050 and 2085. These two periods were selected to be consistent with many of the other national and international analyses. The Vulnerability tool assesses how vulnerable a given HUC-4 watershed is to the impacts of climate change for a given business line using climate hydrology based on a combination of projected climate outputs from the general circulation models (GCMs) and representative concentration pathway (RCPs) resulting in 100 traces per watershed per time period. The top 50% of the traces is called "wet" and the bottom 50% of the traces is called "dry." Meteorological data projected by the GCMs is translated into runoff using the Variable Infiltration Capacity (VIC) Macroscale hydrologic model. For this assessment, the default National Standards Settings are used to carry out the vulnerability assessment.

Based on the results of the USACE Watershed Climate Vulnerability Assessment Tool, relative to the other 202 HUC-4 watersheds in the CONUS, the Gasconade and Osage watershed (HUC 1029) is among the 20% most vulnerable to the impacts of climate change on Water Supply. As seen in Figure 25 and Table 6, several vulnerability indicators are driving the watershed's vulnerability for Water Supply. Primary vulnerability indicators for Water Supply include sediment and runoff elasticity. The vulnerability for Water Supply is likely driven by the projected, future streamflow and precipitation data used as inputs to the vulnerability tool. The primary purpose of the project is to reallocate stored water towards water supply for nearby cities including Springfield, MO, Joplin, MO, and other members of the Tri-State Water Resources Coalition. The sediment indicator measures changes in the average annual sediment load resulting from changes in future precipitation. The sediment indicator is influenced by future precipitation estimates and future sediment loads. Increases in estimated future precipitation and sediment load increases the sediment indicator. Increased sediment loads contribute to increased reservoir sedimentation and reduces the overall storage capacity of the reservoir and water available for water supply. The reservoir was initially designed with a total of 25,000 acre-ft allocated for sediment storage with 8,000 acre-ft in flood pool and 17,000 acre-ft in multipurpose pool. Based on a comparison of the 2009 bathymetric survey and 2018 LiDAR to the 1968 storage elevation curves, approximately 20,300 acre-ft of sediment has deposited in the multipurpose pool, using all originally allocated storage. The current multipurpose pool sedimentation rate is estimated at 510 acre-ft per year based on the 2009 bathymetric survey and 2018 LiDAR compared to 1968 storage elevation curves. With a multipurpose sedimentation rate of 510 acre-ft per year, approximately 26,000 acre-ft of additional sediment will deposit in the multipurpose pool within the next 50 years. The proposed project purposely did not reallocate the entire multipurpose pool to water supply in order to allow additional availability for other uses such as reservoir sedimentation. 171,260 acre-ft and 210,000 acre-ft for current and proposed allocations, respectively, are allocated towards other uses, exceeding the projected sediment deposition volumes for the lifespan of the proposed allocation project. Sedimentation rates may also be managed through watershed programs to reduce sediment disturbance and transport. Upstream bank stabilization projects may be implemented to reduce channel erosion. Runoff elasticity is dependent on runoff. As runoff increases, the vulnerability attributable to this indicator also increases. With increased inflows and possible flood control pool reallocations, increased runoff may be mitigated through reservoir operations and, specifically, discharging the reservoir inflows. Current analyses have indicated that pool reallocations proposed for the project produce negligible downstream impacts including Phase 3 discharges. Additionally, the water supply pool reallocations allow water to be removed from the reservoir without contributing to downstream flooding while also allowing for increased water storage during prolonged droughts and increased variability depicted by the cumulative monthly and annual coefficient of variation (COV). The cumulative monthly COV is a measure of short-term variability in

hydrology and is a ratio of the standard deviation of monthly runoff to the monthly runoff mean, including upstream freshwater inputs. Similarly, the cumulative annual COV is a measure of variability but in the long-term hydrology. Cumulative annual COV is a ratio of the standard deviation of annual runoff to annual runoff mean, including upstream freshwater inputs. Increased pool allocations towards water supply allow more water to be stored to increase water availability during prolonged periods between precipitation events. This also improves drought resiliency.

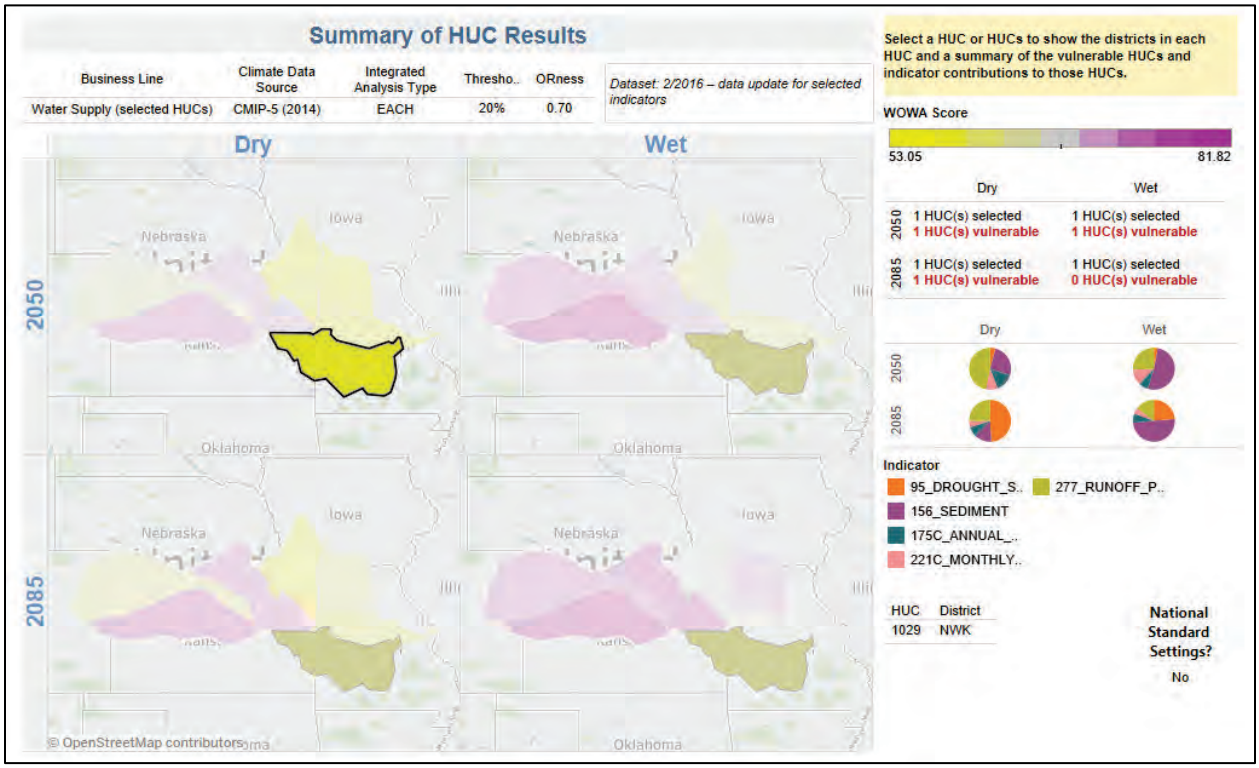


Figure 25. Projected Vulnerability for the Gasconade-Osage Rivers (HUC-4 1029) with respect to Water Supply

Table 6. Comparison of Different Indicators for the Gasconade-Osage watershed (HUC 1029)

2050 Epoch				
Business Line	**Indicator**	**Contribution to WOWA**		**Average Percent Contribution**
		Dry	Wet	
Water Supply	Sediment (Change in Sediment Load/Current Load)	15.17	33.47	38.76%
	Annual COV of Runoff - Cumulative	8.31	4.92	10.86%
	Monthly COV of Runoff - Cumulative	5.33	7.75	10.52%
	Runoff Elasticity (%Change in Runoff / % Change in Precipitation)	27.55	16.61	36.25%
	Drought Severity (Greatest Precipitation Deficit)	2.48	1.93	3.60%

As previously mentioned, the scores are compared to all HUC-4 watersheds in the CONUS. The HUC's with WOWA scores within the top 20% of all CONUS HUC-4s for a given business line are generally considered to be vulnerable. The scores for each business line may only be compared to other HUCs within the same scenario (2050 Dry, 2050 Wet, 2085 Dry, 2085 Wet) and business line. Table 7 provides the WOWA scores for the Gasconade-Osage (1029) HUC-4 watersheds pertaining to Water Supply.

Table 7. Water Supply Projected Vulnerability for Gasconade-Osage (1029) HUC-4 Watershed

Business Line	HUC-4 Watershed	Base	2050 Dry	2050 Wet	2085 Dry	2085 Wet
Water Supply	Gasconade-Osage (1029)	57.31	58.84	64.68	65.09	65.83

3.3. Conclusions

Overall, no strong indication exists within this qualitative analysis to identify what definitive impacts climate change will hold on the project hydrology and streamflow. 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, MO; Little Sac River near Morrisville, MO; and Sac River at Hwy J below Stockton, MO observed flows in addition to Stockton Lake pool elevations. Significant nonstationarities were not detected for the periods of record analyzed so long as the periods analyzed initiated after the reservoir reached multipurpose pool. The periods of record for each gage should utilize the full record for statistical analyses in order to reduce the uncertainty caused by using shorter records with the exception of one gage. The Sac River gage near Dadeville, MO may be analyzed using the assumption of stationarity for the reduced period of record of 1972 to 2015. However, reducing the period of record will result in an increase in uncertainty in the study, but the natural variability in the data should still be captured in the 43-year period of reduced data. 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 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% most vulnerable to the impacts of climate change on Water Supply relative to the other 202 HUC-4 watersheds in CONUS. 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. One resiliency measure incorporated in the proposed project includes multipurpose pool storage allocated towards other uses, such as sedimentation. 171,260 acre-ft and 210,000 acre-ft for current and proposed allocations, respectively, are allocated towards other uses, exceeding the projected sediment deposition volumes for the lifespan of the proposed allocation project. As such, the Future With-Project Conditions will have no significant effect on climate change. Several additional resiliency measures were identified and are recommended to be incorporated into the design or future projects to further reduce sedimentation impacts. These include upland watershed soil conservation practices, streambank stabilization, reservoir operation adjustments, and sediment removal.

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STOCKTON WATER SUPPLY REALLOCATION STUDY

APPENDIX E: Hydropower Impact Analyses

Hydropower Analysis Center | Portland District | September 16, 2019

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STOCKTON WATER SUPPLY REALLOCATION STUDY

HYDROPOWER IMPACT ANALYSES

1 Introduction

1.1 PURPOSE AND SCOPE

This report, prepared by the Hydropower Analysis Center (HAC), for the Kansas City District (NWK), Corps of Engineers, presents an analysis of the hydropower benefits and costs of reallocating reservoir storage in Stockton Lake for Municipal & Industrial Water Supply use.

1.2 REALLOCATION AUTHORITY

Authority for the Corps to reallocate existing storage space to M&I water supply is contained in Public Law 85-500, Title III, Water Supply Act of 1958, as amended. The Assistant Secretary of the Army for Civil Works, ASA(CW), is authorized to cooperate with local interests in providing storage space for M&I water supply in U.S. Army Corps of Engineers projects as long as the local interests demonstrate a need and agree to pay the costs associated with the storage space. Depending on the amount of storage requested, either the Chief of Engineers or the ASA(CW) has the discretionary authority to reallocate storage capacity in Stockton Lake provided the reallocation has no severe effect on other authorized purposes and will not involve major structural or operational changes. If so, Congressional authorization is required.

1.3 PROJECT DESCRIPTION – THE OSAGE RIVER SYSTEM

There are six Corps of Engineers lake and dam projects in the Osage River Basin located within Kansas and Missouri. Melvern Lake, Pomona Lake, Hillsdale Lake, Stockton Lake, Pomme de Terre Lake, and Harry S Truman Lake are managed and operated as a system. The six reservoirs are multi-purpose reservoirs generally authorized for flood control, water supply, recreation and fish and wildlife. Stockton and Harry S Truman also are authorized and operated for hydropower.

The Osage basin starts in east-central Kansas and extends east about 190 miles to the Kansas-Missouri state line, continuing east an additional 306 miles in Missouri to join the Missouri River at RM 129, between Boonville and Hermann. The Osage system is made up of several tributary rivers, including the Marais des Cygnes River, which drains an area of 15,300 square miles in Kansas and Missouri above the junction with the Little Osage River. Melvern Lake is located in the headwaters of the Marais des Cygnes River. Other tributaries include Hundred and Ten Mile Creek, Dragoon Creek, both of which contribute flow to Pomona Lake, Big and Little Bull Creeks which flow into Hillsdale Lake, and the Pottawatomie and Salt Creeks which contribute to the Marias des Cygnes River.

The Marais des Cygnes joins the Little Osage River just below Schell City, Missouri and picks up additional flow from the Marmaton River. The combination of these rivers creates the Osage River, which flows into Harry S Truman Reservoir. The Osage River picks up flow from the Sac River which is controlled by Stockton Dam. Other sources of flow into the Osage basin include the Pomme De Terre River and south Grand River, which flow into Truman. Finally the Osage

flows through the Lake of the Ozarks and picks up the flow from the Niangua River basin before the Osage moves through the control point at St. Thomas, Missouri, then continues to the confluence with the Missouri River at river mile 129. The Osage RESSIM model then routes this flow downstream and picks up flow from the Gasconade River and routes the total flow to the Missouri River at Hermann, Missouri.

Stockton Dam

Stockton Dam is located two miles east of Stockton, Missouri on the Sac River in the Osage Basin, with a drainage area of 1,970 square miles, 1,160 of which is upstream from Stockton. The reservoir falls in parts of Cedar, Dade, and Polk Counties, Missouri. At full pool, the lake extends upstream the Sac River valley about 22 miles and about the same distance up the Little Sac River valley. Stockton is operated for flood control, recreation, hydropower, and water supply.

The dam structure, which is 151 feet high and 5,100 feet long, was authorized by the Flood Control Act of 1954 and construction was completed in September of 1968. The total storage capacity of Stockton Lake is approximately 1,657,000 acre-feet, with 790,000 acre-feet allocated for flood control, 867,000 allocated for conservation (multipurpose), which includes sediment reserves. In 1993, a reallocation study was conducted for City Utilities of Springfield, Missouri and as a result, 50,000 acre-feet of multi-purpose storage was reallocated to water supply in 1994 for Springfield, Missouri. The power plant has a single unit. The original 6-bladed Kaplan turbine was replaced with a new 7-bladed Kaplan turbine which became operational in January 2015. This upgraded unit is rated at 53.54 MW. Original expected annual generation was 55 GWh (net generation in 2015 was 64.4 GWh).

Harry S Truman Dam

Harry S Truman Dam is located approximately 1.5 miles northwest of Warsaw, Missouri. The reservoir falls within Henry, St. Clair, Benton, and Hickory Counties, Missouri and the drainage area upstream of the dam is 9,085 square miles.

The construction of the dam was completed in July of 1977 and is operated for flood control, recreation, hydropower, and water supply. It is 126 feet high and 5,000 feet long and has about 4,187,000 acre-feet of storage. 4,005,415 acre-feet is allocated to flood control with 1,181,617 acre-feet allocated to the multipurpose pool which is divided between hydropower, water supply, and other authorized uses. 1,000 acre-feet was reallocated from Flood Control to Water Supply in 1994.

The Harry S Truman power plant has six turbine generators and a rated capacity of 160,000 kilowatts. The original expected annual generation was 242.2 GWh (10-year average annual generation is 280 GWh).

Bagnell Dam/Lake of the Ozarks

Bagnell Dam holds back water from the Osage River to create the Lake of the Ozarks, which contains 600 billion gallons of water. The dam is half a mile long and rises 148 feet from bedrock. Bagnell dam cost $30 million to build and was put into operation in October of 1931. In a typical year, more than 500 million kilowatt-hours of electricity are produced by the dam. (https://www.ameren.com/missouri/lake-of-the-ozarks/bagnell-dam/how-osage-works)

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Bagnell is a private dam and therefore does not figure into the benefits and cost calculations used to determine the National Economic Development (NED) impacts that USACE computes. However, information using assumptions about the dam's operation were used to provide some details as to how Bagnell may be impacted by the study. This was provided in case this information is needed to conduct a detailed affected environment report.

2 General

This section describes some of the terminology, basic assumptions, and methodology of the analysis.

2.1 PERIOD OF ANALYSIS

The economic period of analysis for this study is 50 years. The "Period of Analysis" as defined in the Engineering Regulation (ER) 1105-2-100, Planning Guidance Notebook, Section 2-4j, for a multi-purpose reservoir project, is not to exceed 100 years. Section E-63 i(1)(a)(1), "Benefits Foregone", defines the period of analysis for storage reallocations as the greater of (a) the remaining economic life of the project, or (b) 50 years. Benefits foregone for this analysis are computed assuming the water supply contract will be implemented in 2019.
The power on-line date and total economic life for the project are shown in Table 2-1.

Table 2-1: Pertinent Study Data Hydropower and Economic Parameters

Power	Stockton	Truman	Bagnell
Installed Capacity	53.54	184	176.2
SWPA Marketable Capacity	52	160	N/A
Economic			
Total Project Life	100	100	100
Interest Rate*	2.875%	2.875%	2.875%
Period of Analysis	50	50	50

*FY19 Federal Discount Rate

2.2 DISCOUNT RATE

Both costs and benefits are expressed at an estimated 2019 (FY 2019) price level. Some prices, such as annual wholesale generation prices in the Energy Information Agency Annual Energy Outlook forecasts, are based on a calendar year price rather than fiscal year. Because the fiscal year overlaps three-quarters of the calendar year, these prices are used as if they were fiscal year prices, without adjustment. Costs and benefits occurring at different points in time are converted to an average annual equivalent basis over a 50-year period of analysis using the federal discount rate prescribed for water resource projects. This rate is currently 2.875%

2.3 PRICE LEVEL

Capacity unit value, energy costs, and energy prices in this report are reported in FY2019 dollars. Because constant value dollars are used for all calculations, inflation, and price escalation are not included in the analysis, as would be the case with nominal dollars.

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2.4 ROUNDING AND TOTALS

Some parts of the study analysis were performed using spreadsheet software. Arithmetic operations and totals were taken to full decimal accuracy within the spreadsheet. Some tables found within this report have been rounded after the mathematical computations were performed; as a consequence, rounded totals may not equal the summation of rounded values.

2.5 HEC RESERVOIR SIMULATION (RESSIM) MODEL

The HEC Reservoir Simulation (RESSIM) model was used to simulate the operation of the Osage system on a daily time-step according to existing guidelines for reservoir and system operation, including the operation of the two hydropower projects in the system. The simulations used in the analysis were based on a period of record of 62 years, from 1950 through 2012.

2.6 WATER SUPPLY REALLOCATION ALTERNATIVES

The following alternatives were analyzed by the HAC for hydropower impacts

2.6.1 Original/Pre-Reallocation Condition Alternative (PR)

The Original/Pre-Reallocation alternative is the original condition of the lake with original seasonal/conservation pool elevations and hydropower generation. Specifically, the 50,000 AF of water supply storage currently under contract to Springfield, Missouri is not accounted for in this alternative. This alternative is used as the basis of comparison to the current condition.

2.6.2 The Current Condition Alternative (BC)

The Current Condition Alternative is the current conditions with appropriate conservation/seasonal pool elevations, hydropower generation and water supply withdrawal rates. This alternative includes the impact of the 50,000 AF of storage reallocated to Springfield, Missouri, which is a withdrawal rate of approximately 30 million gallons per day (MGD). No additional action is implemented beyond the existing condition. This alternative is used as the basis of comparison to the two reallocation alternatives.

2.6.3 Reallocation of 45,750 AF from the Stockton's Multi-Purpose Pool and 49,000 AF from the Flood Control Pool (S7)

This alternative considers a reallocation of 45,750 acre-feet of storage from Stockton's multi-purpose pool and 49,000 acre-feet of storage from the flood control pool. This accounts for a 39 MGD withdrawal.

2.6.4 Reallocation of 90,200 AF from the Stockton's Multi-Purpose Pool (S5)

This alternative considers a reallocation of 90,200 acre-feet of storage from Stockton's multi-purpose pool. This accounts for a 39 MGD withdrawal.

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2.7 STUDY ASSUMPTIONS

The evaluation of energy benefits foregone due to water supply withdrawals from Stockton Lake was performed based on the following assumptions:

- The H&H RESSIM model simulations used in this evaluation include the Minimum Flow Plan with updated hydrology and power loads which are described elsewhere.

- Water supply withdrawals are considered “consumptive use”, meaning that none of the withdrawal amount taken from Stockton Lake will be returned to the reservoir or stream below the reservoir.

- The seasonal water supply withdrawal rates from Stockton Lake are made at a uniform rate throughout the year.

2.8 HYDROPOWER EFFECTS

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 (22 April 2000), Appendix E, paragraph E-57, d(2). These procedures require that the re-allocated storage cost charged to water supply customers be the highest of the following:

- Power benefits foregone
- Power revenues foregone
- Replacement costs of power
- Updated cost of storage

Power benefits foregone, power revenue foregone, and the replacement costs of power are impacts to hydropower. Power benefits foregone and power revenue foregone are calculated in this report. The replacement costs of power is equal to power benefits foregone and is not calculated separately. The updated cost of storage is not power related and will be computed by the Kansas City District based on the storage necessary to yield the requested withdrawals.

3 Power Benefits Foregone

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

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- A loss in head due to 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 foregone are computed by multiplying the expected annual loss in megawatt-hours (MWh) of on-peak and off-peak generation by the average annual prices of on-peak and off-peak energy in dollars per megawatt-hour ($/MWh) over the period 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 fifty 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 foregone for that alternative. The calculation of energy benefits foregone is presented in detail in Section 4.

Capacity benefits foregone 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 foregone are the product of the loss of dependable capacity and the composite fixed cost of the most likely mix of replacement thermal power plants. Calculations of composite costs, dependable capacity, and a description of the average availability method are presented in Section 5.

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4 Energy Benefits Foregone

The amount of energy generated at Stockton under the base condition (being defined as the current operations of the lake) and under the reallocation of storage alternatives at Stockton Lake was computed by the Kansas City District using stream flows from the historical period of record (1950 – 2012) in the RESSIM model on a daily interval.

The price for electrical power varies by hour, day and season. Subdividing the daily generation is necessary to capture the market value for hydropower. On-Peak power has the highest market value. The regional definition for on-peak hours of generation is 6 a.m. to 10 p.m. on weekdays and Saturdays. The off-peak hours of generation are the remaining hours on weekdays, Saturdays and all hours on Sunday. Hydropower generation in the regional power system is concentrated in a subset of the highest-value weekday peak hours to fulfill power contracts for firm energy, these hours were evaluated separately as contract on-peak hours in order to not understate their value. A schedule of contract peak hours that represents the distribution of the contract guarantee of 1,200 hours of generation annually was provided by the Southwestern Power Administration (SWPA), an agency of the U.S. Department of Energy.

Table 4-1 displays the distribution of contract-peak hours, non-contract peak hours, and off-peak hours for each month of the year for weekdays. Table 4-2 displays the distribution of contract-peak hours, non-contract peak hours, and off-peak hours for the Sundays (which are the same year round).

Table 4-1: 1,200 Hours per Year Weekday Generation Schedule for Hydropower Plants

	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours
January	5	11	8
February	3	13	8
March	3	13	8
April	3	13	8
May	3	13	8
June	5	11	8
July	9	7	8
August	9	7	8
September	4	12	8
October	3	13	8
November	3	13	8
December	5	11	8

Table 4-2: 1,200 Hours per Year Weekend Generation Schedule for Hydropower Plants

	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours
Saturdays	0	16	8
Sundays	0	0	24

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As an example of how energy production is an allocation between on-peak and off-peak designations, Table 4-3 shows the simulated energy production for Stockton for the week of March 24, 2008 under the current condition. The capability is constant so the maximum on-peak weekday production would be 16 hours per day of generation at the plant marketable capacity of 45.2 MW (723.2 MWh), of which 3 hours would be contract generation (135.6 MWh) and the remaining 13 hours would be non-contract peak generation (587.6 MWh). Generation in excess of 16 hours on weekdays and Saturdays is off-peak energy. All power generated on Sunday is also off-peak energy.

Table 4-3: On-Peak and Off-Peak Energy Allocation for Stockton, March 24, 2010 – March 30, 2010

Date	Day	Marketable Capacity	Energy Production	On-Peak Energy (contract)	On-Peak Energy (non-contract)	Off-Peak Energy	On-Peak Energy (non-contract)	Off-Peak Energy	Off-Peak Energy
		MW	MWh	MWh	MWh	MWh	MWh	MWh	MWh
				Weekdays	Weekdays	Weekdays	Saturday	Saturday	Sunday
24-Mar-08	Mon	45.2	916.3	135.6	587.6	193.1	0.0	0.0	0.0
25-Mar-08	Tues	45.2	921.6	135.6	587.6	198.4	0.0	0.0	0.0
26-Mar-08	Wed	45.2	932.9	135.6	587.6	209.7	0.0	0.0	0.0
27-Mar-08	Thurs	45.2	941.7	135.6	587.6	218.5	0.0	0.0	0.0
28-Mar-08	Fri	45.2	944.4	135.6	587.6	221.2	0.0	0.0	0.0
29-Mar-08	Sat	45.2	945.7	0.0	0.0	0.0	361.6	584.1	0.0
30-Mar-08	Sun	45.2	925.8	0.0	0.0	0.0	0.0	0.0	925.8

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4.1 AVERAGE MONTHLY ENERGY GENERATION BY PLANT

Average monthly on-peak (contract and non-contract) and off-peak energy for the current condition are graphed in the figures below. The monthly generation for Stockton Lake is shown in Figure 4-1 and data in Table 4-4.

Figure 4-1: Stockton Average Monthly Current Condition Generation (1950-2012)

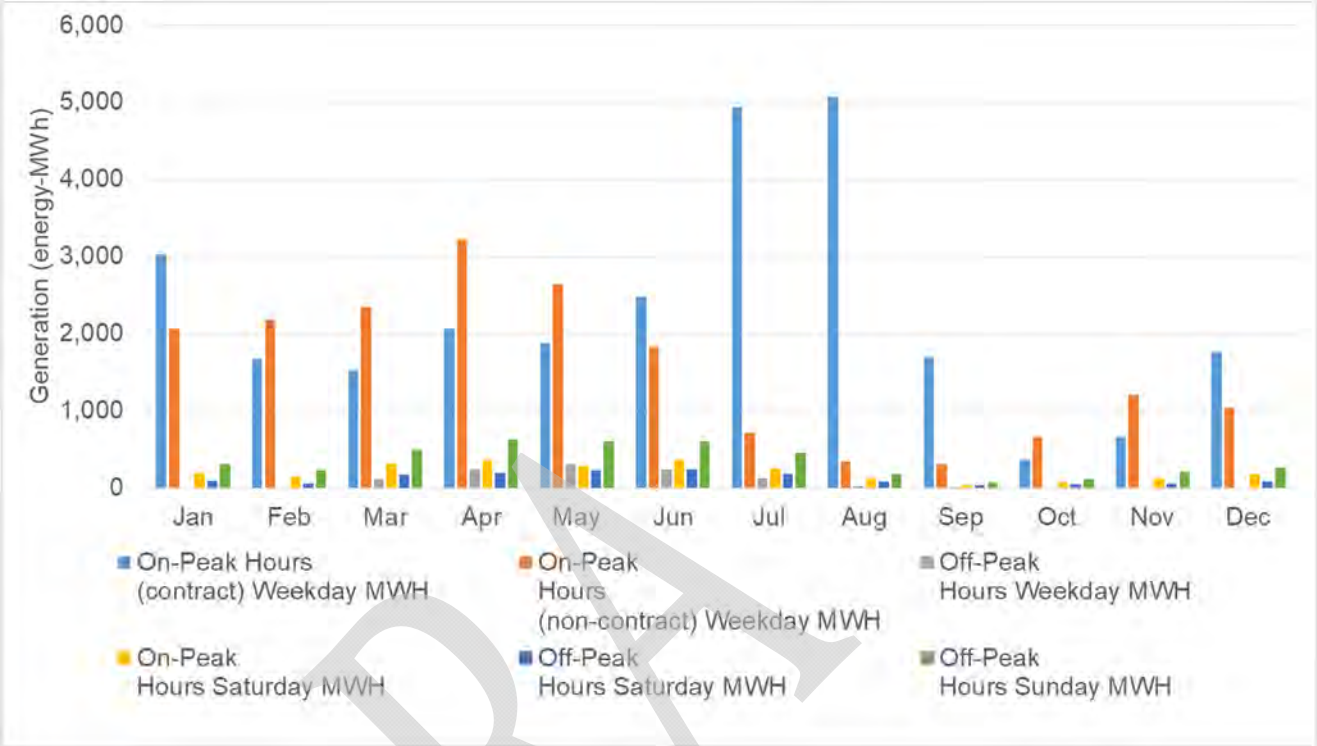

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Table 4-4: Total Average Monthly Current Condition Generation for Stockton Hydropower plant

	Stockton (STN)					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	MWH	MWH	MWH	MWH	MWH	MWH
Jan	3,026	2,057	0	190	96	312
Feb	1,669	2,182	0	153	63	223
Mar	1,522	2,349	114	315	173	489
Apr	2,064	3,221	242	357	199	623
May	1,883	2,640	311	282	225	599
Jun	2,486	1,835	236	369	244	603
Jul	4,942	716	121	255	180	455
Aug	5,073	340	25	128	83	184
Sep	1,701	313	13	40	32	74
Oct	368	665	0	72	45	119
Nov	662	1,202	0	127	56	205
Dec	1,759	1,039	0	185	77	268
Annual	27,156	18,558	1,063	2,471	1,472	4,154
Total	54,874					

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4.2 ENERGY GENERATION LOSSES BY ALTERNATIVE

Table 4-5 below summarizes the overall annual energy losses under each alternative as compared to the Pre-Reallocation condition and the Current condition at Stockton and Truman projects. The change from the Pre-Reallocation/Original Condition to the Current/Existing Condition resulted in an average annual energy loss of 4,880 MWh or a 1.38% decrease in average annual generation. Considering the existing condition as the baseline, the largest change in generation occurs under alternative S5, the reallocation of 90,200 acre-feet from Stockton's multi-purpose pool.

Table 4-5: Estimated Average Annual Generation Total Changes – Stockton and Truman (MWh)

Alternative	Annual Total Energy (MWh)	Annual Energy Change From Pre-Reallocation Condition (MWh)	% Change Pre-Reallocation Condition	Annual Current Change from Existing Condition (MWh)	% Change Current Condition
Pre-Reallocation/ Original Condition	**353,938**	---	---	**4,880**	1.40%
Current/ Existing Condition	**349,058**	**-4,880**	-1.38%	---	---
S7	**343,930**	**-10,008**	-2.83%	**-5,128**	-1.47%
S5	**343,473**	**-10,465**	-2.96%	**-5,585**	-1.60%

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5 Computation of Energy Value

Energy benefits are computed as the product of the energy loss in megawatt-hours and an energy unit value/price ($/MWh). The energy price is based on the cost of energy from regional electrical power generating plants that would replace the lost energy from the hydropower plant due to operational and/or structural changes.

5.1 ENERGY UNIT PRICES

This study uses a simulation of hydrologic conditions and power plant operations over the period of record to estimate the effects of changes in water management on hydropower production. However, in order to evaluate the resulting changes in hydropower benefits over a 50-year period of analysis, forecasts of future energy prices are needed. These forecasted prices also need to reflect seasonal variation of both peak (contract and non-contract) and off-peak prices.

Regional future energy prices reflect both seasonal peak and off-peak variation. The US Department of Energy, Energy Information Administration EIA long term energy annual forecast for the Southwestern Power Pool southern sub-region (SPP/S) as well as the historical hourly Locational Marginal Pricing (LMP) for the SPA (Southwestern Power Administration) pricing node are combined to capture these variations in energy prices. EIA Annual Energy Outlook (AEO) 2019 annual forecast generation prices were used to shape a forecast for hourly LMP values.

5.2 EIA LONG TERM FORECAST

Future and historical energy values in this analysis are based on EIA forecasts from the supplemental tables (https://www.eia.gov/electricity/data/browser/). The EIA forecasts are developed with the Electricity Market Model (EMM) as part of the National Energy Modeling System (NEMS). The following description is from the model documentation report available on the EIA website:

> *The National Energy Modeling System (NEMS) was developed to provide 20-to-25 year forecasts and analyses of energy-related activities. The NEMS uses a central database to store and pass inputs and outputs between the various components. The NEMS Electricity Market Module (EMM) provides a major link in the NEMS framework (Figure 1). In each model year, the EMM receives electricity demand from the NEMS demand modules, fuel prices from the NEMS fuel supply modules, expectations from the NEMS system module, and macroeconomic parameters from the NEMS macroeconomic module. The EMM estimates the actions taken by electricity producers (electric utilities and non-utilities) to meet demand in the most economical manner. The EMM then outputs electricity prices to the demand modules, fuel consumption to the fuel supply modules, emissions to the integrating module, and capital requirements to the macroeconomic module. The model iterates until a solution is reached for each forecast year.*

In addition to providing average annual energy price forecasts of electrical generation prices through 2050, AEO 2019 also includes regional forecasts corresponding to North American Electric Reliability Corporation (NERC) regional entity sub-regions. Most of the electrical generation from USACE Osage River Basin projects is marketed into the region represented by the SPA energy pricing node.

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AEO 2019 reports several forecast cases. In addition to the ‘Reference Case, used for this study. Other cases in Figure 5-1 illustrate a range in forecast generation prices.

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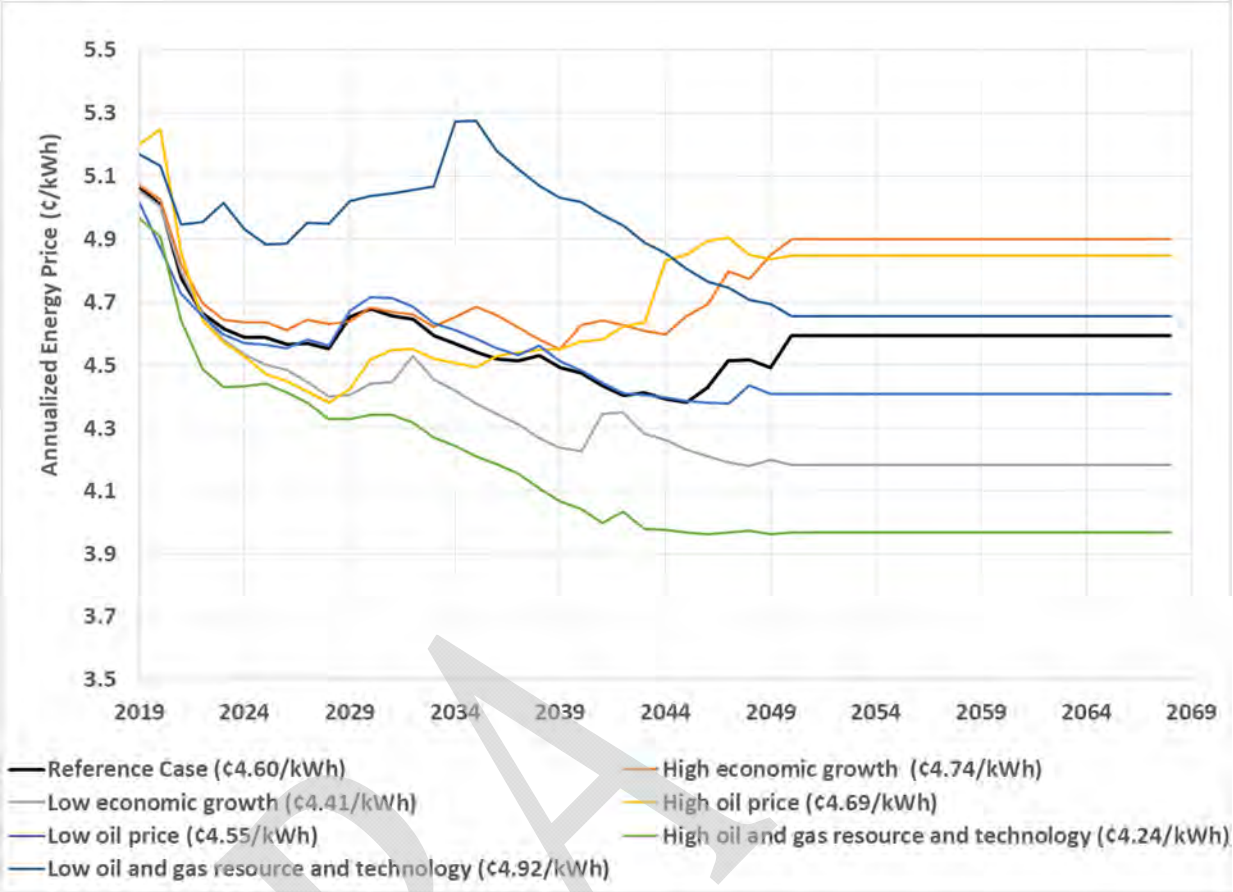
Figure 5-1: EIA 2019 Energy Price Forecast Scenarios



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5.3 LOCATIONAL MARGINAL PRICING (LMP)

The following explanation of how LMP (lambda) is calculated (FERC Form 714 report, Part II, Schedule 6, filed for 2012 by American Electric Power Company, Inc.):

> *The American Electric Power Company, Inc. system's calculation of the firm-load lambda is based on the after-the-fact search for the generating unit that could have theoretically served 'one' MW of additional firm demand, in addition to the actual firm demand. If more than one generating unit were to be candidates to serve that additional MW, the one with the lowest incremental cost would be the one considered.*
>
> *The incremental energy cost, in $/MWh, to raise that unit's loading by one MW above its actual loading is defined as the AEP System's firm-load lambda. Such determination and calculation are carried out on an hourly basis.*
>
> *Prior to determining that incremental generating unit and the associated incremental cost, the computer program is coded to take into consideration all appropriate realities and obligations encountered while the AEP System's generation resources are operating on real-time. These are: consideration of each operating generating unit's seasonal capability, including condition de-ratings and partial outages, if any; exclusion of capacity blocks actually allocated to unit-power sales commitments; exclusion of the Donald C. Cook Nuclear Units #1 & #2 and conventional hydroelectric units from 'incremental' consideration, in as much as those units generally operate to their physical and regulatory limits; and inclusion of the 3% spinning reserve requirement over firm demand, as mandated by the ECAR (East Central Area Reliability Coordination Agreement) Document No. 2.*

LMP hourly values for 2014 - 2017 were obtained from SPP's historical database for the SPA node.

5.4 METHODOLOGY FOR ENERGY PRICE SHAPING

To forecast the LMP using the EIA forecasted generation values the following ratio is assumed:

$$\frac{LMP_{Future}}{LMP_{Past}} = \frac{EIA_Generation_{Future}}{EIA_Generation_{Past}}$$

This can be rewritten as:

$$LMP_{Future} = EIA_Generation_{Future} * \frac{LMP_{Past}}{EIA_Generation_{Past}}$$

Future LMP values can then be computed by the product of the EIA generation forecast and a shaping ratio defined as:

$$ShapingRatio = \frac{LMP_{Past}}{EIA_Generation_{Past}}$$

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To replicate the peak and off peak variation, daily LMP values are sorted from high to low and are averaged using the three generation blocks of peak (contract and non-contract) and off peak periods described in the Energy Benefits Calculation section below. Seasonal variability is taken into account by computing shaping ratios for each month. These shaping ratios are computed as averages among dates with like month and generation block classification using the equation:

$$ShapingRatio(month, generation_block) = Average\left(\frac{LMP_{Past}(month, generation_block, year)}{EIA_Generation_{Past}(year)}\right)$$

This produces the following equation to estimate LMP forecasts for the four block classifications shown in Table 2 for each month.

$$LMP_{Future}(generation_block, month) = EIA_Generation_{Future} * ShapingRatio(generation_block, month)$$

The shaping ratios in the table below were then multiplied by the EIA annualized forecast energy value for each year to obtain estimates of monthly on-peak and off-peak values.

Table 5-1: Shaping Ratios for Generation Blocks for SPA Node

Month	Weekday			Weekend		
				Saturday		Sunday
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours (non-contract)	Off-Peak Hours	Off-Peak Hours
January	0.71400	0.53016	0.42906	0.52898	0.39637	0.48478
February	0.76830	0.54895	0.41091	0.51521	0.37009	0.46684
March	0.72494	0.52511	0.35655	0.52175	0.35284	0.46545
April	0.75146	0.58254	0.36765	0.56118	0.35829	0.49355
May	0.79550	0.59497	0.35135	0.60426	0.33050	0.51300
June	0.79241	0.55598	0.34751	0.62165	0.35030	0.53120
July	0.77261	0.52755	0.36821	0.63354	0.35445	0.54051
August	0.72637	0.49499	0.36334	0.58806	0.36509	0.51374
September	0.73897	0.55495	0.35580	0.59632	0.35124	0.51463
October	0.68294	0.54654	0.36387	0.54741	0.35863	0.48448
November	0.71785	0.54706	0.41056	0.55807	0.40635	0.50750
December	0.40962	0.33119	0.25784	0.30767	0.23562	0.28365

The EIA forecast energy values were indexed to a 2019 price level. To develop the annualized on-peak and off-peak prices for each calendar month, the present value of each month of the 50-year period of analysis was calculated using the Federal discount rate of 2.875%. For each

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month, the resulting present values were then summed and amortized over 50 years ($46.17/MWh).

The resulting annualized monthly prices for the four blocks of peak and off-peak periods for the EIA Reference Case are shown in the table below.

Table 5-2: Average Annual Energy Prices in Dollars per MWh (Reference Case, 2019 Price Level)

Month	Weekday			Weekend		
				Saturday		Sunday
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours (non-contract)	Off-Peak Hours	Off-Peak Hours
January	$32.97	$24.48	$19.81	$24.42	$18.30	$22.38
February	$35.47	$25.35	$18.97	$23.79	$17.09	$21.55
March	$33.47	$24.24	$16.46	$24.09	$16.29	$21.49
April	$34.70	$26.90	$16.97	$25.91	$16.54	$22.79
May	$36.73	$27.47	$16.22	$27.90	$15.26	$23.69
June	$36.59	$25.67	$16.04	$28.70	$16.17	$24.53
July	$35.67	$24.36	$17.00	$29.25	$16.37	$24.96
August	$33.54	$22.85	$16.78	$27.15	$16.86	$23.72
September	$34.12	$25.62	$16.43	$27.53	$16.22	$23.76
October	$31.53	$25.23	$16.80	$25.27	$16.56	$22.37
November	$33.14	$25.26	$18.96	$25.77	$18.76	$23.43
December	$18.91	$15.29	$11.90	$14.21	$10.88	$13.10

5.5 ENERGY BENEFITS FOREGONE

The final step in computing energy benefits foregone 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 foregone by month which are in the tables in Appendix A.

5.5.1 Energy Benefits Foregone

The bottom of Table 5-3 shows benefits foregone (negative benefits are in (red)). Average annual energy benefit impact for the current water supply reallocation of 50,000 AF would be **$103,227**.

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Table 5-3: Combined Annual Energy Benefits Foregone at USACE projects (Reference Case, 2019 Price Level)

ALTERNATIVES	Stockton (STN)	Harry S Truman (HST)	STN+HST	Bagnell
			Federal	Non-Federal
Energy (MWh)				
Pre Reallocation	57,903	296,035	**353,938**	412,887
Current Condition	54,874	294,185	**349,058**	408,797
S7	51,425	292,505	**343,930**	407,514
S5	50,353	293,120	**343,473**	409,478
Energy Value ($)				
Pre Reallocation	$1,642,500	$7,501,484	**$9,143,984**	$10,221,724
Current Condition	$1,576,572	$7,464,185	**$9,040,757**	$10,126,249
S7	$1,489,626	$7,424,363	**$8,913,988**	$10,091,620
S5	$1,467,527	$7,440,913	**$8,908,440**	$10,157,842
Pre Reallocation	0	0	**0**	0
Current Condition[1]	-3,029	-1,850	**-4,880**	-4,091
S7[2]	-3,449	-1,679	**-5,128**	-1,283
S5[2]	-4,520	-1,065	**-5,585**	681
Pre Reallocation	$0	$0	**$0**	$0
Current Condition[1]	($65,928)	($37,299)	**($103,227)**	($95,475)
S7[2]	($86,946)	($39,822)	**($126,769)**	($34,629)
S5[2]	($109,045)	($23,272)	**($132,317)**	$31,593

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5.6 ENERGY BENEFITS SENSITIVITY

This procedure was repeated for the alternatives using the other five EIA price forecast scenarios to indicate the potential range of energy benefits foregone due to variation in EIA forecasts. The table below indicates the ranges of difference depending on the forecast for the base/existing condition as compared to the original condition.

Table 5-4: Sensitivity of Annual Energy Benefits Foregone to Price Scenarios for the Current/Existing/ Base Condition as Compared to the Pre-Reallocation/Original Condition

EIA Forecast Scenarios	Annualized Value	Percent Difference to Reference Case
Low oil and gas resource and technology	-$109,929	-6.49%
High economic growth	-$106,042	-2.73%
High oil price	-$104,942	-1.66%
Reference case	-$103,224	---
Low oil price	-$101,820	1.36%
Low economic growth	-$98,542	4.54%
High oil and gas resource and technology	-$94,735	8.22%

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6 Capacity Benefits Foregone

Capacity benefits foregone 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.

6.1 HYDROPOWER PROJECT DEPENDABLE CAPACITY

A hydropower project's dependable capacity is a measure of the amount of energy that the project can reliably contribute towards meeting system peak power demands. If a hydropower project always maintains approximately the same head, and there is always an adequate supply of stream flow so that there is enough generation for the full capacity to be used in the system load, the full installed capacity can be considered to be the dependable capacity. In some cases, even the overload capacity can be used as its dependable capacity.

However, at storage projects, normal reservoir drawdown can result in a loss of dependable capacity due to a loss in head. At other times, stream flows in low flow periods may result in insufficient generation to support the available capacity in the load. Dependable capacity accounts for these factors by giving a measure of the amount of capacity that can be provided with some degree of reliability during peak demand periods.

There is an important subtle distinction between dependable capacity and marketable capacity. The marketable capacity listed for the Federal plants in Table 1 has been defined by SWPA to represent the amount of capacity that is available under the low hydrologic regime of 1954 in meeting the peak demands of the summer months. SWPA uses this value to market firm energy to their customers. Dependable capacity on the other hand represents the average capacity that is available during the summer months on the entire simulation period. Extreme events are not given any higher weight compared to average years in the calculation of dependable capacity.

6.2 DEPENDABLE CAPACITY EVALUATION METHOD

The most appropriate method for evaluating a hydropower plant’s dependable capacity in a predominantly thermal-based power system is the average availability method, as described in Section 6-7g of EM 1110-2-1701, *Hydropower*, dated 31 December 1985. The occasional unavailability of a portion of a hydropower project's generating capacity due to hydrologic variations is treated in the same manner as the occasional unavailability of all or part of a thermal plant's generating capacity due to forced outages. The average availability method attempts to measure average capacity available during the peak demand periods of the year.

The SPP-South is primarily a thermal-based system, but draws a portion of power from renewable resources as illustrated in Figure 6-1, (renewable resources includes hydropower). Consequently, the average availability method is the most appropriate method for measuring dependable capacity for this analysis.

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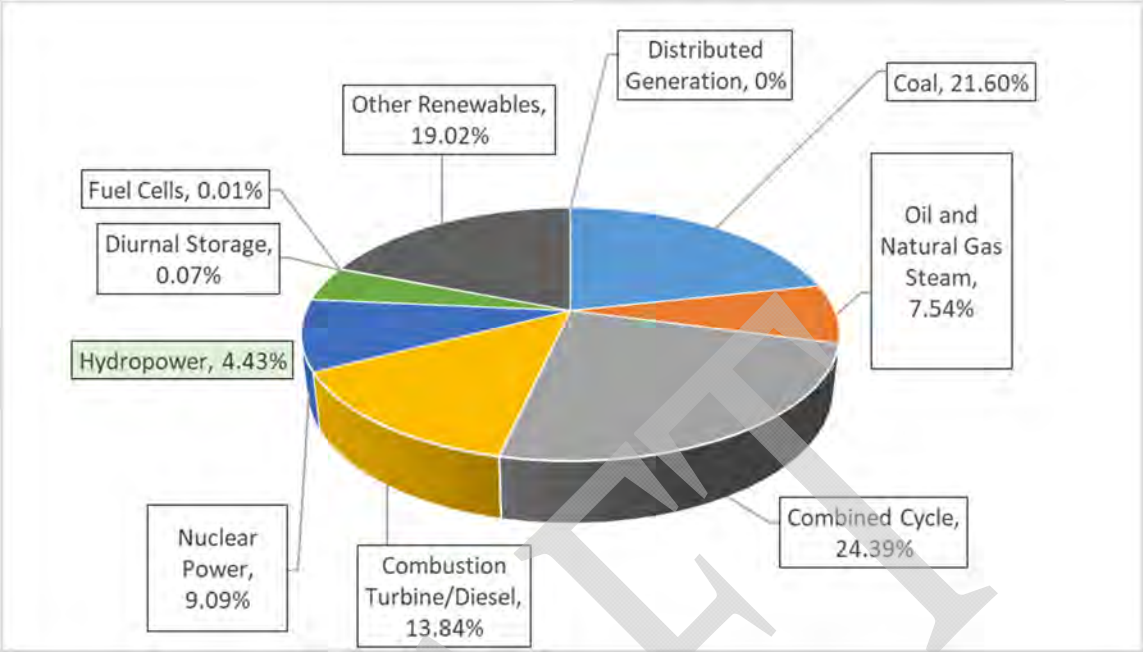
Figure 6-1: 2019 Generation by Power Type for SPP-South



6.3 HYDROLOGIC PERIOD OF ANALYSIS

In order to evaluate the average dependable capacity of a project during its peak demand season, a long-term record of project operation must be used. Actual project operating records can be used, but the period of operation may not be long enough to give a statistically reliable value. Furthermore, operating changes may have occurred over the life of the project, which would make actual data somewhat inconsistent.

An alternative method is the use of a period-of-record computer simulation of system operation. As described in Section 2.5, the Kansas City District provided a daily simulation of the Osage River Basin projects over the period of record of 63 years, from 1950 through 2012. This simulation, which was performed using the RESSIM routing model, served as the basis of this study's dependable capacity computations.

The initial step is to calculate each project's contribution (average weekly generating hours) to the system's capacity for the regional critical year. That contribution estimate was determined by first calculating each project's average weekly energy produced (MWh) for the peak demand months of June through September in 1954, the critical period used by SWPA to calculate marketable capacity. That number was then divided by SWPA's defined marketable capacity (MW), giving an estimate of average weekly generating hours during the peak demand months. These values, as well as the marketable capacity and machine capability (i.e. the overload capacity) of each project, are shown in Table 6-1 below.

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Table 6-1: Capacity and Generation Characteristics for Stockton and Truman

Project	Stockton	Truman
Machine Capability* (MW)	**45.2**	**160**
Average Weekly Energy (MWh) (critical period)	**431.8**	**501.4**
SWPA Marketable Capacity (MW)	**52**	**160**
Average Weekly Generation Hours (critical period 1954)	**8.30**	**3.13**

**Performance of Stockton unit is limited (de-rated) because of the underwater weir upstream of the power plant. The weir was put in place to improve water quality of the power plant discharge.*

Next, each project's average weekly energy (MWh) produced during the peak demand months was calculated for each simulated year. Dividing those values for each project by the average weekly generating hours from the critical period, as determined in the previous step, yields an array of yearly potential supportable capacity values. However, energy produced is limited by the machine capability of the project. The actual supportable capacity for any given year is consequently the lesser of the potential supportable capacity or the machine capability. With the average availability method, dependable capacity is the average actual supportable capacity over the period of record.

These values are defined in the following equations:

Average Weekly Energy (MWh)$_{(year = i)}$ =

(Total Energy (MWh)(Jun 1-Sep 30)$_{(year = i)}$ / 17 weeks

Marketable Capacity (MW) = (values in Table 51)

Average Weekly Generating Hours $_{(baseline\ critical\ period\ in\ 1954)}$ =

Average Weekly Energy (MWH) $_{(baseline\ critical\ period\ 1954)}$ / Marketable Capacity (MW)

Potential Supportable Capacity (MW) $_{(year=i)}$ =

Average Weekly Energy $_{(year=i)}$ / Average Weekly Generating Hours $_{(baseline\ critical\ period\ 1981)}$

Machine Capability (MW) = Overload Capacity of Project (MW)

Actual Supportable Capacity (MW) $_{(year=i)}$ =

MIN (Potential Supportable Capacity (MW) $_{(year=i),}$ Machine Capability (MW))

Dependable Capacity = Average Actual Supportable Capacity over the Period of Record

As an example of how dependable capacity is calculated, Table 6-2 shows the values calculated as described in the previous paragraphs for the Current/Existing Condition for the years 1950 – 2012 for Stockton. The average actual supportable capacity is 45.177 MW. For most years, the actual supportable capacity is equal to the potential supportable capacity of the project.

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Table 6-2: Dependable Capacity Calculations for the Current Condition at Stockton (1950-2012)

Year	Average Weekly Energy	Potential Supportable Capacity	Weekly Average Capability	Actual Supportable Capacity
	MWh	MW	MW	MW
1950	881.86	106.21	45.20	45.20
1951	1636	197.03	45.20	45.20
1952	563.23	67.83	45.20	45.20
1953	570.84	68.75	45.20	45.20
1954	431.78	52	45.20	**45.20**
1955	854.3	102.89	45.20	45.20
1956	363.54	43.78	45.20	43.78
1957	2256.99	271.82	45.20	45.20
1958	2478.67	298.51	45.20	45.20
1959	719.72	86.68	45.20	45.20
1960	512.75	61.75	45.20	45.20
---	---	---	---	---
---	---	---	---	---
---	---	---	---	---
2000	715.76	86.2	45.20	45.20
2001	934.53	112.55	45.20	45.20
2002	1757.55	211.67	45.20	45.20
2003	725.39	87.36	45.20	45.20
2004	626.85	75.49	45.20	45.20
	624.62	75.23	45.20	45.20
	496.35	59.78	45.20	45.20
	2335.88	281.32	45.20	45.20
	3437.95	414.04	45.20	45.20
	1339.06	161.27	45.20	45.20
	1508.39	181.66	45.20	45.20
	1293.13	155.74	45.20	45.20
	689.56	83.05	45.20	45.20
			dependable capacity	45.177

Table 6-3 below summarizes the dependable capacity for Stockton and Truman under each of the alternatives

Table 6-3: Dependable Capacity Summary by Plant and Alternative

ALTERNATIVES	Stockton (STN)	Harry S Truman (HST)	STN+HST	Bagnell
			Federal	Non-Federal
Capacity (MW)				
Pre Reallocation	45.177	155.982	**201.160**	171.624
Current Condition	45.177	154.366	**199.544**	169.875
S7	45.177	153.467	**198.644**	169.907
S5	45.177	153.837	**199.014**	167.052
Change in Capacity (MW)				
Pre Reallocation	0.000	0.000	**0.000**	0.000
Base Condition[1]	0.000	-1.616	**-1.616**	-1.749
S7[2]	0.000	-0.900	**-0.900**	1.069
S5[2]	0.000	-0.530	**-0.530**	-2.822

Note 1: Change in Current Condition from Pre-Reallocation
Note 2: Change in Alternative S7 & S5 from Current Condition

This table shows that the various alternatives have no impact on dependable capacity at Stockton and small impacts on Truman which are likely due to system regulation response to reallocation alternatives. The negative impacts at Truman are small compared to either Original/Pre-Reallocation condition or current/existing condition. Some benefits to capacity are occurring under some of the alternatives, but are also extremely small.

6.4 COMPUTATION OF CAPACITY VALUES

Capacity benefits are an estimate of the investment costs of thermal generating plant capacity that would be needed to replace the lost capacity due to the water withdrawals from the reservoir. Capacity benefits are computed as the product of the dependable capacity loss and a capacity unit value, which is based on the unit cost of constructing the most likely thermal generating alternative.

6.5 MOST LIKELY THERMAL GENERATION ALTERNATIVE

A screening curve analysis was conducted to determine the mix of thermal resources that would be the most likely (least-cost) generation plant alternatives for the hydropower plants. The type of alternative plants considered were coal-fired steam (base loads displacement), gas-fired combined cycle (intermediate loads displacement), and gas-fired combustion turbine (peak loads displacement).

6.6 6.6 VALUES USED IN SCREENING CURVE ANALYSIS

Capacity unit values for coal-fired steam, gas-fired combined cycle and combustion turbine plants were computed using procedures developed by the Federal Energy Regulatory Commission (FERC). Capacity values were computed based on a FY19 2.875% discount rate and a FY2019 price level. The adjusted capacity values incorporate adjustments to account for differences in reliability and operating flexibility between hydropower and thermal generating power plants. See Engineering Manual (EM) 1110-2-1701, Hydropower, Section 9-5c for further discussion on the capacity value FERC adjustments.

Operating costs for coal-fired steam, gas-fired combined cycle and gas fired combustion turbine plants were developed using information obtained from the EIA Electric Power Monthly (DOE/EIA-0226) and other sources. The information obtained included fuel costs, heat rates, and variable Operations and Maintenance (O&M) costs. Since current Corps of Engineers policy does not allow the use of real fuel cost escalation, these values were assumed to apply over the entire period of analysis.

Cost data contained in EIA report "Updated Capital Cost Estimates for Utility Scale Electricity Generating Plants", November 2016, was used to update the base costs indexed in the FERC spreadsheet models for power generation costs.

Adjusted capacity values and operating costs for Arkansas, Oklahoma, and Missouri were averaged and are presented in Table 6-4.

Table 6-4: Regional Plant Capacity and Operating Costs

Metric	Coal-fired Steam	Gas-fired Combined Cycle	Gas-fired Combustion Turbine
	CO	**CC**	**CT**
Adjusted Capacity Value ($/kW-yr)	$330.48	$143.60	$122.23
Operating Costs ($/MWh)	$19.24	$24.23	$34.87

(FY19 price level)

6.7 SCREENING CURVE ANALYSIS

The values shown in Table 6-4 were used to develop a screening curve for each of the thermal generating plant types. A screening curve is a plot of total plant cost (fixed capacity cost plus variable operating cost) versus an annual plant factor.

A screening curve analysis consists of the following steps:

- Construct total plant cost (in $/kW-year) versus annual plant factor (in percent) diagram which includes a curve for each thermal generating plant type; this screening curve will show which type of plant is least cost in each plant factor range.
- Construct a generation-duration curve for the typical existing condition for the plant from hourly generation records. This curve represents the typical operation of the plant over the period of analysis.

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- From the screening curve, determine the “breakpoints” (the plant factors at which the least cost plant type changes).
- Find the points on the generation-duration curve where the percent of time generation is numerically identical to the plant factor breakpoints defined in the preceding step. These intersection points and the maximum and minimum generation define how much plant capacity would be carried by each thermal generation plant type.

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The plot for each thermal generation type was developed by computing the annual plant cost for various plant factors ranging from zero to 100 percent. The annual costs were computed using the following equation:

$$AC = CV + (EV * 0.0876 * PF)$$

where: AC = annual thermal generating plant total cost ($/kW-year)

CV = thermal generating plant capacity cost ($/kW-year)

EV = thermal generating plant operating cost ($/MWh)

PF = annual plant factor (percent)

The combined screening curve for Stockton and Truman is shown in the bottom half of Figure 6-2. The breakpoint between Gas-fired Combustion Turbine and Gas-fired Combined Cycle is at an annual plant factor of 22.9%. The breakpoint is at a capacity of 61 MW meaning Gas-fired Combine Cycle would account for 61 MW of the capacity and Gas-fired Combustion Turbine would account for 165 MW of the capacity and Coal does not become the most cost effective replacement at any point on this curve.

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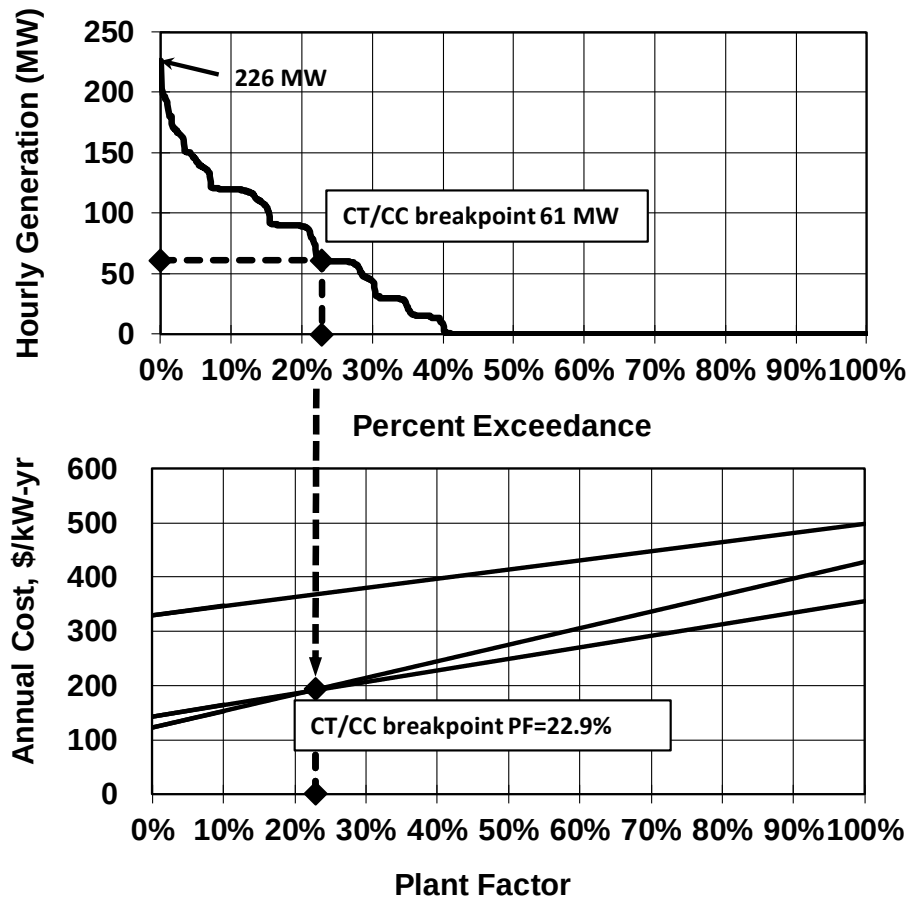
Figure 6-2: Thermal Screening Curve and Combined Hourly Generation-Duration Curve



6.8 LEAST-COST THERMAL MIX

The upper portion of Figure 6-2 presents the generation duration curve for Stockton and Truman combined. The breakpoint annual plant factor obtained from the screening curve is matched to the same percent exceedance values on the generation-duration curve in order to determine the level of generation at which the least cost thermal alternative changes from combined cycle to combustion turbine (power factor = 22.9%).

Using this value, the mix of lowest cost combination of thermal generating plant needed to replace the full capacity of Stockton and Truman's 226 MW of generating capacity would consist of:

- 61 MW of gas-fired combined-cycle plant capacity (the vertical distance between the origin and 22.9% exceedance breakpoint) on the upper hourly generation-duration curve

- 165 MW of gas-fired combustion turbine plant capacity (the vertical distance between the 22.9% exceedance breakpoint and the maximum recorded hourly generation)

These thermal capacities for the two generating plants types are used to weight the respective adjusted capacity values from Table 6-4 and summed to produce a composite capacity value. The calculation is:

$$\text{Adjusted Capacity Value}_{\text{(combined cycle)}} \times \frac{\text{Replacement Capacity}_{\text{(combined cycle)}}}{\text{Maximum Generation}} +$$

$$\text{Adjusted Capacity Value}_{\text{(combustion turbine)}} \times \frac{\text{Replacement Capacity}_{\text{(combustion turbine)}}}{\text{Maximum Generation}}$$

$$= \text{Composite Capacity Value}$$

The resulting composite capacity value for this mix is $128 dollars per kilowatt year. This value is converted to dollars per MW-year ($128,000 $/MW-yr) and multiplied by the respective changes in dependable capacity to give capacity benefits foregone. Table 6-5 summarizes the capacity benefits foregone (negative benefits (red) for each alternative.

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Table 6-5: Capacity Benefits Foregone of the Proposed Alternatives

ALTERNATIVES	Stockton (STN)	Harry S Truman (HST)	STN+HST	Bagnell
			Federal	Non-Federal
Capacity (MW)				
Pre Reallocation	45.177	155.982	**201.160**	171.624
Current Condition	45.177	154.366	**199.544**	169.875
S7	45.177	153.467	**198.644**	169.907
S5	45.177	153.837	**199.014**	167.052
Capacity Value ($)				
Pre Reallocation	$5,782,720	$19,965,723	**$25,748,443**	$21,967,835
Current Condition	$5,782,720	$19,758,904	**$25,541,624**	$21,743,947
S7	$5,782,720	$19,643,721	**$25,426,441**	$21,748,156
S5	$5,782,720	$19,691,115	**$25,473,834**	$21,727,601
Change in Capacity (MW)				
Pre Reallocation	0.000	0.000	**0.000**	0.000
Base Condition[1]	0.000	-1.616	**-1.616**	-1.749
S7[2]	0.000	-0.900	**-0.900**	1.069
S5[2]	0.000	-0.530	**-0.530**	-2.822
Capacity Benefits ($)				
Pre Reallocation	$0	$0	**$0**	$0
Base Condition[1]	$0	-$206,819	**-$206,819**	-$223,889
S7[2]	$0	-$115,183	**-$115,183**	$4,209
S5[2]	$0	-$67,790	**-$67,790**	-$16,345

7 Stockton Hydropower Results Validation

Kansas City District (NWK) modeled reservoir operations using RESSIM at a daily time-step as the initial procedure. The RESSIM software models reservoir operations at one or more reservoirs for a variety of operational goals and constraints. The software simulates reservoir operations for flood management, low flow augmentation, hydropower and water supply for planning studies, detailed reservoir regulation plan investigations and real-time decision support. Kansas City District RESSIM output was provided to HAC with the following parameters for Stockton and Truman reservoirs operation to compute energy and capacity benefits;

- TAILWATER-ELEV (ft)
- POOL-ELEV (ft)
- POOL FLOW-OUT (cfs)
- TURBINES FLOW (cfs)

There were two assumptions made in the RESSIM modeling that HAC feel may impact or bias the results. The first was the assumption of constant turbine efficiency. Turbine efficiency changes as a function of both the flow going through the turbine and its associated head (Reservoir elevation-tailwater elevation.). This efficiency can vary anywhere from 80%-95%. The RESSIM model assumed 85% efficiency. The second assumption comes from assuming a fixed tailwater. This assumption can affect the results in two ways. First as stated above, turbine efficiency is a function of head. Incorrectly calculating the tailwater, may impact efficiency and therefore energy calculations. Second the hydraulic limits of the turbine are also a function of head. An incorrect tailwater assumption could lead to an erroneous hydraulic limit and consequently lead to an incorrect capability calculation which would impact the capacity results.

To test the impact of these assumptions on capacity and energy calculations for Stockton, the HAC performed a model validation procedure comparing the RESSIM results to a more rigorous hydropower generation model used by the Hydroelectric Design Center (HDC) () for turbine sizing studies. This analysis was performed on the Stockton powerhouse across two alternatives to establish the magnitude of the error, and verify whether or not there was a bias between the alternatives made from RESSIM assumptions.

7.1 SCE-TOM MODELING PROCEDURE

The SCE-TOM was developed by the Hydroelectric Design Center (HDC) in 2015 to aid in calculating economic benefits of turbine replacements and uprates across the USACE fleet. The two main motivations of this software development was to standardize the turbine dispatch across the units when comparing across alternatives, and to utilize the breadth of the entire turbine efficiency hill curves. Since its development, the SCE-TOM has been used in a number of uprate studies across the USACE fleet and is now considered the standard approach to evaluate alternatives.

APPENDIX D: HAC Alternate Method for Computing Hydropower Plant Generation is a written description of this SEC-TOM modeling procedure. The procedure was developed for analyses of turbine upgrades for Wolf Creek hydropower plant.

7.1.1 SCE-TOM turbine dispatch model

The goal of optimal hourly unit dispatch is to distribute the flow among the units to maximize generation. Unit efficiency is determined by unit and alternative specific hill curves-lookup tables

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that associate efficiency as a function of flow and head. From these, generation is determined using the standard hydropower equation:

$$Power(MW) = \frac{Q(cfs) * Head(feet) * efficiency}{11{,}800}$$

To maximize generation using the SCE-UA algorithm the following objective function is developed:

$$MAX\left[\sum_{i=1}^{n}\left(P(H_t, Q_t^i, e_t^i) - w_1\left|Q_t^i - Q_{t-1}^i\right| - w_2 F(H_t, Q_t^i)\right)\right]$$

Where,

$\mathrm{n} = \text{Number of units}$

$\mathrm{H_t} = \text{Head at time t}$

$Q_t^i = Flow\ through\ turbine\ at\ time\ t$

$$e_t^i = Efficiency\ of\ turbine\ i\ at\ time\ t$$

$$P(H_t, Q_t^i, e_t^i) = Power(MWH) for\ unit\ i\ at\ time\ t\ with\ efficiency\ e$$

$$F(H_t, Q_t^i) = \begin{cases} 1 & H_t, Q_t^i \in \text{Cavitation Zone} \\ 0 & H_t, Q_t^i \notin \text{Cavitation Zone} \end{cases}$$

$w_1 = Weighted\ penalty\ coefficient\ for\ unit\ flow\ changes$

$w_2 = Weighted\ penalty\ coefficient\ for$ cavitation zones

HDC's Turbo-machinery section provided inputs into this model that include the Turbine Efficiency Hill Curves and Cavitation Flow Limits.

7.1.2 SCE-TOM Hourly flow distribution

Since the RESSIM model only outputs flow and generation on a daily time-step, proper calculation of energy and capacity required shaping these daily outputs into hourly distributions. In general, there are a few approaches HAC can use to create these distributions; optimal economic which seeks to optimize the value of the generation given an hourly electricity price signal, optimal power which seeks to optimize the total power coming from the flow, and simulation based on historical records.

Since the hourly historical records were limited, for this validation the optimal economic assumption was utilized. It was confirmed that this approach was suitable, because Stockton is a peaking plant.

7.2 RESULTS COMPARED

Table 7-1 below shows a comparison of the Stockton results in HAC's calculation of energy and capacity between the RESSIM (35K FP/ 37.5K MP) (an earlier model iteration) model and the

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SCE-TOM (base_comp). For both energy and capacity there seems to be an approximate difference of 3.5%. This difference holds across both alternatives.

Table 7-1: Validation of Stockton Hydropower Results

		CAPACITY (MW)		ENERGY (MWh)	
ALTERNATIVE	method	average availability			
	model data source	RESSIM	SCE_TOM	RESSIM	SCE_TOM
SEC-TOM (base_comp)		51.671	53.516	46,791.7	48,446.8
	difference		3.57%		3.54%
RESSIM (Alt 35,000AF FP/ 37,500 AF MP)		51.671	53.513	44,291.9	45,844.8
	difference		3.56%		3.51%

7.3 VALIDATION CONCONLUSION

HAC has concluded that this error is reasonable and the modeling assumptions are valid.

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8 Summary of Hydropower Benefits Foregone

Table 58 summarizes power benefits foregone for the USACE Osage River Basin hydropower projects due to each of the potential alternatives for water reallocation. Hydropower benefits foregone are the sum of both the energy and capacity benefits. The data in Table 8-1 is derived from prior sections of this report.

Table 8-1: Summary of Average Annual Combined Power Benefits Foregone

ALTERNATIVES	Stockton (STN)	Harry S Truman (HST)	STN+HST	Bagnell
			Federal	Non-Federal
Energy Value (Table 5-3)				
Pre Reallocation	$1,642,500	$7,501,484	**$9,143,984**	$10,221,724
Current Condition	$1,576,572	$7,464,185	**$9,040,757**	$10,126,249
S7	$1,489,626	$7,424,363	**$8,913,988**	$10,091,620
S5	$1,467,527	$7,440,913	**$8,908,440**	$10,157,842
Capacity Value (Table 6-5)				
Pre Reallocation	$5,782,720	$19,965,723	**$25,748,443**	$21,967,835
Current Condition	$5,782,720	$19,758,904	**$25,541,624**	$21,743,947
S7	$5,782,720	$19,643,721	**$25,426,441**	$21,748,156
S5	$5,782,720	$19,691,115	**$25,473,834**	$21,727,601
Hydropower Value (energy+capacity)				
Pre Reallocation	$7,425,220	$27,467,208	**$34,892,427**	$32,189,559
Current Condition	$7,359,292	$27,223,089	**$34,582,381**	$31,870,196
S7	$7,272,345	$27,068,084	**$34,340,429**	$31,839,775
S5	$7,250,246	$27,132,028	**$34,382,274**	$31,885,443
Hydropower Benefits (energy+capacity)				
Pre Reallocation	$0	$0	**$0**	$0
Current Condition[1]	-$65,928	-$244,118	**-$310,046**	-$319,364
S7[2]	-$86,946	-$155,006	**-$241,952**	-$30,420
S5[2]	-$109,045	-$91,061	**-$200,107**	$15,247

Note 1: Change in Current Condition from Pre-Reallocation

Note 2: Change in Alternative S7 & S5 from Current Condition

9 Replacement Cost of Power

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

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10 Revenue Foregone

Revenue foregone 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-yr

To compute energy revenues foregone, the contract peaking energy rate is applied to the average annual on-peak contract energy losses, and the supplemental peaking energy rate is applied to on-peak non-contract energy losses and off-peak energy losses. Supportable capacity in the critical year of 1954, which is used in the revenue foregone calculation, was unaffected by any of the reallocation conditions, so there is no capacity revenue foregone. The tables below show the Power Revenues Foregone for each of the alternatives.

Table 10-1: Revenue Foregone Summary for the Alternatives

Alternative	STN & HST Annual Energy (MWh)	Energy Revenue ($15.30/MWh)	Critical Year Capacity (MW)*	Capacity Revenue ($55,190.40/MW-yr)	Total Revenue	Total Revenue Foregone
Pre Reallocation	353,938	$5,415,251	204.169	$11,268,153.80	$16,683,405	$0
Current Condition[1]	349,058	$5,340,592	205.200	$11,325,070.08	$16,665,662	**-$17,743**
S7[2]	343,930	$5,262,129	205.200	$11,325,070.08	$16,587,199	**-$78,463**
S5[2]	343,473	$5,255,142	205.200	$11,325,070.08	$16,580,212	**-$85,450**

Note 1: Change in Current Condition from Pre-Reallocation
Note 2: Change in Alternative S7 & S5 from Current Condition
Note *: Supportable Capacity in the (SWPA) Critical Year 1954

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11 Credit to Power Marketing Agency

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

Planning Guidance Notebook, Appendix E-57.d.(3)(a) of ER 1105-2-100 (22 April 2002) states;

> "When hydropower is adversely impacted by reallocation of the flood pool to satisfy additional water supply needs, hydropower losses can be mitigated through the provision of financial credit. In this case, credits will be provided to the hydropower account from a portion of the water supply storage proceeds. This credit is based on revenues foregone to the United States Treasury for repayment of the hydropower costs assigned to the project. Revenues foregone reflect the allocated costs to power upon which the rates are based. When reallocation is accomplished through this credit approach, in essence, the allocation of costs is adjusted without performing a laborious new cost allocation. …" *(credit #1)*

> *(credit #2)* "Additionally, where existing Federal power delivery contracts require market purchases of power as a result of storage reallocations and withdrawals, the power marketing agency may obtain an additional credit for the funds expended for those purchases upon demonstration that they were made as a direct result of the reallocation."

Planning Guidance Notebook, ER 1105-2-100 (22 April 2002), Appendix E, SECTION VIII - Water Supply, Para. E-57.d.(3).;

> "If hydropower revenues are being reduced as a result of the reallocation, the power marketing agency will be credited for the amount of revenues to the Treasury foregone as a result of the reallocation assuming uniform annual repayment. In instances where existing contracts between the power marketing agency and its customer would result in a cost to the Federal Government to acquire replacement power to fulfill the obligations of contracts, an additional credit to the power marketing agency can be made for such costs incurred during the remaining period of the contracts. Such credits should not actually be made for replacement costs until the costs are incurred and documented by the power marketing agency."

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Thus, there may be an annual credit due to the PMA resulting from the proposed water supply reallocation that reduces revenues.

For the purposes of providing an estimate, the annual credit will be based on the revenue foregone as calculated in Section 10 because the power sales contracts are “evergreen” with the rate adjusted periodically to cover the cost of O&M for providing hydropower from the Federal projects and to repay the Treasury for the hydropower portion of the Federal investment in the project. In either case, the annual credit is based on revenue lost or costs actually incurred (and documented by the PMA).

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12 Summary of Results

Annual hydropower benefits foregone are described in Sections 3, 4, 5, and 6. 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 foregone for each alternative have been annualized over the 50-year period and the discount rate of 2.875% are shown below.

Under the Current/ExistingCondition (reallocation of 50,000 acre-feet) hydropower benefits are estimated to have been reduced by $310,046 annually. With a pool raise and reallocation of an additional 94,750 acre-feet an additional $241,952 in annual hydropower benefits would be lost. Reallocating 90,200 acre-feet without a pool raise annual hydropower benefits would be reduced by $200,107.

Table 12-1: Average Annual Combined Hydropower Benefits Foregone as Compared to the Existing Condition

ALTERNATIVES	Stockton (STN)	Harry S Truman (HST)	STN+HST	Bagnell
			Federal	Non-Federal
Energy Value (Table 5-3)				
Pre Reallocation	$1,642,500	$7,501,484	**$9,143,984**	$10,221,724
Current Condition	$1,576,572	$7,464,185	**$9,040,757**	$10,126,249
S7	$1,489,626	$7,424,363	**$8,913,988**	$10,091,620
S5	$1,467,527	$7,440,913	**$8,908,440**	$10,157,842
Capacity Value (Table 6-5)				
Pre Reallocation	$5,782,720	$19,965,723	**$25,748,443**	$21,967,835
Current Condition	$5,782,720	$19,758,904	**$25,541,624**	$21,743,947
S7	$5,782,720	$19,643,721	**$25,426,441**	$21,748,156
S5	$5,782,720	$19,691,115	**$25,473,834**	$21,727,601
Hydropower Value (energy+capacity)				
Pre Reallocation	$7,425,220	$27,467,208	**$34,892,427**	$32,189,559
Current Condition	$7,359,292	$27,223,089	**$34,582,381**	$31,870,196
S7	$7,272,345	$27,068,084	**$34,340,429**	$31,839,775
S5	$7,250,246	$27,132,028	**$34,382,274**	$31,885,443
Hydropower Benefits (energy+capacity)				
Pre Reallocation	$0	$0	**$0**	$0
Current Condition[1]	-$65,928	-$244,118	**-$310,046**	-$319,364
S7[2]	-$86,946	-$155,006	**-$241,952**	-$30,420
S5[2]	-$109,045	-$91,061	**-$200,107**	$15,247

Note 1: Change in Current Condition from Pre-Reallocation

Note 2: Change in Alternative S7 & S5 from Current Condition

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Revenues foregone are described in Section 10. Revenue is estimated by applying Power Marketing Administration's Contract Sales Rates to the energy and capacity losses. Total average annual revenues and revenue foregone under each alternative are summarized below.

Under the Current Condition (reallocation of 50,000 acre-feet) revenue is estimated to have been reduced by $17,744 annually. With a pool raise and reallocation of an additional 94,750 acre-feet an additional $78,463 in revenue would be lost. Reallocating 90,200 acre-feet without a pool raise hydropower benefits would be reduced by $85,450.

Table 12-2: Average Annual Combined Revenue Foregone

Alternative	STN & HST Annual Energy (MWh)	Energy Revenue ($15.30/MWh)	Critical Year Capacity (MW)*	Capacity Revenue ($55,190.40/MW-yr)	**Total Revenue**	**Total Revenue Foregone**
Pre Reallocation	353,938	$5,415,251	204.169	$11,268,153.80	**$16,683,405**	**$0**
Current Condition[1]	349,058	$5,340,592	205.200	$11,325,070.08	**$16,665,662**	**-$17,743**
S7[2]	343,930	$5,262,129	205.200	$11,325,070.08	**$16,587,199**	**-$78,463**
S5[2]	343,473	$5,255,142	205.200	$11,325,070.08	**$16,580,212**	**-$85,450**

Note 1: Change in Current Condition from Pre-Reallocation

Credit due the PMA under the water supply reallocation from each alternative is described in Section 11 and for purposes of this study are considered to be the same as Revenue Foregone.

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APPENDIX A: Energy Generation Losses by Alternative

The tables below summarize the generation losses as compared to the Existing Condition. The first section shows the changes between the Pre-Reallocation/Original Condition and the Existing Condition with the current reallocation to water supply. The following sections compared the additional alternatives to the Existing Condition.

Bagnell is shown separately from the other two dams for information because it is not a federal hydropower project.

A 1. Pre-Reallocation/Original Condition

Table A-1-1: Estimated Average Monthly Generation and Energy Values for USACE Plants under Pre-Reallocation /Original Condition

STON-PR---0 Pre-Reallocation/Original Condition

	Stockton (STN)							Harry S. Truman (HST)							STN + HST					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours		On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours		On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday		Weekday	Weekday	Weekday	Saturday	Saturday	Sunday		Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	MWH	MWH	MWH	MWH	MWH	MWH		MWH	MWH	MWH	MWH	MWH	MWH		MWH	MWH	MWH	MWH	MWH	MWH
Jan	3,028	2,084	0	212	105	340	Jan	8,978	5,962	1,032	854	740	1,706	Jan	12,006	8,046	1,032	1,066	845	2,047
Feb	1,671	2,237	5	169	72	252	Feb	6,106	9,213	990	1,095	688	2,014	Feb	7,776	11,450	995	1,264	760	2,266
Mar	1,605	2,515	155	389	208	575	Mar	7,046	14,691	3,554	2,185	2,176	4,552	Mar	8,651	17,206	3,709	2,574	2,384	5,127
Apr	2,062	3,411	285	435	244	758	Apr	6,515	16,227	4,951	2,619	2,494	5,426	Apr	8,577	19,637	5,236	3,054	2,738	6,183
May	1,923	2,859	367	360	280	724	May	6,682	16,573	6,580	2,470	2,849	5,698	May	8,605	19,432	6,947	2,829	3,130	6,422
Jun	2,562	2,131	516	415	357	724	Jun	9,205	12,622	5,341	2,323	2,828	5,018	Jun	11,767	14,753	5,856	2,738	3,185	5,742
Jul	4,811	677	288	221	193	446	Jul	10,017	4,459	3,579	1,417	1,512	3,570	Jul	14,828	5,136	3,867	1,638	1,705	4,016
Aug	5,016	307	63	121	93	196	Aug	6,059	2,077	1,565	757	750	1,394	Aug	11,075	2,384	1,628	878	843	1,590
Sep	1,699	354	4	63	45	75	Sep	4,264	3,516	862	484	548	990	Sep	5,963	3,870	866	547	593	1,065
Oct	359	656	0	83	50	130	Oct	3,394	5,518	1,805	838	980	1,867	Oct	3,754	6,174	1,805	921	1,030	1,997
Nov	673	1,246	0	160	73	235	Nov	4,067	9,331	2,611	1,137	1,377	2,716	Nov	4,740	10,577	2,611	1,297	1,450	2,950
Dec	1,767	1,104	0	221	103	334	Dec	7,122	7,295	2,398	1,403	1,345	3,011	Dec	8,889	8,400	2,398	1,623	1,448	3,346
Annual	27,177	19,582	1,684	2,848	1,823	4,790	Annual	79,455	107,483	35,267	17,581	18,287	37,961	Annual	106,632	127,065	36,950	20,429	20,111	42,752
Total	57,903						Total	296,035						Total	353,938					

	Stockton (STN)							Harry S. Truman (HST)							STN + HST					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours		On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours		On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday		Weekday	Weekday	Weekday	Saturday	Saturday	Sunday		Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	$	$	$	$	$	$		$	$	$	$	$	$		$	$	$	$	$	$
Jan	$99,832	$51,006	$0	$5,171	$1,923	$7,614	Jan	$295,955	$145,945	$20,438	$20,862	$13,548	$38,193	Jan	$395,787	$196,950	$20,438	$26,033	$15,471	$45,807
Feb	$59,259	$56,707	$100	$4,025	$1,225	$5,434	Feb	$216,583	$233,499	$18,782	$26,038	$11,763	$43,415	Feb	$275,842	$290,206	$18,882	$30,062	$12,989	$48,848
Mar	$53,711	$60,972	$2,553	$9,367	$3,388	$12,362	Mar	$235,856	$356,180	$58,505	$52,646	$35,443	$97,813	Mar	$289,567	$417,153	$61,058	$62,013	$38,831	$110,174
Apr	$71,554	$91,739	$4,842	$11,278	$4,036	$17,269	Apr	$226,046	$436,437	$84,038	$67,851	$41,260	$123,639	Apr	$297,600	$528,175	$88,879	$79,129	$45,296	$140,908
May	$70,641	$78,544	$5,949	$10,032	$4,275	$17,148	May	$245,424	$455,256	$106,739	$68,902	$43,480	$134,970	May	$316,066	$533,800	$112,688	$78,934	$47,755	$152,118
Jun	$93,746	$54,708	$8,278	$11,920	$5,776	$17,769	Jun	$336,775	$324,015	$85,688	$66,674	$45,741	$123,066	Jun	$430,521	$378,723	$93,966	$78,594	$51,517	$140,835
Jul	$171,621	$16,483	$4,903	$6,461	$3,156	$11,139	Jul	$357,343	$108,608	$60,845	$41,446	$24,741	$89,093	Jul	$528,964	$125,091	$65,748	$47,907	$27,897	$100,232
Aug	$168,230	$7,014	$1,053	$3,273	$1,571	$4,647	Aug	$203,209	$47,464	$26,251	$20,554	$12,640	$33,060	Aug	$371,439	$54,477	$27,304	$23,827	$14,210	$37,707
Sep	$57,980	$9,082	$70	$1,738	$735	$1,781	Sep	$145,471	$90,090	$14,161	$13,328	$8,885	$23,521	Sep	$203,451	$99,172	$14,230	$15,066	$9,620	$25,302
Oct	$11,332	$16,554	$0	$2,096	$833	$2,911	Oct	$107,031	$139,250	$30,325	$21,176	$16,223	$41,762	Oct	$118,363	$155,804	$30,325	$23,272	$17,056	$44,673
Nov	$22,301	$31,470	$0	$4,122	$1,366	$5,498	Nov	$134,803	$235,679	$49,495	$29,296	$25,841	$63,634	Nov	$157,105	$267,149	$49,495	$33,418	$27,206	$69,132
Dec	$33,411	$16,888	$0	$3,132	$1,117	$4,378	Dec	$134,695	$111,554	$28,552	$19,925	$14,632	$39,438	Dec	$168,106	$128,442	$28,552	$23,058	$15,748	$43,817
Annual	$913,620	$491,169	$27,746	$72,616	$29,400	$107,949	Annual	$2,639,192	$2,683,975	$583,818	$448,697	$294,197	$851,605	Annual	$3,552,812	$3,175,144	$611,564	$521,313	$323,597	$959,555
Total	$1,642,500						Total	$7,501,484						Total	$9,143,984					

Table A-1-2: Estimated Average Monthly Generation and Energy Values for Bagnell under Pre-Reallocation /Original Condition

STON-PR---0	Pre-Reallocation/Original Condition					
	Bagnell					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	MWH	MWH	MWH	MWH	MWH	MWH
Jan	14,623	14,938	4,615	3,037	1,672	4,571
Feb	8,050	17,863	4,571	2,515	1,605	4,329
Mar	8,592	20,895	7,472	3,182	3,371	6,586
Apr	6,211	18,696	8,375	2,623	3,572	6,666
May	6,518	20,374	8,712	2,769	3,789	6,582
Jun	10,206	14,704	8,380	2,605	3,472	6,191
Jul	12,104	5,636	5,234	1,941	2,570	4,087
Aug	7,284	2,717	2,519	1,088	1,126	1,921
Sep	6,372	7,239	2,533	1,330	897	2,375
Oct	3,236	7,232	2,969	1,067	1,470	2,562
Nov	3,963	11,151	4,617	1,441	1,937	3,553
Dec	6,439	8,474	3,966	1,517	1,809	3,577
Annual	93,598	149,919	63,964	25,116	27,290	53,000
Total	412,887					

	Bagnell					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	$	$	$	$	$	$
Jan	$482,047	$365,653	$91,421	$74,163	$30,603	$102,307
Feb	$285,560	$452,752	$86,731	$59,834	$27,419	$93,318
Mar	$287,575	$506,594	$123,012	$76,663	$54,910	$141,529
Apr	$215,507	$502,852	$142,159	$67,969	$59,099	$151,909
May	$239,396	$559,667	$141,335	$77,255	$57,812	$155,909
Jun	$373,390	$377,461	$134,461	$74,762	$56,160	$151,841
Jul	$431,784	$137,284	$88,985	$56,778	$42,056	$101,999
Aug	$244,295	$62,096	$42,264	$29,553	$18,980	$45,555
Sep	$217,419	$185,487	$41,611	$36,607	$14,549	$56,434
Oct	$102,040	$182,496	$49,880	$26,971	$24,337	$57,318
Nov	$131,349	$281,667	$87,511	$37,138	$36,347	$83,254
Dec	$121,783	$129,578	$47,211	$21,554	$19,679	$46,845
Annual	$3,132,143	$3,743,585	$1,076,580	$639,247	$441,951	$1,188,217
Total	$10,221,724					

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A 2. Existing/Current Condition

Table A-2-1: Estimated Average Monthly Generation and Energy Values for USACE Plants under Existing/Current Condition

STON-BC---0 Base Case / Existing Condition

	Stockton (STN)							Harry S. Truman (HST)							STN + HST					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours		On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours		On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday		Weekday	Weekday	Weekday	Saturday	Saturday	Sunday		Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	MWH	MWH	MWH	MWH	MWH	MWH		MWH	MWH	MWH	MWH	MWH	MWH		MWH	MWH	MWH	MWH	MWH	MWH
Jan	3,026	2,057	0	190	96	312	Jan	8,966	5,972	1,130	889	769	1,853	Jan	11,992	8,029	1,130	1,079	864	2,166
Feb	1,669	2,182	0	153	63	223	Feb	6,124	9,233	952	1,109	692	1,994	Feb	7,793	11,415	952	1,261	755	2,217
Mar	1,522	2,349	114	315	173	489	Mar	6,922	14,540	3,562	2,282	2,241	4,390	Mar	8,444	16,889	3,676	2,597	2,414	4,879
Apr	2,064	3,221	242	357	199	623	Apr	6,607	16,181	4,876	2,505	2,662	5,581	Apr	8,671	19,401	5,118	2,861	2,861	6,204
May	1,883	2,640	311	282	225	599	May	6,730	16,877	6,561	2,440	2,882	5,275	May	8,613	19,517	6,872	2,722	3,107	5,874
Jun	2,486	1,835	236	369	244	603	Jun	9,046	12,269	5,045	2,170	2,584	5,044	Jun	11,531	14,104	5,281	2,539	2,827	5,646
Jul	4,942	716	121	255	180	455	Jul	9,984	4,418	3,418	1,423	1,593	3,669	Jul	14,926	5,135	3,540	1,678	1,773	4,124
Aug	5,073	340	25	128	83	184	Aug	6,121	1,932	1,517	700	552	1,517	Aug	11,194	2,272	1,542	827	635	1,700
Sep	1,701	313	13	40	32	74	Sep	4,201	3,428	878	505	570	1,010	Sep	5,901	3,741	891	545	602	1,084
Oct	368	665	0	72	45	119	Oct	3,395	5,604	1,842	870	972	1,781	Oct	3,763	6,269	1,842	942	1,017	1,900
Nov	662	1,202	0	127	56	205	Nov	4,076	9,289	2,629	1,143	1,448	2,703	Nov	4,737	10,490	2,629	1,270	1,504	2,907
Dec	1,759	1,039	0	185	77	268	Dec	7,128	7,049	2,327	1,420	1,285	2,835	Dec	8,887	8,088	2,327	1,605	1,362	3,103
Annual	27,156	18,558	1,063	2,471	1,472	4,154	Annual	79,298	106,793	34,736	17,455	18,251	37,652	Annual	106,454	125,351	35,799	19,926	19,722	41,807
Total	54,874						Total	294,185						Total	349,058					

	Stockton (STN)							Harry S. Truman (HST)							STN + HST					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours		On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours		On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday		Weekday	Weekday	Weekday	Saturday	Saturday	Sunday		Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	$	$	$	$	$	$		$	$	$	$	$	$		$	$	$	$	$	
Jan	$99,744	$50,353	$0	$4,634	$1,754	$6,988	Jan	$295,586	$146,191	$22,377	$21,709	$14,066	$41,485	Jan	$395,330	$196,544	$22,377	$26,342	$15,820	$48,472
Feb	$59,221	$55,303	$0	$3,629	$1,075	$4,811	Feb	$217,228	$234,026	$18,060	$26,375	$11,832	$42,972	Feb	$276,449	$289,329	$18,060	$30,004	$12,906	$47,783
Mar	$50,958	$56,948	$1,875	$7,581	$2,818	$10,503	Mar	$231,688	$352,523	$58,646	$54,977	$36,512	$94,352	Mar	$282,647	$409,471	$60,520	$62,559	$39,330	$104,856
Apr	$71,628	$86,624	$4,112	$9,238	$3,285	$14,202	Apr	$229,234	$435,206	$82,773	$64,901	$44,036	$127,174	Apr	$300,861	$521,830	$86,884	$74,139	$47,321	$141,376
May	$69,176	$72,517	$5,048	$7,872	$3,437	$14,197	May	$247,169	$463,608	$106,431	$68,068	$43,982	$124,945	May	$316,345	$536,125	$111,478	$75,940	$47,419	$139,142
Jun	$90,937	$47,104	$3,789	$10,595	$3,941	$14,788	Jun	$330,958	$314,956	$80,947	$62,276	$41,788	$123,699	Jun	$421,895	$362,060	$84,736	$72,871	$45,729	$138,487
Jul	$176,292	$17,452	$2,065	$7,462	$2,939	$11,364	Jul	$356,162	$107,613	$58,110	$41,615	$26,076	$91,563	Jul	$532,454	$125,065	$60,175	$49,078	$29,015	$102,927
Aug	$170,149	$7,782	$419	$3,467	$1,394	$4,353	Aug	$205,269	$44,148	$25,445	$18,995	$9,309	$35,982	Aug	$375,418	$51,930	$25,864	$22,462	$10,703	$40,335
Sep	$58,022	$8,021	$213	$1,106	$521	$1,755	Sep	$143,321	$87,844	$14,416	$13,903	$9,242	$24,008	Sep	$201,344	$95,865	$14,629	$15,009	$9,762	$25,762
Oct	$11,602	$16,770	$0	$1,812	$747	$2,662	Oct	$107,040	$141,414	$30,938	$21,991	$16,090	$39,849	Oct	$118,642	$158,184	$30,938	$23,804	$16,836	$42,511
Nov	$21,930	$30,358	$0	$3,261	$1,046	$4,792	Nov	$135,090	$234,617	$49,828	$29,462	$27,174	$63,335	Nov	$157,020	$264,975	$49,828	$32,723	$28,220	$68,126
Dec	$33,271	$15,880	$0	$2,627	$839	$3,516	Dec	$134,800	$107,795	$27,707	$20,170	$13,982	$37,125	Dec	$168,071	$123,675	$27,707	$22,797	$14,821	$40,640
Annual	$912,930	$465,113	$17,520	$63,285	$23,795	$93,929	Annual	$2,633,545	$2,669,941	$575,677	$444,444	$294,089	$846,489	Annual	$3,546,476	$3,135,053	$593,197	$507,729	$317,883	$940,419
Total	$1,576,572						Total	$7,464,185						Total	$9,040,757					

Table A-2-2: Estimated Average Monthly Generation and Energy Values for Bagnell under the Existing/ Current Condition (MWh)

STON-BC---0	Base Case / Existing Condition					
	Bagnell					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	MWH	MWH	MWH	MWH	MWH	MWH
Jan	14,458	14,784	4,591	3,031	1,639	4,278
Feb	7,998	17,671	4,597	2,526	1,689	4,391
Mar	8,452	20,383	7,403	3,174	3,402	6,425
Apr	6,461	19,304	8,422	2,565	3,543	6,901
May	6,385	19,837	8,717	2,578	3,561	6,581
Jun	9,939	14,394	8,170	2,752	3,771	5,617
Jul	12,127	5,776	5,262	1,888	2,431	4,143
Aug	7,449	2,668	2,370	1,079	1,008	1,969
Sep	6,372	7,156	2,445	1,374	1,069	2,148
Oct	3,137	6,934	2,802	1,037	1,453	2,506
Nov	3,945	11,100	4,754	1,366	1,701	3,598
Dec	6,369	8,312	3,899	1,587	1,793	3,379
Annual	93,093	148,319	63,431	24,955	27,062	51,937
Total	408,797					

	Bagnell					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	$	$	$	$	$	$
Jan	$476,634	$361,870	$90,956	$74,027	$30,001	$95,760
Feb	$283,719	$447,876	$87,208	$60,083	$28,866	$94,650
Mar	$282,896	$494,190	$121,867	$76,468	$55,427	$138,074
Apr	$224,166	$519,210	$142,963	$66,455	$58,608	$157,251
May	$234,520	$544,940	$141,411	$71,920	$54,346	$155,878
Jun	$363,644	$369,493	$131,082	$78,984	$60,995	$137,769
Jul	$432,612	$140,684	$89,462	$55,213	$39,782	$103,401
Aug	$249,804	$60,982	$39,752	$29,308	$16,990	$46,698
Sep	$217,419	$183,365	$40,165	$37,822	$17,343	$51,042
Oct	$98,911	$174,974	$47,078	$26,199	$24,052	$56,067
Nov	$130,751	$280,372	$90,113	$35,187	$31,920	$84,301
Dec	$120,454	$127,102	$46,413	$22,543	$19,509	$44,252
Annual	$3,115,529	$3,705,058	$1,068,470	$634,211	$437,839	$1,165,142
Total	$10,126,249					

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Table A-2-3: Estimated Average Monthly Generation Changes for USACE Plants under Existing Condition/Baseline vs. Pre-Reallocation/ Original Condition.

PR-BC

	Stockton (STN)					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	MWH	MWH	MWH	MWH	MWH	MWH
Jan	3	27	0	22	9	28
Feb	1	55	5	17	9	29
Mar	82	166	41	74	35	86
Apr	-2	190	43	79	45	135
May	40	219	56	77	55	125
Jun	77	296	280	46	113	122
Jul	-131	-40	167	-34	13	-9
Aug	-57	-34	38	-7	10	12
Sep	-1	41	-9	23	13	1
Oct	-9	-9	0	11	5	11
Nov	11	44	0	33	17	30
Dec	7	66	0	36	26	66
Annual	21	1,023	621	377	352	636
Total	3,029					

	Harry S. Truman (HST)					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	MWH	MWH	MWH	MWH	MWH	MWH
Jan	11	-10	-98	-35	-28	-147
Feb	-18	-21	38	-14	-4	21
Mar	125	151	-9	-97	-66	161
Apr	-92	46	75	114	-168	-155
May	-48	-304	19	30	-33	423
Jun	159	353	295	153	244	-26
Jul	33	41	161	-6	-82	-99
Aug	-61	145	48	57	198	-123
Sep	63	88	-16	-21	-22	-20
Oct	0	-86	-36	-32	8	86
Nov	-9	42	-18	-6	-71	13
Dec	-6	246	71	-17	60	177
Annual	157	690	531	126	37	309
Total	1,850					

	STN + HST					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	MWH	MWH	MWH	MWH	MWH	MWH
Jan	14	17	-98	-13	-19	-119
Feb	-17	35	43	2	5	49
Mar	207	317	33	-23	-31	248
Apr	-94	236	118	193	-122	-21
May	-8	-85	75	107	22	548
Jun	236	649	575	199	358	96
Jul	-98	1	328	-40	-68	-108
Aug	-119	111	86	50	208	-111
Sep	62	129	-24	2	-9	-19
Oct	-9	-94	-36	-21	13	97
Nov	3	86	-18	27	-54	43
Dec	2	312	71	18	85	243
Annual	179	1,714	1,152	503	388	945
Total	4,880					

Table A-2-4: Estimated Average Monthly Generation Changes for Bagnell under Existing Condition/Baseline vs. Pre-Reallocation/ Original Condition.

PR-BC

	Bagnell					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	MWH	MWH	MWH	MWH	MWH	MWH
Jan	164	155	23	6	33	293
Feb	52	192	-25	-10	-85	-62
Mar	140	512	70	8	-32	161
Apr	-250	-608	-47	58	30	-234
May	133	536	-5	191	227	1
Jun	266	310	211	-147	-299	574
Jul	-23	-140	-28	54	139	-56
Aug	-164	49	150	9	118	-48
Sep	0	83	88	-44	-172	227
Oct	99	298	167	31	17	56
Nov	18	51	-137	76	236	-45
Dec	70	162	67	-70	16	198
Annual	505	1,600	533	161	228	1,064
Total	4,091					

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A3. Alternative S7

Reallocation of 45,750 AF from the Stockton's Multi-Purpose Pool and 49,000 AF from the Flood Control Pool

The tables below summarize the energy loss from the existing condition/base condition to the S7 Alternative at each of the plants and the total loss for the system under the current conditions. Bagnell is shown separately and not included in total calculations.

Table A-3-1: Estimated Average Monthly Generation and Energy Values for USACE Plants under Alternative S7

STO17SRDC20 Alternative S17

	Stockton (STN)							Harry S. Truman (HST)							STN + HST					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours		On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours		On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday		Weekday	Weekday	Weekday	Saturday	Saturday	Sunday		Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	MWH	MWH	MWH	MWH	MWH	MWH		MWH	MWH	MWH	MWH	MWH	MWH		MWH	MWH	MWH	MWH	MWH	MWH
Jan	3,006	2,029	0	143	72	224	Jan	8,960	5,969	1,029	843	706	1,744	Jan	11,966	7,998	1,029	986	778	1,968
Feb	1,660	2,114	0	97	37	146	Feb	6,100	9,117	895	1,086	675	1,974	Feb	7,760	11,230	895	1,183	712	2,119
Mar	1,476	2,215	151	233	164	399	Mar	6,974	14,489	3,562	2,150	1,992	4,319	Mar	8,450	16,704	3,712	2,384	2,156	4,718
Apr	2,072	3,099	298	231	168	444	Apr	6,666	16,415	4,974	2,629	2,753	5,181	Apr	8,738	19,513	5,271	2,860	2,921	5,625
May	1,877	2,516	288	199	207	412	May	6,669	16,658	6,668	2,433	2,767	5,251	May	8,546	19,173	6,956	2,631	2,974	5,663
Jun	2,407	1,584	258	258	202	462	Jun	8,945	12,152	5,046	2,248	2,673	4,926	Jun	11,352	13,735	5,304	2,506	2,875	5,388
Jul	4,848	579	116	187	139	356	Jul	10,222	4,517	3,424	1,428	1,498	3,289	Jul	15,070	5,096	3,540	1,615	1,637	3,645
Aug	5,000	274	47	75	58	147	Aug	5,919	1,957	1,496	698	576	1,451	Aug	10,919	2,231	1,543	772	634	1,598
Sep	1,693	276	17	34	23	54	Sep	4,182	3,427	865	503	564	970	Sep	5,875	3,703	882	537	587	1,025
Oct	336	600	0	57	39	95	Oct	3,389	5,501	1,800	858	985	1,884	Oct	3,725	6,100	1,800	915	1,025	1,980
Nov	648	1,148	0	83	38	121	Nov	4,075	9,364	2,572	1,155	1,387	2,537	Nov	4,724	10,512	2,572	1,238	1,424	2,659
Dec	1,741	1,010	0	136	71	229	Dec	7,216	7,341	2,263	1,345	1,184	3,027	Dec	8,958	8,352	2,263	1,481	1,255	3,256
Annual	26,764	17,444	1,174	1,734	1,220	3,089	Annual	79,318	106,905	34,595	17,375	17,758	36,554	Annual	106,082	124,349	35,769	19,109	18,978	39,643
Total	51,425						Total	292,505						Total	343,930					

	Stockton (STN)							Harry S. Truman (HST)							STN + HST					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours		On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours		On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday		Weekday	Weekday	Weekday	Saturday	Saturday	Sunday		Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	$	$	$	$	$	$		$	$	$	$	$	$		$	$	$	$	$	$
Jan	$99,097	$49,677	$0	$3,496	$1,322	$5,004	Jan	$295,377	$146,102	$20,394	$20,586	$12,919	$39,038	Jan	$394,474	$195,779	$20,394	$24,083	$14,241	$44,042
Feb	$58,875	$53,579	$0	$2,319	$639	$3,144	Feb	$216,390	$231,067	$16,989	$25,830	$11,531	$42,539	Feb	$275,265	$284,646	$16,989	$28,149	$12,170	$45,683
Mar	$49,399	$53,707	$2,483	$5,622	$2,666	$8,581	Mar	$233,441	$351,273	$58,631	$51,800	$32,450	$92,817	Mar	$282,840	$404,980	$61,114	$57,422	$35,116	$101,398
Apr	$71,873	$83,347	$5,052	$5,993	$2,784	$10,109	Apr	$231,293	$441,494	$84,428	$68,106	$45,537	$118,071	Apr	$303,166	$524,840	$89,480	$74,100	$48,321	$128,179
May	$68,932	$69,114	$4,671	$5,540	$3,164	$9,763	May	$244,948	$457,587	$108,170	$67,868	$42,217	$124,370	May	$313,880	$526,701	$112,841	$73,408	$45,382	$134,133
Jun	$88,067	$40,651	$4,137	$7,404	$3,266	$11,339	Jun	$327,259	$311,946	$80,966	$64,516	$43,234	$120,811	Jun	$415,326	$352,596	$85,103	$71,919	$46,500	$132,150
Jul	$172,933	$14,107	$1,979	$5,475	$2,278	$8,873	Jul	$364,633	$110,024	$58,208	$41,776	$24,518	$82,083	Jul	$537,566	$124,131	$60,186	$47,251	$26,797	$90,956
Aug	$167,688	$6,270	$782	$2,026	$980	$3,489	Aug	$198,522	$44,725	$25,103	$18,945	$9,701	$34,411	Aug	$366,210	$50,995	$25,886	$20,971	$10,682	$37,900
Sep	$57,760	$7,063	$271	$937	$380	$1,294	Sep	$142,676	$87,821	$14,217	$13,860	$9,147	$23,060	Sep	$200,436	$94,884	$14,488	$14,797	$9,526	$24,354
Oct	$10,609	$15,131	$0	$1,451	$650	$2,134	Oct	$106,848	$138,804	$30,235	$21,681	$16,315	$42,149	Oct	$117,457	$153,935	$30,235	$23,131	$16,964	$44,283
Nov	$21,494	$28,994	$0	$2,132	$706	$2,839	Nov	$135,072	$236,526	$48,763	$29,767	$26,019	$59,456	Nov	$156,566	$265,521	$48,763	$31,899	$26,725	$62,295
Dec	$32,934	$15,447	$0	$1,933	$778	$2,996	Dec	$136,478	$112,259	$26,935	$19,108	$12,875	$39,647	Dec	$169,412	$127,706	$26,935	$21,041	$13,653	$42,643
Annual	$899,659	$437,087	$19,375	$44,328	$19,614	$69,563	Annual	$2,632,939	$2,669,628	$573,038	$443,843	$286,462	$818,452	Annual	$3,532,598	$3,106,714	$592,414	$488,171	$306,076	$888,016
Total	$1,489,626						Total	$7,424,363						Total	$8,913,988					

Table A-3-2: Estimated Average Monthly Generation and Energy Values for Bagnell under Alternative S7

STO17SRDC20	Alternative S17					
	Bagnell					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	MWH	MWH	MWH	MWH	MWH	MWH
Jan	14,482	14,715	4,569	3,055	1,612	4,329
Feb	8,061	17,685	4,519	2,492	1,675	4,258
Mar	8,453	20,101	7,236	3,061	3,322	6,236
Apr	6,474	19,475	8,565	2,457	3,337	6,668
May	6,244	19,699	8,683	2,578	3,544	6,494
Jun	9,925	14,527	8,204	2,326	3,120	6,278
Jul	11,897	5,506	5,151	1,853	2,460	4,370
Aug	7,243	2,734	2,447	1,098	1,060	1,678
Sep	6,273	7,113	2,516	1,351	1,019	2,080
Oct	3,203	7,270	2,996	995	1,250	2,678
Nov	4,025	11,420	4,782	1,373	1,761	3,396
Dec	6,566	8,701	3,948	1,572	1,771	3,501
Annual	92,847	148,945	63,615	24,210	25,931	51,966
Total	407,514					

	Bagnell					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	$	$	$	$	$	$
Jan	$477,427	$360,203	$90,521	$74,602	$29,492	$96,884
Feb	$285,961	$448,230	$85,727	$59,276	$28,626	$91,777
Mar	$282,946	$487,342	$119,124	$73,737	$54,116	$134,008
Apr	$224,610	$523,821	$145,388	$63,658	$55,205	$151,945
May	$229,332	$541,130	$140,851	$71,924	$54,076	$153,818
Jun	$363,132	$372,904	$131,631	$66,772	$50,464	$153,969
Jul	$424,395	$134,104	$87,563	$54,201	$40,263	$109,056
Aug	$242,913	$62,495	$41,056	$29,818	$17,868	$39,791
Sep	$214,023	$182,254	$41,325	$37,206	$16,528	$49,434
Oct	$100,987	$183,454	$50,328	$25,142	$20,701	$59,912
Nov	$133,400	$288,443	$90,653	$35,379	$33,041	$79,583
Dec	$124,184	$133,049	$47,000	$22,324	$19,268	$45,854
Annual	$3,103,310	$3,717,428	$1,071,165	$614,039	$419,647	$1,166,031
Total	$10,091,620					

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Table A-3-3: Estimated Average Monthly Generation Changes for USACE under Alternative S7 vs. Existing Condition/Baseline (MWh)

	BC-S17																			
	Stockton (STN)							Harry S. Truman (HST)							STN + HST					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours		On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours		On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday		Weekday	Weekday	Weekday	Saturday	Saturday	Sunday		Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	MWH	MWH	MWH	MWH	MWH	MWH		MWH	MWH	MWH	MWH	MWH	MWH		MWH	MWH	MWH	MWH	MWH	MWH
Jan	-20	-28	0	-47	-24	-89	Jan	-6	-4	-100	-46	-63	-109	Jan	-26	-31	-100	-93	-86	-198
Feb	-10	-68	0	-55	-25	-77	Feb	-24	-117	-56	-23	-18	-20	Feb	-33	-185	-56	-78	-43	-97
Mar	-47	-134	37	-81	-9	-89	Mar	52	-52	-1	-132	-249	-71	Mar	6	-185	36	-213	-259	-161
Apr	7	-122	55	-125	-30	-180	Apr	59	234	98	124	91	-399	Apr	66	112	153	-2	60	-579
May	-7	-124	-23	-84	-18	-187	May	-60	-219	107	-7	-116	-24	May	-67	-343	84	-91	-133	-211
Jun	-78	-251	22	-111	-42	-141	Jun	-101	-117	1	78	89	-118	Jun	-180	-369	23	-33	48	-258
Jul	-94	-137	-5	-68	-40	-100	Jul	237	99	6	5	-95	-380	Jul	143	-38	1	-62	-136	-480
Aug	-73	-66	22	-53	-25	-36	Aug	-201	25	-20	-2	23	-66	Aug	-275	-41	1	-55	-1	-103
Sep	-8	-37	4	-6	-9	-19	Sep	-19	-1	-12	-2	-6	-40	Sep	-27	-38	-9	-8	-15	-59
Oct	-31	-65	0	-14	-6	-24	Oct	-6	-103	-42	-12	14	103	Oct	-38	-168	-42	-27	8	79
Nov	-13	-54	0	-44	-18	-83	Nov	-1	76	-56	12	-62	-166	Nov	-14	22	-56	-32	-80	-249
Dec	-18	-28	0	-49	-6	-40	Dec	89	292	-65	-75	-102	193	Dec	71	264	-65	-124	-107	153
Annual	-392	-1,115	111	-737	-251	-1,065	Annual	20	113	-141	-79	-493	-1,098	Annual	-372	-1,002	-30	-816	-744	-2,164
Total	-3,449						Total	-1,679						Total	-5,128					

Table A-3-4: Estimated Average Monthly Generation Total Bagnell Changes under Alternative S7 vs. Existing Condition/Baseline (MWh)(For informational purposes only)

	BC-S17					
	Bagnell					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	MWH	MWH	MWH	MWH	MWH	MWH
Jan	24	-68	-22	24	-28	50
Feb	63	14	-78	-34	-14	-133
Mar	1	-282	-167	-113	-80	-189
Apr	13	171	143	-108	-206	-233
May	-141	-139	-35	0	-18	-87
Jun	-14	133	34	-425	-651	661
Jul	-230	-270	-112	-35	29	227
Aug	-205	66	78	19	52	-291
Sep	-100	-43	71	-22	-50	-68
Oct	66	336	193	-42	-202	172
Nov	80	320	28	7	60	-201
Dec	197	389	49	-15	-22	122
Annual	-246	626	184	-745	-1,130	29
Total	-1,283					

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A4. Alternative S5

Reallocation of 90,200 AF from the Stockton's Multi-Purpose Pool

The tables below summarize the energy loss from the baseline to the S5 Alternative at each of the plants and the total loss for the system under the current conditions. Bagnell is shown separately and not included in total calculations.

Table A-4-1: Estimated Average Monthly Generation and Energy Values for USACE Plants under Alternative S5 (MWh)

STO22SRADC0 Alternative S22

	Stockton (STN)							Harry S. Truman (HST)							STN + HST					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours		On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours		On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday		Weekday	Weekday	Weekday	Saturday	Saturday	Sunday		Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	MWH	MWH	MWH	MWH	MWH	MWH		MWH	MWH	MWH	MWH	MWH	MWH		MWH	MWH	MWH	MWH	MWH	MWH
Jan	3,007	2,010	0	157	79	250	Jan	9,003	6,187	1,054	869	755	1,784	Jan	12,011	8,196	1,054	1,025	834	2,034
Feb	1,656	2,073	0	96	35	137	Feb	6,054	8,906	911	1,085	726	2,092	Feb	7,710	10,980	911	1,180	762	2,229
Mar	1,450	2,022	80	210	109	313	Mar	6,957	14,528	3,524	2,256	2,196	4,358	Mar	8,408	16,549	3,604	2,465	2,306	4,671
Apr	2,044	2,955	188	243	140	417	Apr	6,584	16,145	4,705	2,537	2,517	5,338	Apr	8,628	19,100	4,894	2,780	2,658	5,755
May	1,835	2,375	212	188	170	404	May	6,707	16,803	6,700	2,436	2,926	5,399	May	8,542	19,178	6,913	2,625	3,095	5,803
Jun	2,396	1,604	227	265	179	470	Jun	9,123	12,636	5,054	2,234	2,665	4,527	Jun	11,519	14,240	5,281	2,499	2,844	4,997
Jul	4,883	589	112	192	144	357	Jul	10,055	4,369	3,338	1,446	1,544	3,305	Jul	14,938	4,958	3,450	1,638	1,688	3,663
Aug	5,025	297	24	90	65	153	Aug	6,016	1,877	1,532	762	588	1,630	Aug	11,041	2,174	1,556	852	652	1,783
Sep	1,703	299	16	40	32	53	Sep	4,348	3,551	888	481	454	1,045	Sep	6,051	3,850	905	521	486	1,098
Oct	354	652	0	69	45	112	Oct	3,380	5,368	1,861	882	996	1,837	Oct	3,734	6,020	1,861	950	1,040	1,949
Nov	645	1,123	0	82	36	120	Nov	4,059	9,295	2,665	1,117	1,382	2,502	Nov	4,704	10,418	2,665	1,200	1,418	2,622
Dec	1,741	920	0	124	60	204	Dec	7,183	7,270	2,245	1,407	1,246	2,912	Dec	8,924	8,190	2,245	1,531	1,306	3,116
Annual	26,740	16,916	859	1,755	1,094	2,990	Annual	79,469	106,936	34,479	17,511	17,996	36,729	Annual	106,209	123,852	35,339	19,266	19,089	39,719
Total	50,353						Total	293,120						Total	343,473					

	Stockton (STN)							Harry S. Truman (HST)							STN + HST					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours		On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours		On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday		Weekday	Weekday	Weekday	Saturday	Saturday	Sunday		Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	$	$	$	$	$	$		$	$	$	$	$	$		$	$	$	$	$	$
Jan	$99,141	$49,192	$0	$3,823	$1,451	$5,596	Jan	$296,809	$151,441	$20,878	$21,213	$13,816	$39,940	Jan	$395,950	$200,633	$20,878	$25,037	$15,267	$45,535
Feb	$58,732	$52,549	$0	$2,277	$600	$2,952	Feb	$214,767	$225,742	$17,290	$25,801	$12,413	$45,091	Feb	$273,500	$278,291	$17,290	$28,078	$13,013	$48,043
Mar	$48,548	$49,011	$1,314	$5,050	$1,780	$6,728	Mar	$232,872	$352,219	$58,020	$54,338	$35,781	$93,646	Mar	$281,420	$401,231	$59,334	$59,388	$37,561	$100,374
Apr	$70,934	$79,471	$3,193	$6,292	$2,324	$9,511	Apr	$228,431	$434,248	$79,873	$65,741	$41,641	$121,631	Apr	$299,365	$513,719	$83,066	$72,033	$43,965	$131,143
May	$67,381	$65,231	$3,443	$5,252	$2,587	$9,570	May	$246,351	$461,587	$108,697	$67,971	$44,645	$127,876	May	$313,732	$526,818	$112,139	$73,223	$47,232	$137,446
Jun	$87,678	$41,167	$3,643	$7,593	$2,896	$11,517	Jun	$333,770	$324,380	$81,088	$64,130	$43,100	$111,034	Jun	$421,448	$365,547	$84,731	$71,723	$45,996	$122,552
Jul	$174,187	$14,357	$1,897	$5,616	$2,354	$8,920	Jul	$358,672	$106,416	$56,751	$42,302	$25,275	$82,485	Jul	$532,859	$120,773	$58,648	$47,918	$27,629	$91,405
Aug	$168,522	$6,779	$404	$2,436	$1,092	$3,623	Aug	$201,755	$42,905	$25,707	$20,688	$9,906	$38,658	Aug	$370,277	$49,685	$26,110	$23,124	$10,998	$42,281
Sep	$58,101	$7,649	$270	$1,106	$513	$1,257	Sep	$148,339	$90,993	$14,591	$13,232	$7,364	$24,828	Sep	$206,440	$98,642	$14,861	$14,338	$7,877	$26,085
Oct	$11,155	$16,451	$0	$1,741	$738	$2,511	Oct	$106,592	$135,451	$31,267	$22,281	$16,490	$41,093	Oct	$117,747	$151,902	$31,267	$24,021	$17,228	$43,605
Nov	$21,392	$28,358	$0	$2,121	$676	$2,802	Nov	$134,520	$234,781	$50,521	$28,792	$25,934	$58,634	Nov	$155,912	$263,139	$50,521	$30,912	$26,610	$61,436
Dec	$32,922	$14,061	$0	$1,763	$653	$2,671	Dec	$135,846	$111,173	$26,727	$19,980	$13,556	$38,138	Dec	$168,767	$125,233	$26,727	$21,744	$14,209	$40,809
Annual	$898,692	$424,277	$14,164	$45,071	$17,664		Annual	$2,638,724	$2,671,336	$571,409	$446,469	$289,921	$823,054	Annual	$3,537,416	$3,095,614	$585,573	$491,540	$307,584	$890,713
Total	$1,467,527						Total	$7,440,913						Total	$8,908,440					

Table A-4-2: Estimated Average Monthly Generation and Energy Values for Bagnell under Alternative S5 (MWh)

STO22SRADC0 Alternative S22

	Bagnell					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	MWH	MWH	MWH	MWH	MWH	MWH
Jan	14,543	14,983	4,845	3,055	1,627	4,483
Feb	7,968	17,544	4,435	2,474	1,623	4,398
Mar	8,464	20,400	7,350	3,115	3,317	6,459
Apr	6,390	19,143	8,274	2,484	3,369	6,258
May	6,430	20,537	9,041	2,472	3,360	6,249
Jun	10,019	14,517	8,261	2,448	3,292	6,133
Jul	12,138	5,566	4,969	1,953	2,571	4,179
Aug	7,733	2,638	2,322	1,201	1,096	1,980
Sep	6,511	7,446	2,595	1,455	1,029	2,023
Oct	3,273	7,346	2,947	1,076	1,421	2,523
Nov	3,935	11,149	4,573	1,356	1,861	3,513
Dec	6,358	8,411	3,750	1,501	1,596	3,721
Annual	93,762	149,681	63,363	24,592	26,162	51,918
Total	409,478					

	Bagnell					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	$	$	$	$	$	$
Jan	$479,421	$366,756	$95,989	$74,625	$29,770	$100,343
Feb	$282,660	$444,673	$84,150	$58,849	$27,737	$94,798
Mar	$283,308	$494,606	$120,996	$75,047	$54,035	$138,804
Apr	$221,696	$514,875	$140,453	$64,351	$55,737	$142,601
May	$236,155	$564,158	$146,671	$68,977	$51,276	$148,005
Jun	$366,553	$372,647	$132,539	$70,266	$53,250	$150,414
Jul	$433,001	$135,578	$84,472	$57,141	$42,070	$104,279
Aug	$259,346	$60,298	$38,959	$32,602	$18,478	$46,955
Sep	$222,135	$190,787	$42,636	$40,061	$16,690	$48,078
Oct	$103,211	$185,371	$49,507	$27,201	$23,532	$56,440
Nov	$130,418	$281,602	$86,694	$34,949	$34,914	$82,322
Dec	$120,249	$128,619	$44,637	$21,327	$17,358	$48,734
Annual	$3,138,153	$3,739,970	$1,067,703	$625,395	$424,847	$1,161,773
Total	$10,157,842					

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Table A-4-3: Estimated Average Monthly Generation Changes for USACE Plants under Alternative S5 vs. Existing Condition/Baseline (MWh)

BC-S21

	Stockton (STN)					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	MWH	MWH	MWH	MWH	MWH	MWH
Jan	-18	-47	0	-33	-17	-62
Feb	-14	-109	0	-57	-28	-86
Mar	-72	-327	-34	-105	-64	-176
Apr	-20	-266	-54	-114	-58	-206
May	-49	-265	-99	-94	-56	-195
Jun	-89	-231	-9	-105	-65	-133
Jul	-59	-127	-10	-63	-36	-98
Aug	-49	-44	-1	-38	-18	-31
Sep	2	-15	3	0	0	-21
Oct	-14	-13	0	-3	-1	-7
Nov	-16	-79	0	-44	-20	-85
Dec	-18	-119	0	-61	-17	-64
Annual	-416	-1,642	-203	-716	-378	-1,164
Total	-4,520					

	Harry S. Truman (HST)					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	MWH	MWH	MWH	MWH	MWH	MWH
Jan	37	214	-76	-20	-14	-69
Feb	-69	-327	-41	-24	34	98
Mar	35	-13	-38	-27	-45	-33
Apr	-23	-36	-171	32	-145	-243
May	-22	-74	140	-3	43	124
Jun	77	367	9	65	81	-516
Jul	70	-49	-80	23	-49	-364
Aug	-105	-54	16	62	35	113
Sep	147	123	11	-24	-116	35
Oct	-14	-236	20	11	24	56
Nov	-17	6	37	-26	-66	-201
Dec	55	221	-82	-13	-39	77
Annual	171	144	-257	56	-255	-924
Total	-1,065					

	STN + HST					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	MWH	MWH	MWH	MWH	MWH	MWH
Jan	19	167	-76	-53	-30	-131
Feb	-83	-435	-41	-81	6	12
Mar	-37	-340	-72	-132	-109	-209
Apr	-43	-302	-225	-81	-203	-449
May	-71	-339	41	-97	-12	-72
Jun	-12	136	0	-40	16	-650
Jul	11	-176	-90	-40	-85	-462
Aug	-153	-98	15	24	18	82
Sep	149	108	14	-24	-116	14
Oct	-28	-249	20	9	24	49
Nov	-33	-73	37	-70	-86	-286
Dec	37	102	-82	-74	-56	13
Annual	-245	-1,499	-460	-660	-633	-2,088
Total	-5,585					

Table A-4-4: Estimated Average Monthly Generation Total Bagnell Changes under Alternative S5 vs. Existing Condition/Baseline (MWh)(For informational purposes only)

BC-S21

	Bagnell					
	On-Peak Hours (contract)	On-Peak Hours (non-contract)	Off-Peak Hours	On-Peak Hours	Off-Peak Hours	Off-Peak Hours
	Weekday	Weekday	Weekday	Saturday	Saturday	Sunday
	MWH	MWH	MWH	MWH	MWH	MWH
Jan	85	200	254	24	-13	205
Feb	-30	-126	-161	-52	-66	7
Mar	12	17	-53	-59	-85	34
Apr	-71	-161	-148	-81	-174	-643
May	45	700	324	-106	-201	-332
Jun	80	123	91	-304	-479	516
Jul	11	-210	-294	66	140	35
Aug	285	-30	-47	121	88	11
Sep	138	290	150	81	-40	-125
Oct	136	412	145	40	-31	17
Nov	-10	49	-180	-9	160	-84
Dec	-11	99	-149	-86	-198	342
Annual	669	1,362	-68	-364	-899	-18
Total	681					

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APPENDIX B: Capacity and Value By Alternative

The tables below summarize the capacity and value by Alternative.

Bagnell is shown separately from the other two dams for informational because it is not a federal hydropower project.

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B 1. Pre-Reallocation/Original Condition

Table B-1-1: Capacity and Values for USACE Plants under Pre-Reallocation /Original Condition

STON-PR---0	STOCKTON LAKE-POWER PLANT			
52	SWPA Marketable Capacity (MW)			
8.30	Average Weekly Generation Hours (critical period			
Year	Average Weekly Energy	Potential Supportable Capacity	Weekly Average Capability	Actual Supportable Capacity
	MWh	MW	MW	MW
1950	890.95	107.30	45.20	45.200
1951	1787.67	215.29	45.20	45.200
1952	563.23	67.83	45.20	45.200
1953	586.78	70.67	45.20	45.200
1954	431.78	52.00	45.20	45.200
1955	868.91	104.65	45.20	45.200
1956	363.54	43.78	45.20	43.782
1957	2488.50	299.70	45.20	45.200
1958	2706.51	325.95	45.20	45.200
1959	733.61	88.35	45.20	45.200
1960	512.75	61.75	45.20	45.200
1961	3043.35	366.52	45.20	45.200
1962	953.03	114.78	45.20	45.200
1963	610.45	73.52	45.20	45.200
1964	864.73	104.14	45.20	45.200
1965	1063.56	128.09	45.20	45.200
1966	654.48	78.82	45.20	45.200
1967	1429.02	172.10	45.20	45.200
1968	840.37	101.21	45.20	45.200
1969	684.27	82.41	45.20	45.200
1970	533.00	64.19	45.20	45.200
1971	1013.15	122.02	45.20	45.200
1972	593.18	71.44	45.20	45.200
1973	3761.30	452.98	45.20	45.200
1974	1392.89	167.75	45.20	45.200
1975	840.01	101.17	45.20	45.200
1976	1033.90	124.52	45.20	45.200
1977	507.29	61.09	45.20	45.200
1978	767.16	92.39	45.20	45.200
1979	1521.93	183.29	45.20	45.200
1980	592.77	71.39	45.20	45.200
1981	969.33	116.74	45.20	45.200
1982	1223.17	147.31	45.20	45.200
1983	1510.96	181.97	45.20	45.200
1984	783.97	94.42	45.20	45.200
1985	1081.53	130.25	45.20	45.200
1986	815.57	98.22	45.20	45.200
1987	784.53	94.48	45.20	45.200
1988	614.93	74.06	45.20	45.200
1989	850.18	102.39	45.20	45.200
1990	2809.38	338.34	45.20	45.200
1991	585.12	70.47	45.20	45.200
1992	1521.28	183.21	45.20	45.200
1993	2016.75	242.88	45.20	45.200
1994	1829.89	220.38	45.20	45.200
1995	3301.17	397.57	45.20	45.200
1996	856.96	103.21	45.20	45.200
1997	664.10	79.98	45.20	45.200
1998	719.43	86.64	45.20	45.200
1999	2105.13	253.53	45.20	45.200
2000	715.76	86.20	45.20	45.200
2001	1063.55	128.09	45.20	45.200
2002	1976.90	238.08	45.20	45.200
2003	773.10	93.11	45.20	45.200
2004	644.43	77.61	45.20	45.200
2005	634.17	76.38	45.20	45.200
2006	496.35	59.78	45.20	45.200
2007	2786.52	335.59	45.20	45.200
2008	3585.60	431.82	45.20	45.200
2009	1388.80	167.26	45.20	45.200
2010	1527.09	183.91	45.20	45.200
2011	1322.10	159.22	45.20	45.200
2012	689.56	83.05	45.20	45.200
MIN	363.54			
AVERAGE	1226.69	average availability		45.177
		value of capacity		$5,782,720

STON-PR---0	HARRY S TRUMAN RESERVOIR-POWER PLANT			
160	SWPA Marketable Capacity (MW)			
3.13	Average Weekly Generation Hours (critical			
Year	Average Weekly Energy	Potential Supportable Capacity	Weekly Average Capability	Actual Supportable Capacity
	MWh	MW	MW	MW
1950	9423.82	3007.14	160.00	160.000
1951	20139.90	6426.64	160.00	160.000
1952	427.10	136.29	160.00	136.287
1953	196.27	62.63	160.00	62.629
1954	498.18	158.97	160.00	158.969
1955	2315.93	739.01	160.00	160.000
1956	631.66	201.56	160.00	160.000
1957	5495.98	1753.76	160.00	160.000
1958	8979.07	2865.22	160.00	160.000
1959	739.79	236.07	160.00	160.000
1960	663.55	211.74	160.00	160.000
1961	12044.41	3843.37	160.00	160.000
1962	1733.04	553.01	160.00	160.000
1963	1163.19	371.17	160.00	160.000
1964	3158.18	1007.78	160.00	160.000
1965	7268.81	2319.48	157.38	157.377
1966	963.98	307.61	160.00	160.000
1967	7398.40	2360.83	160.00	160.000
1968	4260.89	1359.65	160.00	160.000
1969	7020.05	2240.10	160.00	160.000
1970	5546.23	1769.80	160.00	160.000
1971	1582.09	504.85	160.00	160.000
1972	654.29	208.78	160.00	160.000
1973	12488.10	3984.95	160.00	160.000
1974	3187.94	1017.27	160.00	160.000
1975	3351.64	1069.51	160.00	160.000
1976	1375.17	438.82	160.00	160.000
1977	5544.43	1769.23	160.00	160.000
1978	882.23	281.52	160.00	160.000
1979	4490.13	1432.80	160.00	160.000
1980	359.44	114.70	160.00	114.697
1981	8572.27	2735.41	160.00	160.000
1982	8348.10	2663.88	160.00	160.000
1983	3726.63	1189.17	160.00	160.000
1984	3832.43	1222.93	160.00	160.000
1985	7540.70	2406.24	160.00	160.000
1986	2885.33	920.71	158.69	158.689
1987	1793.09	572.18	160.00	160.000
1988	586.74	187.23	160.00	160.000
1989	3417.41	1090.49	160.00	160.000
1990	8150.47	2600.81	160.00	160.000
1991	495.83	158.22	160.00	158.218
1992	4385.36	1399.37	160.00	160.000
1993	13192.06	4209.58	160.00	160.000
1994	5109.98	1630.59	160.00	160.000
1995	14587.66	4654.92	160.00	160.000
1996	3478.96	1110.13	160.00	160.000
1997	3355.04	1070.59	160.00	160.000
1998	5953.68	1899.82	160.00	160.000
1999	7640.31	2438.02	160.00	160.000
2000	1627.88	519.45	160.00	160.000
2001	5969.70	1904.93	160.00	160.000
2002	4993.70	1593.49	160.00	160.000
2003	1295.55	413.41	160.00	160.000
2004	3427.61	1093.75	160.00	160.000
2005	4774.82	1523.64	160.00	160.000
2006	490.80	156.61	160.00	156.613
2007	13747.91	4386.95	158.69	158.689
2008	12234.72	3904.09	160.00	160.000
2009	6922.47	2208.96	160.00	160.000
2010	8647.02	2759.26	160.00	160.000
2011	2381.09	759.81	160.00	160.000
2012	265.48	84.71	160.00	84.713
MIN	196.27			
AVERAGE	4885.95	average availability		155.982
		value of capacity		$19,965,723

STON-PR---0	BAGNELL DAM			
176.2	SWPA Marketable Capacity (MW)			
3.54	Average Weekly Generation Hours (critical			
Year	Average Weekly Energy	Potential Supportable Capacity	Weekly Average Capability	Actual Supportable Capacity
	MWh	MW	MW	MW
1950	14345.70	4054.47	176.20	176.200
1951	21962.89	6207.29	176.20	176.200
1952	1455.72	411.42	176.20	176.200
1953	209.56	59.23	176.20	59.226
1954	623.96	176.35	176.20	176.200
1955	3606.27	1019.23	176.20	176.200
1956	155.59	43.97	176.20	43.974
1957	7449.44	2105.41	176.20	176.200
1958	13144.06	3714.86	176.20	176.200
1959	2062.28	582.86	176.20	176.200
1960	1411.26	398.86	176.20	176.200
1961	14301.89	4042.09	176.20	176.200
1962	3624.27	1024.31	176.20	176.200
1963	1929.37	545.29	176.20	176.200
1964	4609.71	1302.83	176.20	176.200
1965	12634.20	3570.76	176.20	176.200
1966	1930.94	545.73	176.20	176.200
1967	7916.82	2237.50	176.20	176.200
1968	6577.72	1859.04	176.20	176.200
1969	10785.35	3048.23	176.20	176.200
1970	6370.75	1800.54	176.20	176.200
1971	3243.63	916.74	176.20	176.200
1972	1162.70	328.61	176.20	176.200
1973	12861.16	3634.90	176.20	176.200
1974	6572.26	1857.49	176.20	176.200
1975	6148.17	1737.63	176.20	176.200
1976	2650.88	749.21	176.20	176.200
1977	6396.31	1807.77	176.20	176.200
1978	2211.74	625.10	176.20	176.200
1979	8351.24	2360.28	176.20	176.200
1980	587.14	165.94	176.20	165.942
1981	10368.66	2930.46	176.20	176.200
1982	9156.02	2587.73	176.20	176.200
1983	3954.52	1117.65	176.20	176.200
1984	4618.24	1305.24	176.20	176.200
1985	9799.28	2769.54	176.20	176.200
1986	6435.08	1818.72	176.20	176.200
1987	3657.19	1033.62	176.20	176.200
1988	1329.17	375.66	176.20	176.200
1989	6331.81	1789.54	176.20	176.200
1990	9087.44	2568.35	176.20	176.200
1991	847.83	239.62	176.20	176.200
1992	7800.79	2204.71	176.20	176.200
1993	16066.56	4540.83	176.20	176.200
1994	5838.43	1650.09	176.20	176.200
1995	14534.79	4107.92	176.20	176.200
1996	6760.90	1910.81	176.20	176.200
1997	5430.92	1534.92	176.20	176.200
1998	9973.36	2818.73	176.20	176.200
1999	8257.63	2333.82	176.20	176.200
2000	2555.03	722.12	176.20	176.200
2001	8478.11	2396.14	176.20	176.200
2002	5012.16	1416.57	176.20	176.200
2003	2843.37	803.61	176.20	176.200
2004	6763.07	1911.42	176.20	176.200
2005	7100.10	2006.68	176.20	176.200
2006	537.56	151.93	176.20	151.928
2007	13763.60	3889.96	176.20	176.200
2008	15093.59	4265.85	176.20	176.200
2009	9507.67	2687.12	176.20	176.200
2010	11224.52	3172.35	176.20	176.200
2011	3586.40	1013.61	176.20	176.200
MIN	155.59	average availability		171.624
AVERAGE	6677.53	value of capacity		$21,967,835

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B 2. Current/Existing Condition

Table B-2-1: Capacity and Values for USACE Plants under Current/Existing Condition

STON-BC---0	STOCKTON LAKE-POWER PLANT			
52	SWPA Marketable Capacity (MW)			
8.30	Average Weekly Generation Hours (critical period			
Year	Average Weekly Energy	Potential Supportable Capacity	Weekly Average Capability	Actual Supportable Capacity
	MWh	MW	MW	MW
1950	881.52	106.16	45.20	45.200
1951	1577.65	190.00	45.20	45.200
1952	563.23	67.83	45.20	45.200
1953	570.84	68.75	45.20	45.200
1954	431.78	52.00	45.20	45.200
1955	853.60	102.80	45.20	45.200
1956	363.54	43.78	45.20	43.782
1957	2261.93	272.41	45.20	45.200
1958	2546.61	306.70	45.20	45.200
1959	719.01	86.59	45.20	45.200
1960	512.75	61.75	45.20	45.200
1961	2854.46	343.77	45.20	45.200
1962	937.39	112.89	45.20	45.200
1963	610.45	73.52	45.20	45.200
1964	697.59	84.01	45.20	45.200
1965	1054.61	127.01	45.20	45.200
1966	649.63	78.24	45.20	45.200
1967	1410.73	169.90	45.20	45.200
1968	817.07	98.40	45.20	45.200
1969	664.54	80.03	45.20	45.200
1970	533.00	64.19	45.20	45.200
1971	1006.39	121.20	45.20	45.200
1972	593.18	71.44	45.20	45.200
1973	3722.75	448.34	45.20	45.200
1974	1391.39	167.57	45.20	45.200
1975	821.14	98.89	45.20	45.200
1976	1012.57	121.95	45.20	45.200
1977	507.29	61.09	45.20	45.200
1978	760.58	91.60	45.20	45.200
1979	1425.24	171.65	45.20	45.200
1980	592.77	71.39	45.20	45.200
1981	928.09	111.77	45.20	45.200
1982	1051.60	126.65	45.20	45.200
1983	1531.44	184.44	45.20	45.200
1984	738.59	88.95	45.20	45.200
1985	1069.65	128.82	45.20	45.200
1986	785.95	94.65	45.20	45.200
1987	784.53	94.48	45.20	45.200
1988	614.93	74.06	45.20	45.200
1989	819.90	98.74	45.20	45.200
1990	2596.29	312.68	45.20	45.200
1991	585.12	70.47	45.20	45.200
1992	1360.50	163.85	45.20	45.200
1993	1996.79	240.48	45.20	45.200
1994	1759.23	211.87	45.20	45.200
1995	3190.74	384.27	45.20	45.200
1996	849.83	102.35	45.20	45.200
1997	664.10	79.98	45.20	45.200
1998	714.89	86.10	45.20	45.200
1999	2055.95	247.60	45.20	45.200
2000	715.76	86.20	45.20	45.200
2001	994.56	119.78	45.20	45.200
2002	1746.60	210.35	45.20	45.200
2003	725.39	87.36	45.20	45.200
2004	626.85	75.49	45.20	45.200
2005	623.70	75.11	45.20	45.200
2006	496.35	59.78	45.20	45.200
2007	2333.82	281.07	45.20	45.200
2008	3439.64	414.25	45.20	45.200
2009	1331.99	160.42	45.20	45.200
2010	1435.13	172.84	45.20	45.200
2011	1311.51	157.95	45.20	45.200
2012	689.56	83.05	45.20	45.200
MIN	363.54			
AVERAGE	1173.24	average availability		45.177
		value of capacity		$5,782,720

STON-BC---0	HARRY S TRUMAN RESERVOIR-POWER PLANT			
160	SWPA Marketable Capacity (MW)			
3.13	Average Weekly Generation Hours (critical			
Year	Average Weekly Energy	Potential Supportable Capacity	Weekly Average Capability	Actual Supportable Capacity
	MWh	MW	MW	MW
1950	9251.88	2952.27	160.00	160.000
1951	20117.84	6419.60	160.00	160.000
1952	428.78	136.82	160.00	136.823
1953	173.61	55.40	160.00	55.400
1954	501.41	160.00	160.00	160.000
1955	2159.61	689.13	160.00	160.000
1956	634.85	202.58	160.00	160.000
1957	5281.77	1685.41	160.00	160.000
1958	8934.72	2851.07	160.00	160.000
1959	794.53	253.53	160.00	160.000
1960	496.00	158.27	160.00	158.274
1961	11923.20	3804.69	160.00	160.000
1962	1725.81	550.70	160.00	160.000
1963	1168.08	372.73	160.00	160.000
1964	3076.21	981.62	160.00	160.000
1965	7309.22	2332.37	157.38	157.377
1966	966.13	308.29	160.00	160.000
1967	7426.34	2369.74	160.00	160.000
1968	4269.50	1362.40	160.00	160.000
1969	6828.56	2178.99	160.00	160.000
1970	5321.42	1698.06	160.00	160.000
1971	1575.18	502.64	160.00	160.000
1972	351.61	112.20	160.00	112.198
1973	12434.21	3967.75	160.00	160.000
1974	3191.39	1018.37	160.00	160.000
1975	3092.61	986.85	160.00	160.000
1976	1363.44	435.07	160.00	160.000
1977	5474.01	1746.76	160.00	160.000
1978	981.24	313.11	160.00	160.000
1979	4420.04	1410.44	160.00	160.000
1980	361.12	115.23	160.00	115.232
1981	8563.91	2732.74	160.00	160.000
1982	8073.95	2576.39	160.00	160.000
1983	3620.80	1155.40	160.00	160.000
1984	3177.05	1013.79	160.00	160.000
1985	7566.45	2414.45	160.00	160.000
1986	2865.73	914.45	160.00	160.000
1987	1795.17	572.84	160.00	160.000
1988	590.92	188.56	160.00	160.000
1989	3389.75	1081.67	160.00	160.000
1990	8383.63	2675.21	160.00	160.000
1991	370.36	118.18	160.00	118.182
1992	4240.38	1353.10	160.00	160.000
1993	13008.10	4150.88	160.00	160.000
1994	5055.54	1613.22	160.00	160.000
1995	14433.52	4605.73	160.00	160.000
1996	3323.59	1060.56	160.00	160.000
1997	3447.30	1100.03	160.00	160.000
1998	5217.09	1664.77	160.00	160.000
1999	7818.14	2494.77	160.00	160.000
2000	1630.77	520.38	160.00	160.000
2001	6014.35	1919.18	160.00	160.000
2002	4405.96	1405.94	158.69	158.689
2003	1276.03	407.18	160.00	160.000
2004	3573.24	1140.22	160.00	160.000
2005	4772.65	1522.95	160.00	160.000
2006	465.28	148.47	160.00	148.472
2007	13435.66	4287.32	160.00	160.000
2008	11606.99	3703.79	160.00	160.000
2009	6866.73	2191.17	160.00	160.000
2010	8322.07	2655.57	160.00	160.000
2011	2555.03	815.31	160.00	160.000
2012	264.62	84.44	160.00	84.439
MIN	173.61			
AVERAGE	4796.27	average availability		154.366
		value of capacity		$19,758,904

STON-BC---0	BAGNELL DAM			
176.2	SWPA Marketable Capacity (MW)			
3.54	Average Weekly Generation Hours (critical			
1950	14315.70	4046.00	176.20	176.200
1951	22144.82	6258.71	176.20	176.200
1952	1457.39	411.90	176.20	176.200
1953	167.07	47.22	176.20	47.219
1954	623.44	176.20	176.20	176.200
1955	3679.32	1039.87	176.20	176.200
1956	162.76	46.00	176.20	46.001
1957	7505.23	2121.18	176.20	176.200
1958	12905.79	3647.52	176.20	176.200
1959	2186.10	617.85	176.20	176.200
1960	1090.33	308.16	176.20	176.200
1961	14734.15	4164.26	176.20	176.200
1962	3607.60	1019.60	176.20	176.200
1963	1939.69	548.21	176.20	176.200
1964	4500.41	1271.94	176.20	176.200
1965	13029.82	3682.57	176.20	176.200
1966	1924.22	543.83	176.20	176.200
1967	7512.45	2123.22	176.20	176.200
1968	6580.24	1859.75	176.20	176.200
1969	11258.39	3181.92	176.20	176.200
1970	6864.68	1940.14	176.20	176.200
1971	3234.88	914.26	176.20	176.200
1972	542.06	153.20	176.20	153.202
1973	12920.59	3651.70	176.20	176.200
1974	6756.72	1909.63	176.20	176.200
1975	6077.20	1717.58	176.20	176.200
1976	2627.64	742.64	176.20	176.200
1977	6262.67	1769.99	176.20	176.200
1978	2240.65	633.27	176.20	176.200
1979	7438.85	2102.42	176.20	176.200
1980	381.08	107.70	176.20	107.703
1981	10373.46	2931.81	176.20	176.200
1982	9171.55	2592.12	176.20	176.200
1983	3613.85	1021.37	176.20	176.200
1984	5043.44	1425.41	176.20	176.200
1985	9740.37	2752.89	176.20	176.200
1986	6429.98	1817.28	176.20	176.200
1987	3659.62	1034.30	176.20	176.200
1988	1331.34	376.27	176.20	176.200
1989	6255.63	1768.01	176.20	176.200
1990	9510.08	2687.80	176.20	176.200
1991	682.13	192.79	176.20	176.200
1992	7383.00	2086.63	176.20	176.200
1993	15937.86	4504.46	176.20	176.200
1994	6245.27	1765.08	176.20	176.200
1995	14495.79	4096.89	176.20	176.200
1996	6559.46	1853.88	176.20	176.200
1997	5384.57	1521.82	176.20	176.200
1998	9303.27	2629.35	176.20	176.200
1999	7820.83	2210.37	176.20	176.200
2000	2560.64	723.70	176.20	176.200
2001	8679.49	2453.05	176.20	176.200
2002	4444.81	1256.22	176.20	176.200
2003	2799.23	791.14	176.20	176.200
2004	7148.69	2020.41	176.20	176.200
2005	7126.83	2014.23	176.20	176.200
2006	476.60	134.70	176.20	134.699
2007	13767.71	3891.12	176.20	176.200
2008	13372.02	3779.29	176.20	176.200
2009	9161.67	2589.33	176.20	176.200
2010	11006.03	3110.59	176.20	176.200
2011	3674.77	1038.59	176.20	176.200
MIN	162.76	average availability		
AVERAGE	6610.19	value of capacity		$21,743,947

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B 3. Alternative S7

Table B-3-1: Capacity and Values for USACE Plants under Alternative S7

STO17SRDC20	STOCKTON LAKE-POWER PLANT			
52	SWPA Marketable Capacity (MW)			
	Average Weekly Generation Hours (critical period			
1950	875.15	105.40	45.20	45.200
1951	1821.43	219.36	45.20	45.200
1952	563.23	67.83	45.20	45.200
1953	570.84	68.75	45.20	45.200
1954	431.78	52.00	45.20	45.200
1955	773.15	93.11	45.20	45.200
1956	363.54	43.78	45.20	43.782
1957	1784.32	214.89	45.20	45.200
1958	2510.66	302.37	45.20	45.200
1959	716.20	86.25	45.20	45.200
1960	512.75	61.75	45.20	45.200
1961	2694.57	324.52	45.20	45.200
1962	913.02	109.96	45.20	45.200
1963	610.45	73.52	45.20	45.200
1964	697.59	84.01	45.20	45.200
1965	949.31	114.33	45.20	45.200
1966	649.63	78.24	45.20	45.200
1967	1141.94	137.53	45.20	45.200
1968	813.64	97.99	45.20	45.200
1969	624.84	75.25	45.20	45.200
1970	533.00	64.19	45.20	45.200
1971	872.86	105.12	45.20	45.200
1972	593.18	71.44	45.20	45.200
1973	3510.24	422.75	45.20	45.200
1974	1401.60	168.80	45.20	45.200
1975	799.00	96.23	45.20	45.200
1976	966.49	116.40	45.20	45.200
1977	507.29	61.09	45.20	45.200
1978	754.05	90.81	45.20	45.200
1979	1213.08	146.10	45.20	45.200
1980	592.77	71.39	45.20	45.200
1981	926.82	111.62	45.20	45.200
1982	1051.19	126.60	45.20	45.200
1983	915.48	110.25	45.20	45.200
1984	738.59	88.95	45.20	45.200
1985	1046.63	126.05	45.20	45.200
1986	767.77	92.47	45.20	45.200
1987	784.53	94.48	45.20	45.200
1988	614.93	74.06	45.20	45.200
1989	792.72	95.47	45.20	45.200
1990	2529.29	304.61	45.20	45.200
1991	585.12	70.47	45.20	45.200
1992	1109.40	133.61	45.20	45.200
1993	1931.09	232.57	45.20	45.200
1994	1598.84	192.55	45.20	45.200
1995	3059.28	368.44	45.20	45.200
1996	756.23	91.07	45.20	45.200
		79.98	45.20	45.200
1998	714.89	86.10	45.20	45.200
1999	1746.85	210.38	45.20	45.200
2000	715.76	86.20	45.20	45.200
2001	934.22	112.51	45.20	45.200
2002	1348.45	162.40	45.20	45.200
2003	725.39	87.36	45.20	45.200
2004	626.85	75.49	45.20	45.200
2005	613.32	73.86	45.20	45.200
2006	496.35	59.78	45.20	45.200
2007	2025.92	243.99	45.20	45.200
2008	3162.07	380.82	45.20	45.200
2009	1092.62	131.59	45.20	45.200
2010	1383.41	166.61	45.20	45.200
2011	1110.09	133.69	45.20	45.200
2012	689.56	83.05	45.20	45.200
MIN	363.54			
AVERAGE	1095.55	average availability		45.177
		value of capacity		$5,782,720

STO17SRDC20	HARRY S TRUMAN RESERVOIR-POWER PLANT			
160	SWPA Marketable Capacity (MW)			
3.13	Average Weekly Generation Hours (critical			
Year	Average Weekly Energy	Potential Supportable Capacity	Weekly Average Capability	Actual Supportable Capacity
	MWh	MW	MW	MW
1950	9,153.86	2921.00	160.00	160.000
1951	20,260.20	6465.02	160.00	160.000
1952	425.91	135.91	160.00	135.908
1953	173.58	55.39	160.00	55.389
1954	507.10	161.82	160.00	160.000
1955	2,291.56	731.24	160.00	160.000
1956	642.36	204.98	160.00	160.000
1957	5,208.03	1661.88	160.00	160.000
1958	8,885.65	2835.41	160.00	160.000
1959	728.70	232.53	160.00	160.000
1960	398.05	127.02	160.00	127.019
1961	11,956.40	3815.28	160.00	160.000
1962	1,707.19	544.76	160.00	160.000
1963	1,167.84	372.66	160.00	160.000
1964	3,066.33	978.47	160.00	160.000
1965	7,250.56	2313.65	157.38	157.377
1966	963.26	307.37	160.00	160.000
1967	7,247.51	2312.68	160.00	160.000
1968	4,061.62	1296.06	160.00	160.000
1969	6,774.85	2161.85	160.00	160.000
1970	4,876.33	1556.04	160.00	160.000
1971	1,512.08	482.50	160.00	160.000
1972	356.65	113.81	160.00	113.807
1973	12,043.38	3843.04	160.00	160.000
1974	3,249.20	1036.82	160.00	160.000
1975	2,950.36	941.46	160.00	160.000
1976	1,323.61	422.36	160.00	160.000
1977	5,517.64	1760.68	160.00	160.000
1978	886.46	282.87	160.00	160.000
1979	4,387.54	1400.06	160.00	160.000
1980	362.89	115.80	160.00	115.798
1981	8,578.82	2737.50	160.00	160.000
1982	8,150.36	2600.78	160.00	160.000
1983	3,368.00	1074.73	160.00	160.000
1984	3,310.45	1056.36	160.00	160.000
1985	7,467.64	2382.92	160.00	160.000
1986	2,850.27	909.52	158.69	158.689
1987	1,787.66	570.44	160.00	160.000
1988	583.53	186.20	160.00	160.000
1989	3,359.58	1072.04	160.00	160.000
1990	8,477.43	2705.15	160.00	160.000
1991	306.38	97.77	160.00	97.767
1992	4,097.25	1307.43	160.00	160.000
1993	13,083.42	4174.92	160.00	160.000
1994	5,058.91	1614.30	160.00	160.000
1995	14,349.53	4578.93	160.00	160.000
1996	3,315.94	1058.12	160.00	160.000
1997	3,405.81	1086.79	160.00	160.000
1998	5,675.13	1810.93	160.00	160.000
1999	7,117.22	2271.10	160.00	160.000
2000	1,634.77	521.66	160.00	160.000
2001	5,993.22	1912.43	160.00	160.000
2002	4,001.99	1277.03	160.00	160.000
2003	1,284.77	409.97	160.00	160.000
2004	3,785.96	1208.10	160.00	160.000
2005	4,768.84	1521.74	160.00	160.000
2006	455.34	145.30	160.00	145.300
2007	13,398.73	4275.53	160.00	160.000
2008	12,011.95	3833.01	160.00	160.000
2009	6,653.90	2123.26	160.00	160.000
2010	8,654.30	2761.58	160.00	160.000
2011	2,362.45	753.86	160.00	160.000
2012	254.91	81.34	160.00	81.341
MIN	173.58			
AVERAGE	4760.97	average availability		153.467
		value of capacity		$19,643,721

STO17SRDC20	BAGNELL DAM			
176.2	SWPA Marketable Capacity (MW)			
3.54	Average Weekly Generation Hours (critical			
Year	Average Weekly Energy	Potential Supportable Capacity	Weekly Average Capability	Actual Supportable Capacity
	MWh	MW	MW	MW
1950	9153.86	2587.12	160.00	160.000
1951	20260.20	5726.07	160.00	160.000
1952	425.91	120.37	160.00	120.374
1953	173.58	49.06	160.00	49.058
1954	507.10	143.32	160.00	143.321
1955	2291.56	647.66	160.00	160.000
1956	642.36	181.55	160.00	160.000
1957	5208.03	1471.93	160.00	160.000
1958	8885.65	2511.32	160.00	160.000
1959	728.70	205.95	160.00	160.000
1960	398.05	112.50	160.00	112.500
1961	11956.40	3379.19	160.00	160.000
1962	1707.19	482.50	160.00	160.000
1963	1167.84	330.06	160.00	160.000
1964	3066.33	866.63	160.00	160.000
1965	7250.56	2049.20	157.38	157.377
1966	963.26	272.24	160.00	160.000
1967	7247.51	2048.34	160.00	160.000
1968	4061.62	1147.92	160.00	160.000
1969	6774.85	1914.75	160.00	160.000
1970	4876.33	1378.18	160.00	160.000
1971	1512.08	427.35	160.00	160.000
1972	356.65	100.80	160.00	100.799
1973	12043.38	3403.78	160.00	160.000
1974	3249.20	918.31	160.00	160.000
1975	2950.36	833.85	160.00	160.000
1976	1323.61	374.09	160.00	160.000
1977	5517.64	1559.43	160.00	160.000
1978	886.46	250.54	160.00	160.000
1979	4387.54	1240.03	160.00	160.000
1980	362.89	102.56	160.00	102.562
1981	8578.82	2424.60	160.00	160.000
1982	8150.36	2303.51	160.00	160.000
1983	3368.00	951.89	160.00	160.000
1984	3310.45	935.62	160.00	160.000
1985	7467.64	2110.55	160.00	160.000
1986	2850.27	805.56	158.69	158.689
1987	1787.66	505.24	160.00	160.000
1988	583.53	164.92	160.00	160.000
1989	3359.58	949.51	160.00	160.000
1990	8477.43	2395.94	160.00	160.000
1991	306.38	86.59	160.00	86.592
1992	4097.25	1157.99	160.00	160.000
1993	13083.42	3697.72	160.00	160.000
1994	5058.91	1429.78	160.00	160.000
1995	14349.53	4055.56	160.00	160.000
1996	3315.94	937.17	160.00	160.000
1997	3405.81	962.57	160.00	160.000
1998	5675.13	1603.94	160.00	160.000
1999	7117.22	2011.51	160.00	160.000
2000	1634.77	462.03	160.00	160.000
2001	5993.22	1693.84	160.00	160.000
2002	4001.99	1131.07	160.00	160.000
2003	1284.77	363.11	160.00	160.000
2004	3785.96	1070.01	160.00	160.000
2005	4768.84	1347.80	160.00	160.000
2006	455.34	128.69	160.00	128.692
2007	13398.73	3786.84	160.00	160.000
2008	12011.95	3394.89	160.00	160.000
2009	6653.90	1880.57	160.00	160.000
2010	8654.30	2445.93	160.00	160.000
2011	2362.45	667.69	160.00	160.000
MIN	173.58	average availability		152.903
AVERAGE	4833.65	value of capacity		$19,571,538

B4. Alternative S5

Table B-4-1: Capacity and Values for USACE Plants under Alternative S5

STO22SRADC0	STOCKTON LAKE-POWER PLANT			
52	SWPA Marketable Capacity (MW)			
8.30	Average Weekly Generation Hours (critical period			
Year	Average Weekly Energy	Potential Supportable Capacity	Weekly Average Capability	Actual Supportable Capacity
	MWh	MW	MW	MW
1950	869.29	104.69	45.20	45.200
1951	1535.42	184.92	45.20	45.200
1952	563.23	67.83	45.20	45.200
1953	570.84	68.75	45.20	45.200
1954	431.78	52.00	45.20	45.200
1955	773.15	93.11	45.20	45.200
1956	363.54	43.78	45.20	43.782
1957	1669.24	201.03	45.20	45.200
1958	2412.98	290.60	45.20	45.200
1959	716.03	86.23	45.20	45.200
1960	512.75	61.75	45.20	45.200
1961	2681.11	322.89	45.20	45.200
1962	916.68	110.40	45.20	45.200
1963	610.45	73.52	45.20	45.200
1964	697.59	84.01	45.20	45.200
1965	949.19	114.31	45.20	45.200
1966	649.63	78.24	45.20	45.200
1967	1016.54	122.42	45.20	45.200
1968	810.87	97.66	45.20	45.200
1969	624.72	75.24	45.20	45.200
1970	533.00	64.19	45.20	45.200
1971	872.82	105.12	45.20	45.200
1972	593.18	71.44	45.20	45.200
1973	3706.22	446.35	45.20	45.200
1974	1389.42	167.33	45.20	45.200
1975	798.78	96.20	45.20	45.200
1976	932.17	112.26	45.20	45.200
1977	507.29	61.09	45.20	45.200
1978	754.05	90.81	45.20	45.200
1979	1213.08	146.10	45.20	45.200
1980	592.77	71.39	45.20	45.200
1981	924.70	111.36	45.20	45.200
1982	1050.79	126.55	45.20	45.200
1983	915.48	110.25	45.20	45.200
1984	866.70	104.38	45.20	45.200
1985	1053.70	126.90	45.20	45.200
1986	767.77	92.47	45.20	45.200
1987	784.53	94.48	45.20	45.200
1988	614.93	74.06	45.20	45.200
1989	792.72	95.47	45.20	45.200
1990	2485.02	299.28	45.20	45.200
1991	585.12	70.47	45.20	45.200
1992	1094.09	131.77	45.20	45.200
1993	1966.76	236.86	45.20	45.200
1994	1746.85	210.38	45.20	45.200
1995	3124.43	376.28	45.20	45.200
1996	787.31	94.82	45.20	45.200
1997	664.10	79.98	45.20	45.200
1998	714.89	86.10	45.20	45.200
1999	1949.40	234.77	45.20	45.200
2000	715.76	86.20	45.20	45.200
2001	934.00	112.48	45.20	45.200
2002	1440.09	173.43	45.20	45.200
2003	725.39	87.36	45.20	45.200
2004	626.85	75.49	45.20	45.200
2005	613.32	73.86	45.20	45.200
2006	496.35	59.78	45.20	45.200
2007	1961.07	236.18	45.20	45.200
2008	3250.31	391.45	45.20	45.200
2009	1260.07	151.75	45.20	45.200
2010	1430.57	172.29	45.20	45.200
2011	1150.21	138.52	45.20	45.200
2012	689.56	83.05	45.20	45.200
MIN	363.54			
AVERAGE	1102.39	average availability		45.177
		value of capacity		$5,782,720

STO22SRADC0	HARRY S TRUMAN RESERVOIR-POWER PLANT			
160	SWPA Marketable Capacity (MW)			
3.13	Average Weekly Generation Hours (critical period			
Year	Average Weekly Energy	Potential Supportable Capacity	Weekly Average Capability	Actual Supportable Capacity
	MWh	MW	MW	MW
1950	9242.81	2949.38	160.00	160.000
1951	20305.88	6479.60	160.00	160.000
1952	457.89	146.11	160.00	146.114
1953	179.55	57.30	160.00	57.295
1954	519.58	165.80	160.00	160.000
1955	2309.35	736.91	160.00	160.000
1956	649.88	207.38	160.00	160.000
1957	5178.08	1652.32	160.00	160.000
1958	8952.20	2856.65	160.00	160.000
1959	739.62	236.01	160.00	160.000
1960	567.56	181.11	160.00	160.000
1961	11900.10	3797.32	160.00	160.000
1962	1715.78	547.51	160.00	160.000
1963	1175.26	375.03	160.00	160.000
1964	3091.56	986.52	160.00	160.000
1965	7253.54	2314.60	157.38	157.377
1966	973.29	310.58	160.00	160.000
1967	7208.17	2300.13	160.00	160.000
1968	4199.34	1340.01	160.00	160.000
1969	6783.74	2164.69	160.00	160.000
1970	5281.14	1685.21	160.00	160.000
1971	1519.73	484.95	160.00	160.000
1972	366.24	116.87	160.00	116.868
1973	12288.84	3921.37	160.00	160.000
1974	3251.50	1037.55	160.00	160.000
1975	3092.99	986.97	160.00	160.000
1976	1324.35	422.60	160.00	160.000
1977	5544.65	1769.30	160.00	160.000
1978	958.59	305.88	160.00	160.000
1979	4404.80	1405.57	160.00	160.000
1980	375.58	119.85	160.00	119.847
1981	8607.09	2746.52	160.00	160.000
1982	8342.88	2662.21	160.00	160.000
1983	3405.45	1086.68	160.00	160.000
1984	4512.55	1439.95	160.00	160.000
1985	7459.05	2380.18	160.00	160.000
1986	2858.69	912.21	158.69	158.689
1987	1797.28	573.51	160.00	160.000
1988	584.21	186.42	160.00	160.000
1989	3370.39	1075.49	160.00	160.000
1990	7892.81	2518.59	160.00	160.000
1991	306.19	97.70	160.00	97.705
1992	4130.44	1318.02	160.00	160.000
1993	13083.81	4175.04	160.00	160.000
1994	5053.02	1612.42	160.00	160.000
1995	14405.30	4596.73	160.00	160.000
1996	3558.81	1135.61	160.00	160.000
1997	3353.07	1069.96	160.00	160.000
1998	4968.92	1585.58	160.00	160.000
1999	7390.85	2358.42	160.00	160.000
2000	1639.91	523.30	160.00	160.000
2001	6000.55	1914.77	160.00	160.000
2002	4133.13	1318.88	157.38	157.377
2003	1288.55	411.18	160.00	160.000
2004	3747.31	1195.77	160.00	160.000
2005	4784.35	1526.68	160.00	160.000
2006	362.92	115.81	160.00	115.809
2007	13258.72	4230.85	160.00	160.000
2008	11880.23	3790.98	160.00	160.000
2009	6657.47	2124.40	160.00	160.000
2010	8393.20	2678.27	160.00	160.000
2011	2413.09	770.02	160.00	160.000
2012	265.25	84.64	160.00	84.640
MIN	179.55			
AVERAGE	4789.16	average availability		153.837
		value of capacity		$19,691,115

STO22SRADC0	BAGNELL DAM			
176.2	SWPA Marketable Capacity (MW)			
3.54	Average Weekly Generation Hours (critical			
Year	Average Weekly Energy	Potential Supportable Capacity	Weekly Average Capability	Actual Supportable Capacity
	MWh	MW	MW	MW
1950	14325.57	4048.78	176.20	176.200
1951	22621.01	6393.30	176.20	176.200
1952	1528.17	431.90	176.20	176.200
1953	168.79	47.70	176.20	47.704
1954	630.69	178.25	176.20	176.200
1955	3768.94	1065.20	176.20	176.200
1956	198.35	56.06	176.20	56.058
1957	7259.21	2051.64	176.20	176.200
1958	13046.13	3687.18	176.20	176.200
1959	2068.10	584.50	176.20	176.200
1960	1236.53	349.48	176.20	176.200
1961	14349.97	4055.68	176.20	176.200
1962	3561.48	1006.57	176.20	176.200
1963	1954.78	552.47	176.20	176.200
1964	4544.15	1284.30	176.20	176.200
1965	12592.77	3559.05	176.20	176.200
1966	1949.33	550.93	176.20	176.200
1967	7786.78	2200.75	176.20	176.200
1968	6552.09	1851.79	176.20	176.200
1969	11032.58	3118.10	176.20	176.200
1970	6732.25	1902.71	176.20	176.200
1971	3119.40	881.63	176.20	176.200
1972	573.07	161.96	176.20	161.964
1973	12955.54	3661.58	176.20	176.200
1974	6843.28	1934.09	176.20	176.200
1975	6115.91	1728.52	176.20	176.200
1976	2540.49	718.01	176.20	176.200
1977	6389.65	1805.88	176.20	176.200
1978	2358.16	666.48	176.20	176.200
1979	8242.60	2329.58	176.20	176.200
1980	482.90	136.48	176.20	136.479
1981	10425.61	2946.55	176.20	176.200
1982	9360.72	2645.59	176.20	176.200
1983	3442.10	972.83	176.20	176.200
1984	6028.79	1703.90	176.20	176.200
1985	9522.24	2691.24	176.20	176.200
1986	6439.64	1820.01	176.20	176.200
1987	3664.08	1035.57	176.20	176.200
1988	1320.99	373.35	176.20	176.200
1989	6210.65	1755.29	176.20	176.200
1990	9181.28	2594.87	176.20	176.200
1991	617.31	174.47	176.20	174.469
1992	7575.20	2140.95	176.20	176.200
1993	15461.51	4369.83	176.20	176.200
1994	5945.71	1680.42	176.20	176.200
1995	14444.73	4082.46	176.20	176.200
1996	6342.33	1792.51	176.20	176.200
1997	5373.51	1518.70	176.20	176.200
1998	9285.00	2624.19	176.20	176.200
1999	7631.58	2156.88	176.20	176.200
2000	2580.59	729.34	176.20	176.200
2001	8603.90	2431.69	176.20	176.200
2002	4220.72	1192.89	176.20	176.200
2003	2824.56	798.29	176.20	176.200
2004	7301.38	2063.56	176.20	176.200
2005	7062.63	1996.09	176.20	176.200
2006	284.59	80.43	176.20	80.432
2007	14287.65	4038.07	176.20	176.200
2008	15139.00	4278.68	176.20	176.200
2009	9153.20	2586.94	176.20	176.200
2010	11422.81	3228.39	176.20	176.200
2011	3669.19	1037.01	176.20	176.200
MIN	168.79	average availability		169.747
AVERAGE	6650.84	value of capacity		$21,727,601

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APPENDIX C: Cost Estimates for Alternative Thermal Generating Plant Types in Arkansas, Missouri, and Oklahoma

Table C-0-1: Summary of Capital and Operating Costs for Thermal Generating Plant Types

State	Thermal Generating Plant Type					
	Coal-fired Steam Turbine		Natural Gas-fired Combined Cycle		Natural Gas-fired Turbine	
	CO		CC		CT	
	Capacity Value	Energy Value	Capacity Value	Energy Value	Capacity Value	Energy Value
Arkansas	$325.03	$20.50	$143.60	$24.23	$122.07	$35.58
Missouri	$341.43	$18.61	$143.60	$24.23	$122.57	$35.35
Oklahoma	$324.97	$18.60	$143.60	$24.23	$122.07	$33.68
Average	**$330.48**	**$19.24**	**$143.60**	**$24.23**	**$122.23**	**$34.87**

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C 1. Coal-fired steam turbine

Table C-1-1: **Coal-Fired Steam Turbine POWER VALUE**

				Date Run
COAL-FIRED STEAM POWER VALUE				08/21/19
PROJECT NAME:	Stockton WSR _ July 2019			
LOCATION:	Arkansas			
FINANCING:	FEDERAL @	2.875%		
Capacity Value		$325.03	per kW-yr	
Energy Value		$20.50	per Mwh	
PROGRAM INPUT DATA			State Index Number	4
			State Location	AR
Cost Level Date	7/21/2019		H-W Index Reg No	4
Single unit capacity	600		ROW ($/acre)	3034
Capacity factor	0.65		Clearing % of ROW	0.60
Trans Voltage	345		Rec Sub Land Cost	28536
Transformer MVA	200		Plant Invest	2538
No of Trans	6		FC Mov-Ave Time Frame	60
No of Trans Pos	2		Fuel Cost	212.8
Single or Three Phase	1		Heat Rate	8080
Length Line 1	50		Variable O&M	3.30
Length Line 2	0		Fixed O&M	104.76
Line 1: Total Circuits	3		O&M update	4.52
No of Single Circ	1		Plant update	4.91
No of Double Circ	1		Transmission update	3.61
Line 2: Total Circuits	0		Depreciation Plant (%)	2.14
No of Single Circ	0		Deprec Sub (%)	2.14
No of Double Circ	0		Deprec Trans Tower (%)	0.92
			Deprec Trans Pole (%)	2.14
Cost of Money (%)	2.875			
Plant Life	30		Fed Inc Tax (%)	0.000
Substation Life	30		Fed Misc Tax (%)	0.000
Trans (towers) Life	50		State & Local Tax (%)	0.000
Trans (poles) life	30			
			Hydro Flex Adjust	0.050
Plant insurance (%)	0.25		Alt Mechanical Avail	0.850
Trans Insurance (%)	0.10		Hydro Mech Avail	0.980
Sub insurance (%)	0.25		Mech Avail Adjust	0.153
			ALT CAP FAC	65.00
			HYDRO CAP FAC	65.00
			VAL DISPLACED ENERGY	0.00
			EV ADJUST	20.50
			VARIABLE O&M	3.30
			ESC ENERGY VALUE	20.50
			ESCALATION FACTOR	1.00

				Date Run
COAL-FIRED STEAM POWER VALUE				08/21/19
PROJECT NAME:	Stockton WSR _ July 2019			
LOCATION:	Missouri			
FINANCING:	FEDERAL @	2.875%		
Capacity Value		$341.43	per kW-yr	
Energy Value		$18.61	per Mwh	
PROGRAM INPUT DATA			State Index Number	26
			State Location	MO
Cost Level Date	7/21/2019		H-W Index Reg No	3
Single unit capacity	600		ROW ($/acre)	3034
Capacity factor	0.65		Clearing % of ROW	0.60
Trans Voltage	345		Rec Sub Land Cost	28536
Transformer MVA	200		Plant Invest	2764
No of Trans	6		FC Mov-Ave Time Frame	60
No of Trans Pos	2		Fuel Cost	186.1
Single or Three Phase	1		Heat Rate	8080
Length Line 1	50		Variable O&M	3.57
Length Line 2	0		Fixed O&M	105.03
Line 1: Total Circuits	3		O&M update	4.52
No of Single Circ	1		Plant update	5.33
No of Double Circ	1		Transmission update	4.51
Line 2: Total Circuits	0		Depreciation Plant (%)	2.14
No of Single Circ	0		Deprec Sub (%)	2.14
No of Double Circ	0		Deprec Trans Tower (%)	0.92
			Deprec Trans Pole (%)	2.14
Cost of Money (%)	2.875			
Plant Life	30		Fed Inc Tax (%)	0.000
Substation Life	30		Fed Misc Tax (%)	0.000
Trans (towers) Life	50		State & Local Tax (%)	0.000
Trans (poles) life	30			
			Hydro Flex Adjust	0.050
Plant insurance (%)	0.25		Alt Mechanical Avail	0.850
Trans Insurance (%)	0.10		Hydro Mech Avail	0.980
Sub insurance (%)	0.25		Mech Avail Adjust	0.153
			ALT CAP FAC	65.00
			HYDRO CAP FAC	65.00
			VAL DISPLACED ENERGY	0.00
			EV ADJUST	18.61
			VARIABLE O&M	3.57
			ESC ENERGY VALUE	18.61
			ESCALATION FACTOR	1.00

				Date Run
COAL-FIRED STEAM POWER VALUE				08/21/19
PROJECT NAME:	Stockton WSR - July 2019			
LOCATION:	Oklahoma			
FINANCING:	FEDERAL @	2.875%		
Capacity Value		$324.97	per kW-yr	
Energy Value		$18.60	per Mwh	
PROGRAM INPUT DATA			State Index Number	37
			State Location	OK
Cost Level Date	7/21/2019		H-W Index Reg No	4
Single unit capacity	600		ROW ($/acre)	3034
Capacity factor	0.65		Clearing % of ROW	0.60
Trans Voltage	345		Rec Sub Land Cost	28536
Transformer MVA	200		Plant Invest	2538
No of Trans	6		FC Mov-Ave Time Frame	60
No of Trans Pos	2		Fuel Cost	189.4
Single or Three Phase	1		Heat Rate	8080
Length Line 1	50		Variable O&M	3.30
Length Line 2	0		Fixed O&M	104.76
Line 1: Total Circuits	3		O&M update	4.52
No of Single Circ	1		Plant update	4.91
No of Double Circ	1		Transmission update	3.61
Line 2: Total Circuits	0		Depreciation Plant (%)	2.14
No of Single Circ	0		Deprec Sub (%)	2.14
No of Double Circ	0		Deprec Trans Tower (%)	0.92
			Deprec Trans Pole (%)	2.14
Cost of Money (%)	2.875			
Plant Life	30		Fed Inc Tax (%)	0.000
Substation Life	30		Fed Misc Tax (%)	0.000
Trans (towers) Life	50		State & Local Tax (%)	0.000
Trans (poles) life	30			
			Hydro Flex Adjust	0.050
Plant insurance (%)	0.25		Alt Mechanical Avail	0.850
Trans Insurance (%)	0.10		Hydro Mech Avail	0.980
Sub insurance (%)	0.25		Mech Avail Adjust	0.153
			ALT CAP FAC	65.00
			HYDRO CAP FAC	65.00
			VAL DISPLACED ENERGY	0.00
			EV ADJUST	18.60
			VARIABLE O&M	3.30
			ESC ENERGY VALUE	18.60
			ESCALATION FACTOR	1.00

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C 2. Natural Gas-fired Combined Cycle

Table C-2-1: Natural Gas-fired Combined Cycle POWER VALUE

				Date Run
COMBINED CYCLE POWER VALUE				08/21/19
PROJECT NAME:	Stockton WSR _ July 2019			
LOCATION:	Arkansas			
FINANCING:	FEDERAL @	2.875%		
Capacity Value		$143.60	per kW-yr	
Energy Value		$24.23	per MWh	
PROGRAM INPUT DATA			State Index Number	4
			State Abbr. (exact)	AR
Cost Level Date	7/1/2019		H-W Index Reg No	4
Single unit capacity	620		ROW ($/acre)	3031
Capacity factor	0.20		Clearing % of ROW	0.60
Trans Voltage	230		Rec Sub Land Cost	28508
Transformer MVA	200		Plant Invest	1186
No of Trans	1		FC Mov-Ave Time Frame	60
No of Trans Positions	1		Fuel Cost	326.6
Single or Three Phase	3		Heat Rate	7050
Length Line 1	0		Variable O&M	1.20
Length Line 2	0		Fixed O&M	60.35
Line 1: Total Circuits	2		O&M update	4.52
No of Single Circ	2		Plant update	4.91
No of Double Circ	0		Transmission update	3.61
Line 2: Total Circuits	0		Depreciation Plant (%)	2.14
No of Single Circ	0		Deprec Sub (%)	2.14
No of Double Circ	0		Deprec Trans Tower (%)	0.92
			Deprec Trans Pole (%)	2.14
Cost of Money (%)	2.875			
Plant Life	30		Fed Inc Tax (%)	0.000
Substation Life	30		Fed Misc Tax (%)	0.000
Trans (towers) Life	50		State & Local Tax (%)	0.000
Trans (poles) life	30			
			Hydro Flex Adjust	0.025
Plant insurance (%)	0.25		Alt Mechanical Avail	0.900
Trans Insurance (%)	0.10		Hydro Mech Avail	0.980
Sub insurance (%)	0.25		Mech Avail Adjust	0.089
			ALT CAP FAC	5.00
			HYDRO CAP FAC	5.00
			VAL DISPLACED ENERGY	0.00
			EV ADJUST	24.23
			VARIABLE O&M	1.20
			ESC ENERGY VALUE	24.23
			ESCALATION FACTOR	1.00

				Date Run
COMBINED CYCLE POWER VALUE				08/28/19
PROJECT NAME:	Stockton WSR _ July 2019			
LOCATION:	Missouri			
FINANCING:	FEDERAL @	2.875%		
Capacity Value		$143.60	per kW-yr	
Energy Value		$24.23	per MWh	
PROGRAM INPUT DATA			State Index Number	26
			State Abbr. (exact)	MO
Cost Level Date	7/1/2019		H-W Index Reg No	1
Single unit capacity	620		ROW ($/acre)	3031
Capacity factor	0.20		Clearing % of ROW	0.60
Trans Voltage	230		Rec Sub Land Cost	28508
Transformer MVA	200		Plant Invest	1186
No of Trans	1		FC Mov-Ave Time Frame	60
No of Trans Positions	1		Fuel Cost	324.5
Single or Three Phase	3		Heat Rate	7050
Length Line 1	0		Variable O&M	1.20
Length Line 2	0		Fixed O&M	60.35
Line 1: Total Circuits	2		O&M update	4.52
No of Single Circ	2		Plant update	5.67
No of Double Circ	0		Transmission update	4.48
Line 2: Total Circuits	0		Depreciation Plant (%)	2.14
No of Single Circ	0		Deprec Sub (%)	2.14
No of Double Circ	0		Deprec Trans Tower (%)	0.92
			Deprec Trans Pole (%)	2.14
Cost of Money (%)	2.875			
Plant Life	30		Fed Inc Tax (%)	0.000
Substation Life	30		Fed Misc Tax (%)	0.000
Trans (towers) Life	50		State & Local Tax (%)	0.000
Trans (poles) life	30			
			Hydro Flex Adjust	0.025
Plant insurance (%)	0.25		Alt Mechanical Avail	0.900
Trans Insurance (%)	0.10		Hydro Mech Avail	0.980
Sub insurance (%)	0.25		Mech Avail Adjust	0.089
			ALT CAP FAC	5.00
			HYDRO CAP FAC	5.00
			VAL DISPLACED ENERGY	0.00
			EV ADJUST	24.23
			VARIABLE O&M	1.20
			ESC ENERGY VALUE	24.23
			ESCALATION FACTOR	1.00

				Date Run
COMBINED CYCLE POWER VALUE				08/28/19
PROJECT NAME:	Stockton WSR - July 2019			
LOCATION:	Oklahoma			
FINANCING:	FEDERAL @	2.875%		
Capacity Value		$143.60	per kW-yr	
Energy Value		$24.23	per MWh	
PROGRAM INPUT DATA			State Index Number	37
			State Abbr. (exact)	OK
Cost Level Date	7/1/2019		H-W Index Reg No	5
Single unit capacity	620		ROW ($/acre)	3031
Capacity factor	0.20		Clearing % of ROW	0.60
Trans Voltage	230		Rec Sub Land Cost	28508
Transformer MVA	200		Plant Invest	1186
No of Trans	1		FC Mov-Ave Time Frame	60
No of Trans Positions	1		Fuel Cost	309.1
Single or Three Phase	3		Heat Rate	7050
Length Line 1	0		Variable O&M	1.20
Length Line 2	0		Fixed O&M	60.35
Line 1: Total Circuits	2		O&M update	4.52
No of Single Circ	2		Plant update	4.99
No of Double Circ	0		Transmission update	3.69
Line 2: Total Circuits	0		Depreciation Plant (%)	2.14
No of Single Circ	0		Deprec Sub (%)	2.14
No of Double Circ	0		Deprec Trans Tower (%)	0.92
			Deprec Trans Pole (%)	2.14
Cost of Money (%)	2.875			
Plant Life	30		Fed Inc Tax (%)	0.000
Substation Life	30		Fed Misc Tax (%)	0.000
Trans (towers) Life	50		State & Local Tax (%)	0.000
Trans (poles) life	30			
			Hydro Flex Adjust	0.025
Plant insurance (%)	0.25		Alt Mechanical Avail	0.900
Trans Insurance (%)	0.10		Hydro Mech Avail	0.980
Sub insurance (%)	0.25		Mech Avail Adjust	0.089
			ALT CAP FAC	5.00
			HYDRO CAP FAC	5.00
			VAL DISPLACED ENERGY	0.00
			EV ADJUST	24.23
			VARIABLE O&M	1.20
			ESC ENERGY VALUE	24.23
			ESCALATION FACTOR	1.00

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C 3. Natural Gas-fired turbine

Table C-3-1: Natural Gas-fired Turbine POWER VALUE

				Date Run
COMBUSTION TURBINE POWER VALUE				08/21/19
PROJECT NAME:	Stockton WSR _ July 2019			
LOCATION:	Missouri			
FINANCING:	FEDERAL @	2.875%		
Capacity Value		$122.07	per kW-yr	
Energy Value		$35.58	per MWh	
PROGRAM INPUT DATA			State Index Number	4
			State Location	AR
Cost Level Date	7/1/2019		H-W Index Reg No	4
Single unit capacity	85		ROW ($/acre)	3031
Capacity Factor	0.10		Clearing % of ROW	0.60
Transmission Voltage	230		Rec Sub Land Cost	28508
Transformer MVA	125		Plant Invest	1170
No of Trans	2		FC Mov-Ave Time Frame	60
No of Trans Pos	2		Fuel Cost	326.6
Single or Three Phase	3		Heat Rate	10800
Length Line 1	0		Variable O&M	0.30
Length Line 2	0		Fixed O&M	35.30
Line 1: Total Circuits	2		O&M update	4.52
No of Single Circ	2		Plant update	4.91
No of Double Circ	0		Transmission update	3.61
Line 2: Total Circuits	0		Depreciation Plant (%)	2.14
No of Single Circ	0		Deprec Sub (%)	2.14
No of Double Circ	0		Deprec Trans Tower (%)	0.92
			Deprec Trans Pole (%)	2.14
Cost of Money (%)	2.875			
Plant Life	30		Fed Inc Tax (%)	0.000
Substation Life	30		Fed Misc Tax (%)	0.000
Trans (towers) Life	50		State & Local Tax (%)	0.000
Trans (poles) life	30			
			Hydro Flex Adjust	0.025
Plant insurance (%)	0.25		Alt Mechanical Avail	0.900
Trans Insurance (%)	0.10		Hydro Mechanical Avail	0.980
Sub insurance (%)	0.25		Mech Avail Adjust	0.089
			ALT PLANT CAP FAC	5.00
			HYDRO CAP FAC	5.00
			VAL DISPLACED ENERGY	0.00
			EV ADJUST	35.58
			VARIABLE O&M	0.30
			ESC ENERGY VAL	35.58
			ESCALATION FACTOR	1.00

				Date Run
COMBUSTION TURBINE POWER VALUE				08/21/19
PROJECT NAME:	Stockton WSR _ July 2019			
LOCATION:	Missouri			
FINANCING:	FEDERAL @	2.875%		
Capacity Value		$122.57	per kW-yr	
Energy Value		$35.35	per MWh	
PROGRAM INPUT DATA			State Index Number	26
			State Location	MO
Cost Level Date	7/1/2019		H-W Index Reg No	3
Single unit capacity	85		ROW ($/acre)	3031
Capacity Factor	0.10		Clearing % of ROW	0.60
Transmission Voltage	230		Rec Sub Land Cost	28508
Transformer MVA	125		Plant Invest	1167
No of Trans	2		FC Mov-Ave Time Frame	60
No of Trans Pos	2		Fuel Cost	324.5
Single or Three Phase	3		Heat Rate	10800
Length Line 1	0		Variable O&M	0.30
Length Line 2	0		Fixed O&M	35.30
Line 1: Total Circuits	2		O&M update	4.52
No of Single Circ	2		Plant update	5.33
No of Double Circ	0		Transmission update	4.51
Line 2: Total Circuits	0		Depreciation Plant (%)	2.14
No of Single Circ	0		Deprec Sub (%)	2.14
No of Double Circ	0		Deprec Trans Tower (%)	0.92
			Deprec Trans Pole (%)	2.14
Cost of Money (%)	2.875			
Plant Life	30		Fed Inc Tax (%)	0.000
Substation Life	30		Fed Misc Tax (%)	0.000
Trans (towers) Life	50		State & Local Tax (%)	0.000
Trans (poles) life	30			
			Hydro Flex Adjust	0.025
Plant insurance (%)	0.25		Alt Mechanical Avail	0.900
Trans Insurance (%)	0.10		Hydro Mechanical Avail	0.980
Sub insurance (%)	0.25		Mech Avail Adjust	0.089
			ALT PLANT CAP FAC	5.00
			HYDRO CAP FAC	5.00
			VAL DISPLACED ENERGY	0.00
			EV ADJUST	35.35
			VARIABLE O&M	0.30
			ESC ENERGY VAL	35.35
			ESCALATION FACTOR	1.00

				Date Run
COMBUSTION TURBINE POWER VALUE				08/21/19
PROJECT NAME:	Stockton WSR - July 2019			
LOCATION:	Missouri			
FINANCING:	FEDERAL @	2.875%		
Capacity Value		$122.07	per kW-yr	
Energy Value		$33.68	per MWh	
PROGRAM INPUT DATA			State Index Number	37
			State Location	OK
Cost Level Date	7/1/2019		H-W Index Reg No	4
Single unit capacity	85		ROW ($/acre)	3031
Capacity Factor	0.10		Clearing % of ROW	0.60
Transmission Voltage	230		Rec Sub Land Cost	28508
Transformer MVA	125		Plant Invest	1170
No of Trans	2		FC Mov-Ave Time Frame	60
No of Trans Pos	2		Fuel Cost	309.1
Single or Three Phase	3		Heat Rate	10800
Length Line 1	0		Variable O&M	0.30
Length Line 2	0		Fixed O&M	35.30
Line 1: Total Circuits	2		O&M update	4.52
No of Single Circ	2		Plant update	4.91
No of Double Circ	0		Transmission update	3.61
Line 2: Total Circuits	0		Depreciation Plant (%)	2.14
No of Single Circ	0		Deprec Sub (%)	2.14
No of Double Circ	0		Deprec Trans Tower (%)	0.92
			Deprec Trans Pole (%)	2.14
Cost of Money (%)	2.875			
Plant Life	30		Fed Inc Tax (%)	0.000
Substation Life	30		Fed Misc Tax (%)	0.000
Trans (towers) Life	50		State & Local Tax (%)	0.000
Trans (poles) life	30			
			Hydro Flex Adjust	0.025
Plant insurance (%)	0.25		Alt Mechanical Avail	0.900
Trans Insurance (%)	0.10		Hydro Mechanical Avail	0.980
Sub insurance (%)	0.25		Mech Avail Adjust	0.089
			ALT PLANT CAP FAC	5.00
			HYDRO CAP FAC	5.00
			VAL DISPLACED ENERGY	0.00
			EV ADJUST	33.68
			VARIABLE O&M	0.30
			ESC ENERGY VAL	33.68
			ESCALATION FACTOR	1.00

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APPENDIX D: HAC Alternate Method for Computing Hydropower Plant Generation *(Wolf Creek)*

EXHIBIT 1: Flow Simulation Model

A flow simulation on the historical records was performed to estimate how the powerhouse would operate if there was no DO releases. Figures D1-D4 illustrate the process. First, in Figure D1, the hourly flows are separated in a given day into two categories using historical records, DO releases, and Powerhouse flows.

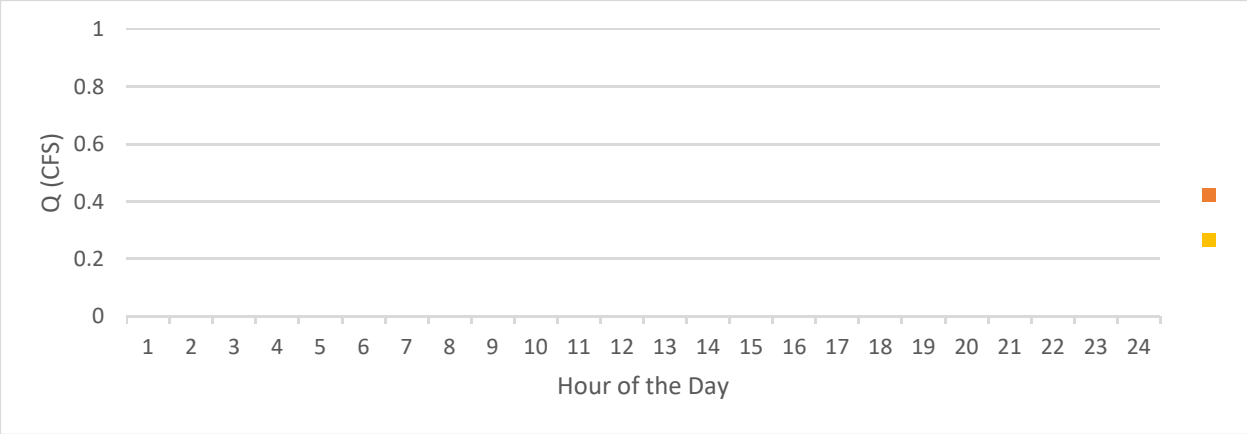

Figure D1. Historical Flow Record for Wolf Creek Sept 23, 2006

Secondly, in Figure D2, the powerhouse flows are sorted from high to low with their corresponding DO releases. This sorting allows for the alignment of high to low hourly energy prices.

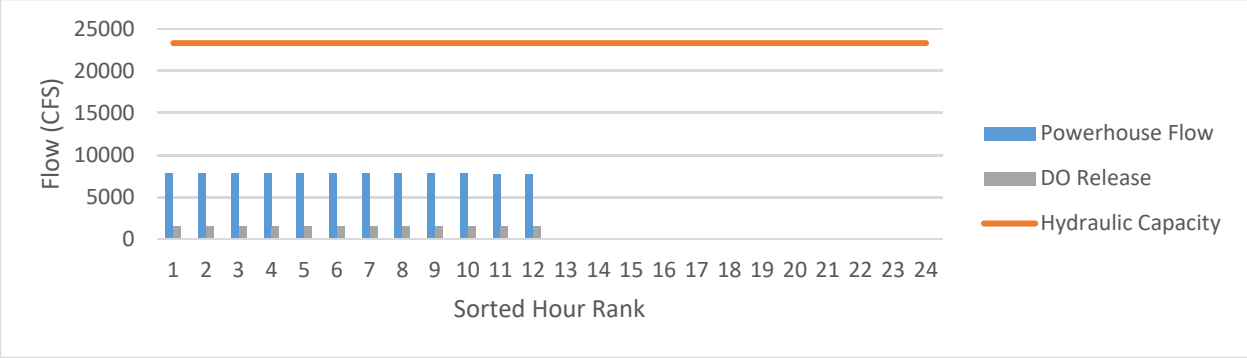

Figure D2. Sorted Historical record for Wolf Creek Sept 23, 2006

Also in this step, the powerhouse hydraulic capacity is calculated corresponding to the reservoir elevation in Figure A3.

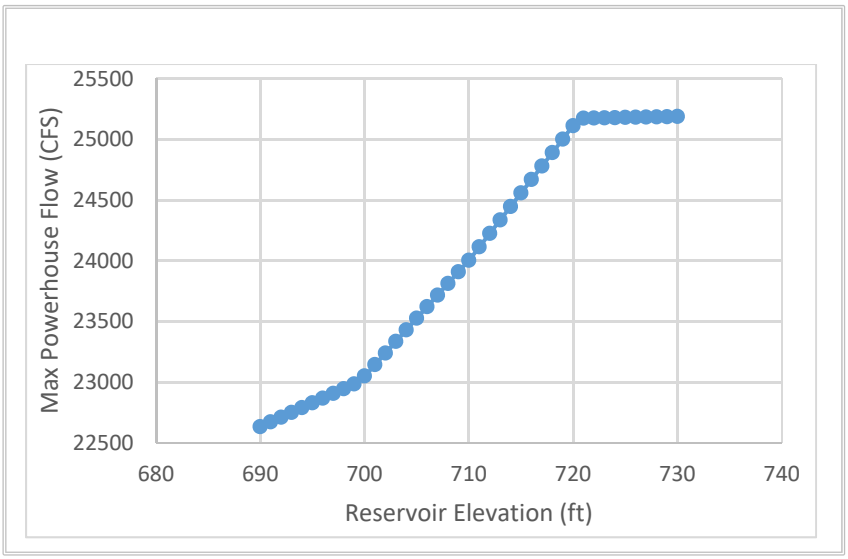

Figure D3. Powerhouse flow limits as a function of Reservoir Elevation for Wolf Creek DO study

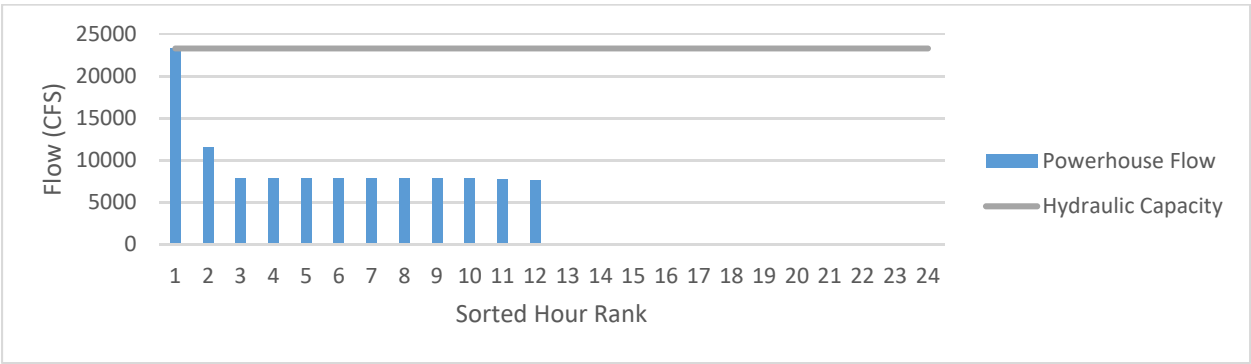

Figure D4. Simulated Wolf Creek Flows with re-distributed DO releases for Sept 23, 2006

EXHIBIT 2: Hourly Energy Simulation Model

Since the power generation of the simulated flow releases will need to be modeled, both the historical and the simulated flow records are run through the HDC's Shuffled-Complex Evolutionary Turbine Optimization Model (SCE-TOM) for Wolf Creek Powerhouse.

2.1. Modeling Inputs

HDC's Turbomachinery section provided inputs into this model that include the Turbine Efficiency Hill Curves (Figure D5) and Cavitation Flow Limits (Figure D6). The turbine efficiency hill curve was estimated using the 1948 turbine model test and applying an efficiency degradation factor. The cavitation flow limits were estimated using a scaling factor from Center Hill.

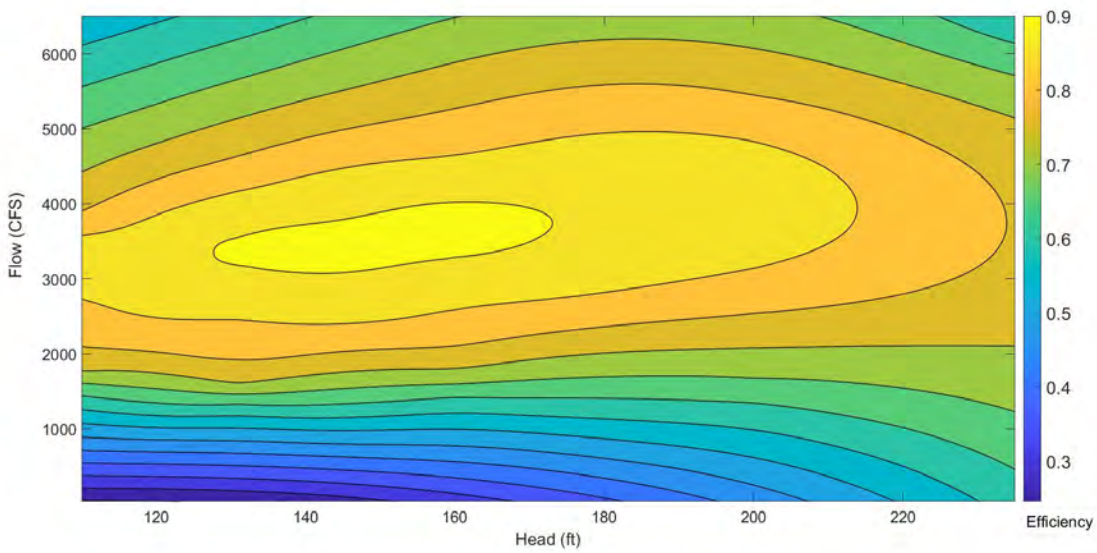

Figure D5.Turbine Hill Curves used for Wolf Creek DO analysis

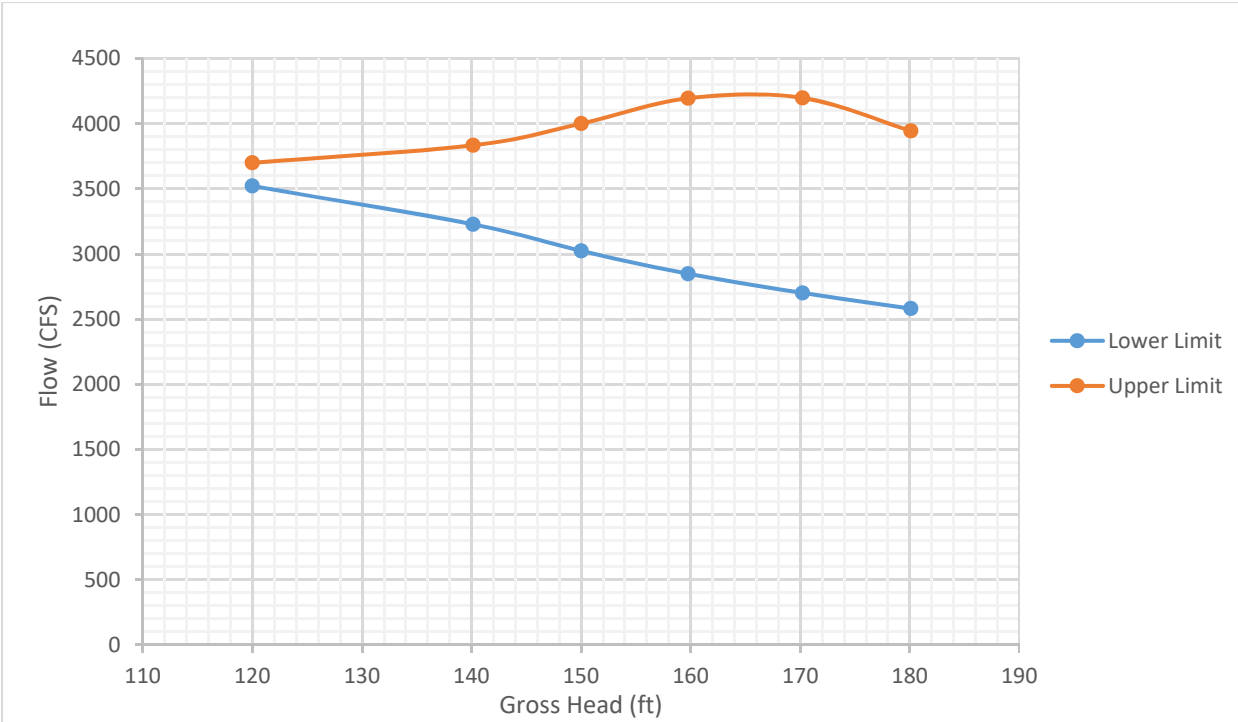

Figure D6. Cavitation Flow limits used for Wolf Creek DO analysis

Using the cavitation flow limits illustrated in Figure B2 and Wolf Creek's tailwater rating curve, the powerhouse flow limits can be determined as a function of Reservoir Elevation by solving the following non-linear equation.

$$\sum_{i=1}^{num_units} Q_i = \sum_{i=1}^{num_units} \max_flow(RE - TW(\sum_{i=1}^{num_units} Q_i))$$

Figure D6 illustrates the powerhouse flow limits computed for Wolf Creek as a function of reservoir elevation. This will be used as a constraint to shifting DO releases into peaking time periods.

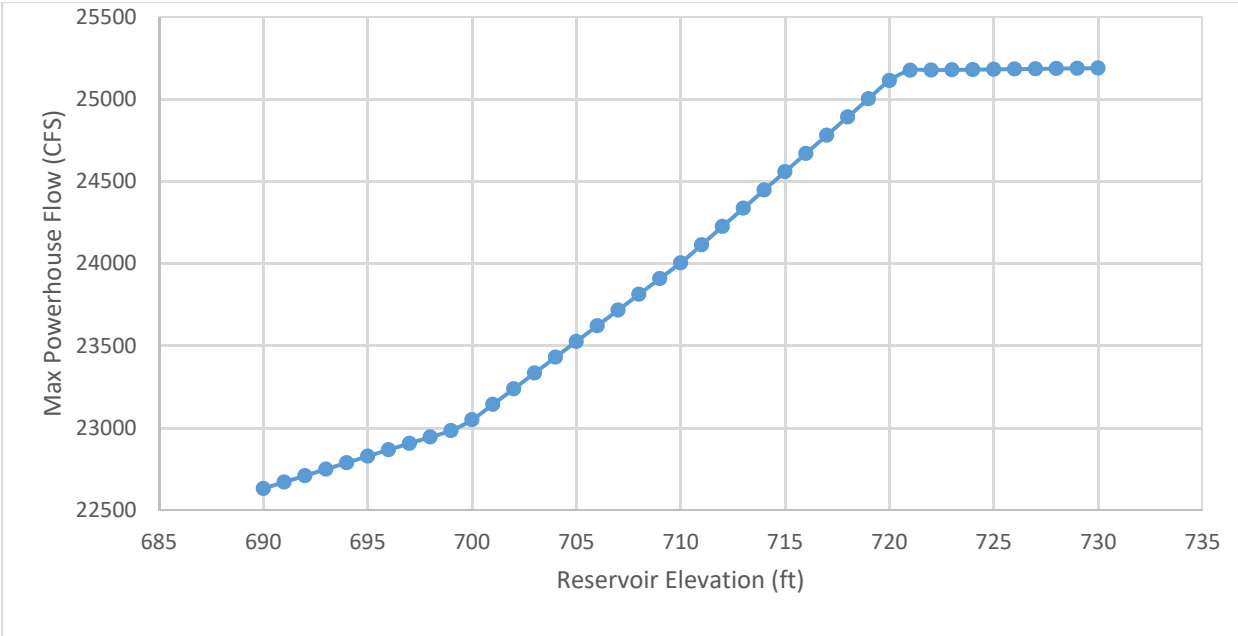

Figure D7. Powerhouse flow limits as a function of Reservoir Elevation for Wolf Creek DO study

2.2. Shuffle-Complex Evolutionary Turbine Optimization Model (SEC-TOM)

The SCE-TOM optimized flow through the turbines using the shuffled complex evolutionary algorithm (SCE-UA). This algorithm was first developed in 1992 by Duan et al as an efficient and effective method to calibrate rainfall-runoff models[1]. Like a hydropower facility with several units that could be turned on or off, rainfall-runoff models usually consist of several parameters that need to be calibrated.

The basic procedure of the SCE-UA algorithm involves first randomly searching through the feasible space through a number of solution sets (guesses). The solution sets are then ranked according to their objective function scores. Lower ranking scores evolve by being manipulated to reflect the higher scoring objective functions within a complex (a subset of the total solution sets). After this evolution step, the procedure is repeated until a maximum set of iterations. The SCE-UA algorithm optimizes the function only in the statistical sense (ex. % of time) where the performance success is generally dependent on a number of iterations or objective function computations. More information can be found on this algorithm in the paper, Effective and Efficient Global Optimization for Conceptual Rainfall-Runoff Models (Duan et al 1992) and the model documentation being written concurrently with this report.

Optimal Hourly Unit Dispatch

The goal of optimal hourly unit dispatch is to distribute the flow among the units to maximize generation. Unit efficiency is determined by unit and alternative specific hill curves-lookup tables that associate efficiency as a function of flow and head. From these, generation is determined by using the standard hydropower equation:

[1] http://www.rap.ucar.edu/~barlage/CWB/papers/Duan_1992.pdf

$$Power\,(MW) = \frac{Q(cfs) * Head\,(\,feet\,) * efficiency}{11800}$$

To maximize generation using the SCE-UA algorithm, the following objective function is developed:

$$MAX\left[\sum_{i=1}^{n}\left(P(H_t, Q_t^i, e_t^i) - w_1\left|Q_t^i - Q_{t-1}^i\right| - w_2 F(H_t, Q_t^i)\right)\right]$$

Where,

$n = \text{number of units}$

$H_t = \text{Head at time t}$

$Q_t^i = \text{Flow through turbine i at time t}$

$e_t^i = \text{efficiency of turbine i at time t}$

$P(H_t, Q_t^i, e_t^i) = \text{Power (MWH) for Unit i at time t with Efficiency e}$

$$F(H_t, Q_t^i) = \begin{cases} 1 & H_t, Q_t^i \in \text{Cavitation Zone} \\ 0 & H_t, Q_t^i \notin \text{Cavitation Zone} \end{cases}$$

$w_1 = \text{weighted penalty coefficient for unit flow changes}$

$w_2 = \text{weighted penalty coefficient for cavitation zones}$

The objective function is the summation of the power generation across all of the units combined with two negative penalty functions. The first penalty function $\left|Q_t^i - Q_{t-1}^i\right|$ seeks to minimize extreme changes in flow distribution between time intervals for particular units. For example, this penalty function reduces the likelihood of a situation where a particular unit running at full capacity is somehow turned off and replaced with another unit running at full capacity. The second penalty function, $F(H_t, Q_t^i)$ seeks to minimize the time that units are operating in the cavitation or rough zone.

2.3. Powerhill Matrices

The SCE-TOM model is run over a number of flow head relationships to form powerhill matrices. These powerhill matrices form a power lookup considering the head/flow relationships given in both the simulated and the historical flow records. Wolf Creek's powerhill matrix spans 2000-28000 CFS using steps of 100 CFS by 120-200 ft. of head using a 1 ft. step size. Figure B4 shows the Powerhill matrix used for this study.

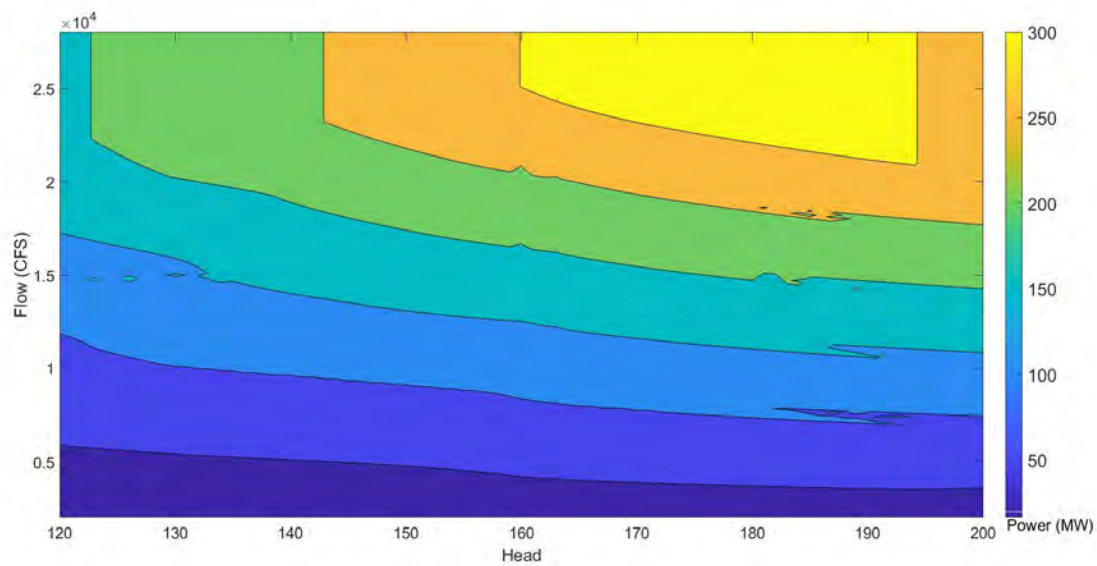

Figure D7. Powerhill matrix used for Wolf Creek DO study

EXHIBIT 3. Turbine "Hill Curve" Lookup Table

These are partial tables (extracts) to illustrate the concept.

Table D-1 Turbine Performance in Aerating Model

Turbine Performance in Aerating Mode POWER (MW)								
Head (ft) / Power Flow (cfs)	125	126	127	128	129	130	131	132
1,000	0.3787	0.47528	0.5654	0.64871	0.73256	0.81494	0.89116	0.96129
1,100	2.0033	2.0951	2.1857	2.2739	2.359	2.4396	2.5162	2.5901
1,200	3.6698	3.762	3.8664	3.9721	4.0636	4.1484	4.2374	4.3286
1,300	5.2133	5.3197	5.4334	5.5492	5.6601	5.7665	5.8742	5.9815
1,400	6.5859	6.7127	6.8369	6.9613	7.0881	7.2166	7.3428	7.4629
1,500	7.8617	8.0042	8.1389	8.2687	8.4049	8.5538	8.7005	8.8387
1,600	9.115	9.2663	9.4146	9.5617	9.7111	9.8642	10.017	10.164
1,700	10.371	10.532	10.692	10.852	11.012	11.17	11.326	11.479
1,800	11.638	11.806	11.974	12.141	12.308	12.473	12.637	12.797
1,900	12.92	13.093	13.266	13.441	13.615	13.787	13.958	14.126
2,000	14.214	14.392	14.574	14.758	14.941	15.12	15.298	15.471
2,100	15.522	15.71	15.903	16.096	16.287	16.474	16.658	16.836
2,200	16.846	17.047	17.249	17.449	17.647	17.841	18.031	18.215
2,300	18.175	18.392	18.597	18.795	18.989	19.181	19.374	19.572
2,400	19.501	19.724	19.928	20.117	20.301	20.485	20.674	20.877
2,500	20.822	21.034	21.234	21.428	21.623	21.821	22.02	22.224
2,600	22.172	22.383	22.59	22.798	23.013	23.234	23.454	23.665
2,700	23.558	23.781	24.007	24.235	24.467	24.699	24.928	25.153
2,800	24.952	25.182	25.408	25.638	25.874	26.113	26.353	26.598
2,900	26.218	26.466	26.704	26.942	27.184	27.429	27.675	27.92
3,000	27.351	27.611	27.869	28.131	28.394	28.654	28.908	29.153
3,100	28.451	28.717	28.981	29.247	29.519	29.795	30.071	30.333
3,200	29.549	29.823	30.09	30.349	30.61	30.888	31.176	31.459
3,300	30.626	30.912	31.194	31.461	31.726	32.004	32.293	32.58
3,400	31.678	31.954	32.22	32.491	32.786	33.098	33.412	33.709
3,500	32.741	33.029	33.295	33.565	33.867	34.187	34.507	34.815
3,600	33.833	34.14	34.436	34.73	35.03	35.336	35.646	35.954
3,700	34.809	35.253	35.57	35.899	36.225	36.544	36.855	37.158
3,800	34.809	35.529	36.284	37.047	37.416	37.744	38.067	38.38
3,900	34.809	35.529	36.284	37.047	37.798	38.523	39.194	39.538
4,000	34.809	35.529	36.284	37.047	37.798	38.523	39.244	39.982
4,100	34.809	35.529	36.284	37.047	37.798	38.523	39.244	39.982
4,200	34.809	35.529	36.284	37.047	37.798	38.523	39.244	39.982
4,300	34.809	35.529	36.284	37.047	37.798	38.523	39.244	39.982
4,400	34.809	35.529	36.284	37.047	37.798	38.523	39.244	39.982
4,500	34.809	35.529	36.284	37.047	37.798	38.523	39.244	39.982
4,600	34.809	35.529	36.284	37.047	37.798	38.523	39.244	39.982
4,700	35.375	35.646	36.284	37.047	37.798	38.523	39.244	39.982
4,800	37.017	37.23	37.479	37.75	38.066	38.523	39.244	39.982
4,900	38.673	38.9	39.143	39.381	39.605	39.827	40.065	40.341
5,000	40.194	40.491	40.794	41.078	41.303	41.497	41.681	41.883
5,100	42.994	43.417	43.824	44.226	44.636	45.055	45.474	45.889
5,200	44.38	44.815	45.241	45.663	46.09	46.52	46.948	47.377
5,300	45.774	46.216	46.642	47.066	47.497	47.934	48.373	48.822

Table D-2 Turbine Performance in Non-Aerating Mode

Turbine Performance in Non-Aerating Mode POWER (MW)								
Head (ft) / Power Flow (cfs)	125	126	127	128	129	130	131	132
1,000	0.64016	0.74193	0.83416	0.91959	1.0056	1.0901	1.1684	1.2407
1,100	2.2942	2.3883	2.4813	2.5719	2.6592	2.7422	2.8212	2.8974
1,200	3.9871	4.0819	4.1889	4.2971	4.3911	4.4785	4.57	4.6638
1,300	5.5571	5.6662	5.7827	5.9012	6.0149	6.124	6.2345	6.3446
1,400	6.9561	7.0858	7.213	7.3404	7.4701	7.6016	7.7307	7.8538
1,500	8.2583	8.4039	8.5419	8.6748	8.8142	8.9662	9.1161	9.2576
1,600	9.538	9.6926	9.8443	9.9948	10.148	10.304	10.46	10.611
1,700	10.82	10.985	11.149	11.312	11.476	11.638	11.797	11.953
1,800	12.113	12.285	12.457	12.628	12.798	12.968	13.135	13.299
1,900	13.422	13.599	13.777	13.955	14.133	14.31	14.484	14.656
2,000	14.742	14.924	15.111	15.299	15.486	15.67	15.851	16.029
2,100	16.077	16.269	16.466	16.664	16.86	17.051	17.239	17.422
2,200	17.427	17.633	17.839	18.044	18.246	18.445	18.64	18.829
2,300	18.782	19.004	19.214	19.417	19.616	19.813	20.011	20.213
2,400	20.134	20.363	20.571	20.766	20.955	21.144	21.339	21.546
2,500	21.482	21.699	21.904	22.104	22.304	22.507	22.712	22.921
2,600	22.858	23.074	23.288	23.5	23.721	23.948	24.173	24.39
2,700	24.271	24.499	24.731	24.965	25.202	25.44	25.675	25.906
2,800	25.69	25.927	26.159	26.395	26.636	26.881	27.127	27.378
2,900	26.983	27.237	27.481	27.725	27.974	28.225	28.477	28.728
3,000	28.142	28.408	28.673	28.941	29.21	29.477	29.738	29.989
3,100	29.269	29.541	29.812	30.084	30.363	30.646	30.928	31.197
3,200	30.392	30.674	30.947	31.213	31.481	31.766	32.06	32.35
3,300	31.496	31.788	32.078	32.352	32.624	32.909	33.205	33.499
3,400	32.574	32.857	33.13	33.409	33.711	34.03	34.352	34.656
3,500	33.663	33.959	34.232	34.509	34.819	35.147	35.473	35.789
3,600	34.782	35.096	35.4	35.701	36.009	36.323	36.64	36.956
3,700	35.78	36.236	36.56	36.898	37.231	37.558	37.876	38.187
3,800	35.78	36.517	37.29	38.071	38.449	38.785	39.116	39.437
3,900	35.78	36.517	37.29	38.071	38.84	39.583	40.27	40.622
4,000	35.78	36.517	37.29	38.071	38.84	39.583	40.321	41.078
4,100	35.78	36.517	37.29	38.071	38.84	39.583	40.321	41.078
4,200	35.78	36.517	37.29	38.071	38.84	39.583	40.321	41.078
4,300	35.78	36.517	37.29	38.071	38.84	39.583	40.321	41.078
4,400	35.78	36.517	37.29	38.071	38.84	39.583	40.321	41.078
4,500	35.78	36.517	37.29	38.071	38.84	39.583	40.321	41.078
4,600	35.78	36.517	37.29	38.071	38.84	39.583	40.321	41.078
4,700	36.614	36.894	37.29	38.071	38.84	39.583	40.321	41.078
4,800	38.282	38.505	38.764	39.046	39.345	39.736	40.321	41.078
4,900	39.965	40.201	40.456	40.704	40.939	41.171	41.418	41.705
5,000	41.512	41.819	42.134	42.428	42.664	42.868	43.062	43.275
5,100	44.34	44.773	45.192	45.604	46.025	46.455	46.885	47.311
5,200	45.753	46.198	46.635	47.069	47.506	47.947	48.387	48.827
5,300	47.172	47.626	48.063	48.499	48.94	49.388	49.839	50.299

Stockton Lake Reallocation Study

Draft Integrated Water Supply Storage Reallocation Report and Environmental Assessment

Appendix F-NEPA Correspondence

June 2020

US Army Corps of Engineers ®
Kansas City District

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1.0 Introduction

As part of the National Environmental Policy Act (NEPA), coordination with other agencies is conducted in order to make others aware of our project. The National Environmental Policy Act (NEPA) and the National Historic Preservation Act (NHPA), Section 106 are separate laws which require Federal agencies to evaluate and take in account the impacts of the proposed Federal action. These two laws are independent, but the process can be integrated to create efficiencies. Cultural resources correspondence can be found in Appendix G, State Historic Preservation Office and Tribal Coordination.

2.0 Initial Coordination

Coordination begins at the beginning of the study process. Although the study had been active for a couple of years, plan formulation was still in progress. Coordination was initiated prior to the study's Alternative Milestone Meeting (AMM) held in July 2018, where a set of the final array of alternatives was presented to Headquarters USACE, the Northwestern Division USACE, and the Kansas City District project delivery team (PDT).

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.

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

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.

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 copies of the letters can be found in Attachment 1, responses to the letters can be found in Attachment 2 and the enclosures to the letters, which were a study factsheet, Stockton Lake project boundary, can be found in Attachment 3.

3.0 Alternative Evaluation

The final array of alternatives for evaluation include the following:

Alternative 1: Federal No Action/ Future Without Project (FWOP) Condition– 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 National Geodetic Vertical Datum (NGVD) of 1929. The total water supply storage reallocation would yield approximately 39 million gallons per day (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.

4.0 Continued Coordination

A second round of coordination was conducted in February 2020 after the Tentatively Selected Plan (TSP) milestone meeting was conducted. 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.

Attachment 1: Initiation Letters

Attachment 1 includes initiation letters to the following:

- United States Fish and Wildlife Service (USFWS)
- Missouri Department of Conservation (MDC)
- Southwestern Power Administration (SWPA)
- Missouri Department of Natural Resources (MNDR)
- Environmental Protection Agency (EPA)

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E. 12TH STREET
KANSAS CITY, MISSOURI 64106-2824

JUL 28 2017

Planning Branch

Ms. Jane Ledwin
U.S. Fish and Wildlife Service
101 Park DeVille Drive
Columbia, Missouri 65203

RE: Coordination Request for the Stockton Lake Water Reallocation Study, Missouri

Dear Ms. Ledwin,

The U.S. Army Corps of Engineers Kansas City District (Corps) received a request from the Tri-State Water Resources Coalition of Southwest Missouri to study the feasibility of reallocating water-supply storage at Stockton Lake, Missouri. The project is currently in the feasibility stage, which will assess a range of alternatives and ultimately identify a preferred alternative for implementation. A project fact sheet is included as an attachment to this letter for additional details on the proposed project. This letter is to inform the U.S. Fish and Wildlife Service of the proposed undertaking and initiate consultation under the Fish and Wildlife Coordination Act based on the proposed list of alternatives described below. This letter also serves to initiate informal Section 7 consultation through the request of any federally listed species and or critical habitat in the Stockton Lake study area that may be affected by the proposed project alternatives.

In 2012 and 2014, the Corps' Planning Assistance to States program in partnership with Missouri Department of Natural Resources was used to forecast both the water demand and supply for the Southwest Missouri region. Due to continued regional growth there will be municipal and industrial water needs in the future that existing supplies cannot provide. To address this shortfall, Tri-State Water Resources Coalition requested the Kansas City District to study the possibility of a water-supply reallocation at Stockton Lake for the purposes of municipal and industrial use. The Water Supply Resources Act of 1958 allows the Corps to engage with local entities to assist with their water-resources planning needs. Studies that date back to 2009 suggest that seeking water from Stockton Lake would be a more cost-effective method than building a new reservoir to serve the communities in need. Since the study is in the preliminary phases, a preferred alternative has not been selected. Once it is confirmed in the screening phase that water storage from Stockton Lake is the most cost-efficient way to obtain a reliable water source, the study team will then evaluate from which pool the water would come. Initial alternatives for the reallocation of water-supply storage include:

- Reallocating water from the flood control pool means a lake level raise. The lake level raise would not be expected to exceed two feet.

- Reallocating water from the conservation pool means that the normal lake level elevation of 867.0 would not change; however, a portion of the conservation pool would be specifically dedicated to water-supply storage.

- Reallocating water from both the flood control pool and the conversation pool is a combination of the previous two alternatives. Again, the lake level raise would not be expected to exceed two feet.

The feasibility report will document and evaluate how the preferred alternative would affect other authorized purposes. The report will also discuss any associated out-grant applications that would be necessary in order to design and construct a water-intake structure and pipelines on Corps' property to get the water to the communities in need. Additional National Environmental Policy Act and associated permitting under Section 404 and 401 of the Clean Water Act would be required and completed by Tri-State Water Resources Coalition for pipeline(s) alignments located off Corps property.

Based on initial assessment of the proposed study area, the Corps has identified eleven federally listed species that may occur or could potentially be affected by activities in Cedar, Dade, and Polk county Missouri; the Gray Bat, Indiana Bat, Northern Long-Eared Bat, Arkansas Darter, Niangua Darter, Pink Mucket, Spectacle Case Pearly Mussel, Geocarpon, Mead's Mildweed, Missouri Bladderpods, and Running Buffalo Clover. To assist with our Section 7 planning efforts, please provide additional information regarding these or any other federally listed species, candidate species, or designated critical habitat known to be within or adjacent to the project area. In addition, we anticipate the need for a Fish and Wildlife Coordination Act kickoff meeting in the near future to help plan and identify funding for recommended fish and wildlife resource assessment activities within or in the vicinity of the study area.

At this time we are requesting your comments on the proposed project. If you have any questions or concerns, please contact Mr. Jeffry Tripe of my staff at jeffry.a.tripe@usace.army.mil or (816) 389-2455.

Sincerely,

Jason W. Farmer
Chief, Environmental Resources Section

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 EAST 12TH STREET
KANSAS CITY MO 64106-2824

Planning Branch

OCT 11 2017

Ms. Sarah Parker Pauley, Director
Missouri Department of Conservation
PO Box 180
Jefferson City, Missouri 65102-0180

RE: Coordination Request for the Stockton Lake Water Reallocation Study, Missouri

Dear Ms. Pauley,

The U.S. Army Corps of Engineers Kansas City District (Corps) received a request from the Tri-State Water Resources Coalition of Southwest Missouri to study the feasibility of reallocating water-supply storage at Stockton Lake, Missouri. The project is currently in the feasibility stage, which will assess a range of alternatives and ultimately identify a preferred alternative for implementation. A project fact sheet is included as an attachment to this letter for additional details on the proposed project. This letter is to inform the Missouri Department of Conservation of the proposed undertaking.

In 2012 and 2014, the Corps' Planning Assistance to States program in partnership with Missouri Department of Natural Resources was used to forecast both the water demand and supply for the Southwest Missouri region. Due to continued regional growth there will be municipal and industrial water needs in the future that existing supplies cannot provide. To address this shortfall, Tri-State Water Resources Coalition requested the Kansas City District to study the possibility of a water-supply reallocation at Stockton Lake for the purposes of municipal and industrial use. The Water Supply Resources Act of 1958 allows the Corps to engage with local entities to assist with their water-resources planning needs. Studies that date back to 2009 suggest that seeking water from Stockton Lake would be a more cost-effective method than building a new reservoir to serve the communities in need. Since the study is in the preliminary phases, a preferred alternative has not been selected. Once it is confirmed in the screening phase that water storage from Stockton Lake is the most cost-efficient way to obtain a reliable water source, the study team will then evaluate from which pool the water would come. Initial alternatives for the reallocation of water-supply storage include:

- Reallocating water from the flood control pool means a lake level raise. The lake level raise would not be expected to exceed two feet.

- Reallocating water from the conservation pool means that the normal lake level elevation of 867.0 would not change; however, a portion of the conservation pool would be specifically dedicated to water-supply storage.

- Reallocating water from both the flood control pool and the conversation pool is a combination of the previous two alternatives. Again, the lake level raise would not be expected to exceed two feet.

The feasibility report will document and evaluate how the preferred alternative would affect other authorized purposes. The report will also discuss any associated out-grant applications that would be necessary in order to design and construct a water-intake structure and pipelines on Corps' property to get the water to the communities in need. Additional National Environmental Policy Act and associated permitting under Section 404 and 401 of the Clean Water Act would be required and completed by Tri-State Water Resources Coalition for pipeline(s) alignments located off Corps property.

Based on initial assessment of the proposed study area, the Corps has identified eleven federally listed species that may occur or could potentially be affected by activities in Cedar, Dade, and Polk county Missouri; the gray bat, Indiana bat, northern long-eared bat, Arkansas darter, Niangua darter, pink mucket, spectacle case pearly mussel, geocarpon, Mead's milkdweed, Missouri bladderpods, and running buffalo clover. To assist with our Section 7 planning efforts, please provide additional information regarding these or any other federally listed species, candidate species, or designated critical habitat known to be within or adjacent to the project area. In addition, we anticipate the need for a Fish and Wildlife Coordination Act kickoff meeting in the near future to help plan and identify funding for recommended fish and wildlife resource assessment activities within or in the vicinity of the study area.

At this time we are requesting your comments on the proposed project. If you have any questions or concerns, please contact Mr. Jeffry Tripe of my staff at jeffry.a.tripe@usace.army.mil or (816) 389-2455.

Sincerely,

10/10/2017

Jason W. Farmer
Chief, Environmental Resources Section

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BLDG
601 E. 12TH STREET
KANSAS CITY MO 64106-2824

AUG 0 9 2019

Planning and Project
Management Branch

Mr. Michael Wech
Administrator
Southwestern Power Administration
One West Third Street
Tulsa, Oklahoma 74103-3502

Dear Mr. Wech,

The U.S. Army Corps of Engineers Kansas City District (Corps) received a request from the Tri-State Water Resources Coalition of Southwest Missouri to study the feasibility of reallocating water supply storage at Stockton Lake near Stockton, Missouri. The project is now in the feasibility phase. This letter is to inform your agency of the proposed undertaking and invite your review and comment.

The proposed reallocation is being considered because of continued regional growth, there will be a municipal and industrial water supply demand in the future that existing supplies cannot meet. To address this shortfall, Tri-State Water Resources Coalition requested the Kansas City District to study the possibility of a water supply reallocation at Stockton Lake for the purposes of municipal and industrial (M&I) use.

The Water Supply Resources Act of 1958 allows the Corps of Engineers to engage with local entities to assist with their water resources planning needs. Studies that date back to 2009 suggest that seeking water from Stockton would be a more cost effective method than building a new reservoir to serve the communities in need. Since the study is in the formulation stage, a recommended alternative has not yet been selected. Upon confirmation that water supply storage from Stockton Lake is the most cost efficient way to obtain a reliable water source, then the study team will evaluate which pool the water will come from. Potential options for the reallocation of water supply storage include:

- Reallocating water from the flood control pool, which means a lake level raise. The lake level raise is not expected to exceed 2.0 feet
- Reallocating water from the conservation pool, which means that the normal lake level elevation of 867.0 would not change; however, a portion of the conservation pool would be specifically dedicated to water supply storage.

- Reallocating water from both the flood control pool and the conversation pool – a combination of the previous 2 options. Once again, the lake level raise is not expected to exceed 2 feet.

The report will document and evaluate how the selected alternative will affect other authorized purposes. The report will also include an evaluation of hydropower benefits forgone. The Kansas City District in conjunction with the Hydropower Analysis Center in the Portland District has participated in (and hosted) past Hydropower Storage Reallocation Team meetings and discussed methodologies for calculating hydropower benefits forgone and shared preliminary results from initial calculations.

At this time we are requesting your concerns or comments on the proposed project. If you have any questions or concerns, please contact me at John.J.Grothaus@usace.army.mil or (816) 389-3110.

Sincerely,

John Grothaus
Chief, Plan Formulation Section

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 EAST 12TH STREET
KANSAS CITY MO 64106-2824

Planning Branch

FEB 2 6 2020

Mr. Chris Wieberg,
Director, Water Protection Program
Missouri Department of Natural Resources
PO Box 176
Jefferson City, Missouri 65102-0180

RE: Coordination Request for the Stockton Lake Water Reallocation Study, Missouri

Dear Mr. Wieberg:

The U.S. Army Corps of Engineers Kansas City District (Corps) received a request from the Tri-State Water Resources Coalition of Southwest Missouri to study the feasibility of reallocating water-supply storage at Stockton Lake, Missouri. The project is currently in the feasibility stage, which will assess a range of alternatives and ultimately identify a preferred alternative for implementation. A project fact sheet is included as an attachment to this letter for additional details on the proposed project. This letter is to inform the Missouri Department of Natural Resources of the proposed undertaking.

In 2012 and 2014, the Corps' Planning Assistance to States program in partnership with Missouri Department of Natural Resources was used to forecast both the water demand and supply for the Southwest Missouri region. Due to continued regional growth there will be municipal and industrial water needs in the future that existing supplies cannot provide. To address this shortfall, Tri-State Water Resources Coalition requested the Kansas City District to study the possibility of a water-supply reallocation at Stockton Lake for the purposes of municipal and industrial use. The Water Supply Resources Act of 1958 allows the Corps to engage with local entities to assist with their water-resources planning needs. Studies that date back to 2009 suggest that seeking water from Stockton Lake would be a more cost-effective method than building a new reservoir to serve the communities in need. Since the study is in the preliminary phases, a preferred alternative has not been selected. The study team is currently evaluating potential alternatives for water reallocation from the flood and conservation pools at Stockton Lake. Initial alternatives for the reallocation of water-supply storage include:

- Reallocating water from the flood control pool means a lake level raise. The lake level raise would not be expected to exceed two feet.

- Reallocating water from the conservation pool means that the normal lake

level elevation of 867.0 would not change; however, a portion of the conservation pool would be specifically dedicated to water-supply storage.

- Reallocating water from both the flood control pool and the conversation pool is a combination of the previous two alternatives. Again, the lake level raise would not be expected to exceed two feet.

The feasibility report and integrated Environmental Assessment will document and evaluate potential effects of the proposed alternatives on other authorized purposes and the human and natural environment. The report will also discuss any associated out-grant applications that would be necessary in order to design and construct a water-intake structure on Corps property. Future pipeline projects located off of Corps property, to get water from Stockton Lake to the communities in need, would be completed by Tri-State Water Resources Coalition through additional National Environmental Policy Act and associated permitting under Section 404 and 401 of the Clean Water Act.

Relative to water quality at Stockton Lake, the latest Corps water quality report (https://www.nwk.usace.army.mil/Locations/Water-Quality/), documents water quality conditions beneficial to authorized purposes and compliant with state water quality standards for class L2 waters and designated uses defined by Table G of Missouri Department of Natural Resources Water Quality Standards (10 CSR 20-7.031). Of particular interest to water quality conditions at Stockton Lake is the skimming weir constructed just upstream of the dam, which functions as a physical barrier designed to prevent low dissolved oxygen water releases downstream into the Sac River. The skimming weir at Stockton Lake is designed to be fully functional at a range of elevations that would include alternatives with a 2 foot pool raise. No impacts to downstream water quality are anticipated with the reallocation alternatives as currently proposed.

At this time we are requesting any questions or comments that your agency may have relative to the proposed project, and to identify a point of contact for any future coordination needs. In addition, a draft Environmental Assessment will be prepared and provided to the public as part of this study, with a scheduled release date this summer. If you have any questions or concerns, please contact Mr. Jeffry Tripe of my staff at jeffry.a.tripe@usace.army.mil or (816) 389-2455.

Sincerely,

Jason W. Farmer
Chief, Environmental Resources Section

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 EAST 12TH STREET
KANSAS CITY MO 64106-2824

Planning Branch FEB 2 6 2020

Mr. Jim Gulliford,
Administrator, Region 7
Environmental Protection Agency
11201 Renner Boulevard
Lenexa, Kansas 66219

RE: Coordination Request for the Stockton Lake Water Reallocation Study, Missouri

Dear Mr. Gulliford:

The U.S. Army Corps of Engineers Kansas City District (Corps) received a request from the Tri-State Water Resources Coalition of Southwest Missouri to study the feasibility of reallocating water-supply storage at Stockton Lake, Missouri. The project is currently in the feasibility stage, which will assess a range of alternatives and ultimately identify a preferred alternative for implementation. A project fact sheet is included as an attachment to this letter for additional details on the proposed project. This letter is to inform the Environmental Protection Agency, Region 7 of the proposed undertaking.

In 2012 and 2014, the Corps' Planning Assistance to States program in partnership with Missouri Department of Natural Resources was used to forecast both the water demand and supply for the Southwest Missouri region. Due to continued regional growth there will be municipal and industrial water needs in the future that existing supplies cannot provide. To address this shortfall, Tri-State Water Resources Coalition requested the Kansas City District to study the possibility of a water-supply reallocation at Stockton Lake for the purposes of municipal and industrial use. The Water Supply Resources Act of 1958 allows the Corps to engage with local entities to assist with their water-resources planning needs. Studies that date back to 2009 suggest that seeking water from Stockton Lake would be a more cost-effective method than building a new reservoir to serve the communities in need. Since the study is in the preliminary phases, a preferred alternative has not been selected. The study team is currently evaluating potential alternatives for water reallocation from the flood and conservation pools at Stockton Lake. Initial alternatives for the reallocation of water-supply storage include:

- Reallocating water from the flood control pool means a lake level raise. The lake level raise would not be expected to exceed two feet.

- Reallocating water from the conservation pool means that the normal lake

level elevation of 867.0 would not change; however, a portion of the conservation pool would be specifically dedicated to water-supply storage.

- Reallocating water from both the flood control pool and the conversation pool is a combination of the previous two alternatives. Again, the lake level raise would not be expected to exceed two feet.

The feasibility report and integrated Environmental Assessment will document and evaluate potential effects of the proposed alternatives on other authorized purposes and the human and natural environment. The report will also discuss any associated out-grant applications that would be necessary in order to design and construct a water-intake structure on Corps property. Future pipeline projects located off of Corps property, to get water from Stockton Lake to the communities in need, would be completed by Tri-State Water Resources Coalition through additional National Environmental Policy Act and associated permitting under Section 404 and 401 of the Clean Water Act.

At this time we are requesting any questions or comments that your agency may have relative to the proposed project, and to identify a point of contact for any future coordination needs. In addition, the draft Environmental Assessment will be prepared and provided to the public as part of this study, with a scheduled release date this summer. If you have any questions or concerns, please contact Mr. Jeffry Tripe of my staff at jeffry.a.tripe@usace.army.mil or (816) 389-2455.

Sincerely,

Jason W. Farmer
Chief, Environmental Resources Section

Attachment 2: Response to Initiation Letters

Attachment 2 includes response letters from the following:

- USFWS
- SWPA

From:	Tripe, Jeffry A CIV USARMY CENWK (USA)
To:	Simmons, Bryan
Cc:	Herrington, Karen; Henggeler, Jennifer A CIV USARMY CENWK (US)
Subject:	RE: [EXTERNAL] Fish and Wildlife Coordination Request, Stockton Lake Project (UNCLASSIFIED)
Date:	Friday, September 1, 2017 4:48:36 PM

CLASSIFICATION: UNCLASSIFIED

Thanks Bryan.

Please let me know sometime next week how your calendar looks over the next month to try and conduct our initial coordination meeting. Ideally, we would like to conduct the meeting prior to the end of our FY17 cycle, so that we can budget associated FWCA activities for FY18.

Thanks, Jeff

-----Original Message-----
From: Simmons, Bryan [mailto:bryan_simmons@fws.gov]
Sent: Friday, September 01, 2017 1:54 PM
To: Tripe, Jeffry A CIV USARMY CENWK (US) <Jeffry.A.Tripe@usace.army.mil>
Cc: Herrington, Karen <Karen_herrington@fws.gov>
Subject: [EXTERNAL] Fish and Wildlife Coordination Request, Stockton Lake Project

Mr. Tripe,

I have reviewed the project materials titled: Stockton Lake Project, Water Supply Reallocation Study, Sac River, Cedar/Dade/Polk Counties, Missouri which were received on July 28, 2017 and forwarded to me on August 11, 2017. To summarize, the U.S. Fish and Wildlife Service (Service) accepts the opportunity to work with the U.S. Army Corps of Engineers (USACE) to evaluate the Stockton Lake Project's potential impacts to fish and wildlife resources which may also include potential impacts to federally listed species. We agree that an initial meeting in the near future would be very beneficial to help define project elements, milestone dates, information needs, and essential funding necessary to evaluate potential impacts resulting from the Stockton Project. As mentioned during our phone conversation, some of the information needs may include relevant habitat assessments, fish and wildlife resource inventories and review of pertinent scientific literature.

We look forward to this coordination opportunity.

Bryan Simmons
U.S. Fish and Wildlife Service

Ecological Services
Missouri State University
Department of Biology
Springfield, Missouri 65897

CLASSIFICATION: UNCLASSIFIED

Department of Energy
Southwestern Power Administration
One West Third Street
Tulsa, Oklahoma 74103-3502

October 25, 2019

John Grothaus
Chief, Plan Formulation Section
U.S. Army Corps of Engineers, Kansas City District
635 Federal Building
601 E. 12th Street
Kansas City, MO 64106-2824

Dear Mr. Grothaus:

This is in response to your letter dated August 9, 2019, requesting review and comments on the proposed water storage reallocation at Stockton Lake for the Tri-State Water Resources Coalition. Southwestern Power Administration (Southwestern) appreciates the previous coordination and information provided by the Kansas City District through the Hydropower Storage Reallocation Team (HSRT), and we are happy to offer comments to assist you as you continue to evaluate the proposed storage reallocation.

As you know, Southwestern is an agency within the U.S. Department of Energy which is responsible for marketing the hydroelectric power and energy from 24 Corps of Engineers (Corps) projects in the region, including Stockton. As the Federal agency responsible for marketing the hydropower from Stockton, Southwestern has concerns with the proposed storage reallocation. Federal hydropower will be the project purpose most adversely affected by the proposed reallocation. The proposed reallocation must meet three criteria: 1) the reallocated storage is satisfying an immediate need for water supply; 2) the reallocation is the lowest cost alternative for the water supply; and 3) Federal hydropower must be properly compensated for losses resulting from the reallocation. The third criterion is typically not met in Corps studies.

Southwestern is extremely concerned that the Corps has abandoned its long-held practice of observing a defined limit to its discretionary authority under the Water Supply Act of 1958 to reallocate storage for water supply at Corps projects. When the Corps previously reallocated 50,000 acre-feet of storage in Stockton Lake for the City of Springfield, Missouri, both the Corps and Southwestern recognized that no further storage was available for reallocation in Stockton Lake under the Corps' discretionary authority per the Corps' Engineer Regulation (ER) 1105-2-100. Further, it was understood at that time that any additional reallocation of storage at Stockton Lake would seriously affect the authorized project purposes and would require approval by Congress. It

was with that understanding that Southwestern and its customers supported the investment of over $40 million to rehabilitate the Stockton hydropower facilities following a failure of the turbine in 2009, as all of those costs are accounted for in Southwestern's power rates to its customers such that it is fully repaid, with interest, to the U.S. Treasury. Unfortunately, the new Corps approach to storage reallocation is apparently to evaluate on a case by case basis whether a proposed reallocation seriously affects the authorized purposes at a Corps project, in which case the reallocation would then require Congressional authorization under the Water Supply Act of 1958. We believe the proposed reallocation will seriously affect Federal hydropower at Stockton, jeopardizing the recent significant investment in the plant and threatening the viability of Federal hydropower at Stockton. Southwestern has yet to see any actual analysis conducted by the Corps regarding the proposed reallocation impact on the authorized purposes, but is aware of the alternatives being evaluated for selection which indicate the Corps did not determine those alternatives would seriously affect the authorized purposes. Under the Corps' new approach, by the time they decide hydropower is seriously affected, hydropower may not have any storage left.

Southwestern has provided comments for all recent water storage reallocation reports prepared by the Corps for storage at Corps hydropower projects in Southwestern's region. There are longstanding disagreements between Southwestern and the Corps regarding storage reallocations, and Southwestern typically provides similar comments on every reallocation report. Those disagreements primarily deal with three areas: 1) the determination of the actual loss of hydropower capacity and energy; 2) the value of the lost capacity and energy; and 3) the procedure used to determine hydropower financial credits for the loss. The HSRT, made up of representatives from Southwestern, Southeastern Power Administration, Western Area Power Administration, Bonneville Power Administration, Corps Headquarters, Corps divisions and districts, and the Corps' Hydropower Analysis Center, has made progress toward resolving the longstanding issues, but there is still much to be done. Agreement between the Corps and the Power Marketing Administrations, as the Federal hydropower program partners, would simplify the preparation and evaluation of future storage reallocation reports and would speed the approval of the reports.

Southwestern is pleased to see that the Corps is considering flood storage for the proposed reallocation. In almost all reallocation studies evaluated by Southwestern, reallocation of flood storage provides the least benefits foregone. We would expect the same result in the current study. In addition to a flood storage reallocation, the use of storage for hydropower yield protection operation (HYPO) is an available option that should be utilized. ER 1105-2-100 recommends the use of operational changes, when possible, to compensate hydropower users. The use of HYPO, similar to dependable yield mitigation storage (DYMS) for existing water supply users, is another method of protecting the hydropower purpose. The Corps has the discretion to include HYPO and did so in the Little Rock District's White River Minimum Flow Study. It is a viable alternative that should be considered in formulating the plan for reallocation. The use of HYPO as part of a storage reallocation would maintain the current yield of the hydropower storage and, therefore, minimize the hydropower losses, especially capacity and on-peak energy losses.

Thanks again for your previous coordination through the HSRT and for the opportunity to provide comments on the proposed storage reallocation. Please contact Mr. Michael Denny at (918) 595-6683 or Michael.Denny@swpa.gov if you have any questions concerning our comments.

Sincerely,

Fritha Ohlson
Chief Operating Officer
Office of Corporate Operations

Attachment 3: Letter enclosures

Attachment 3 includes the enclosures that were sent with the initial coordination letters. The enclosures are the following:

- Stockton Lake Water Supply Storage Reallocation Study Factsheet
- Stockton Lake Project Boundary

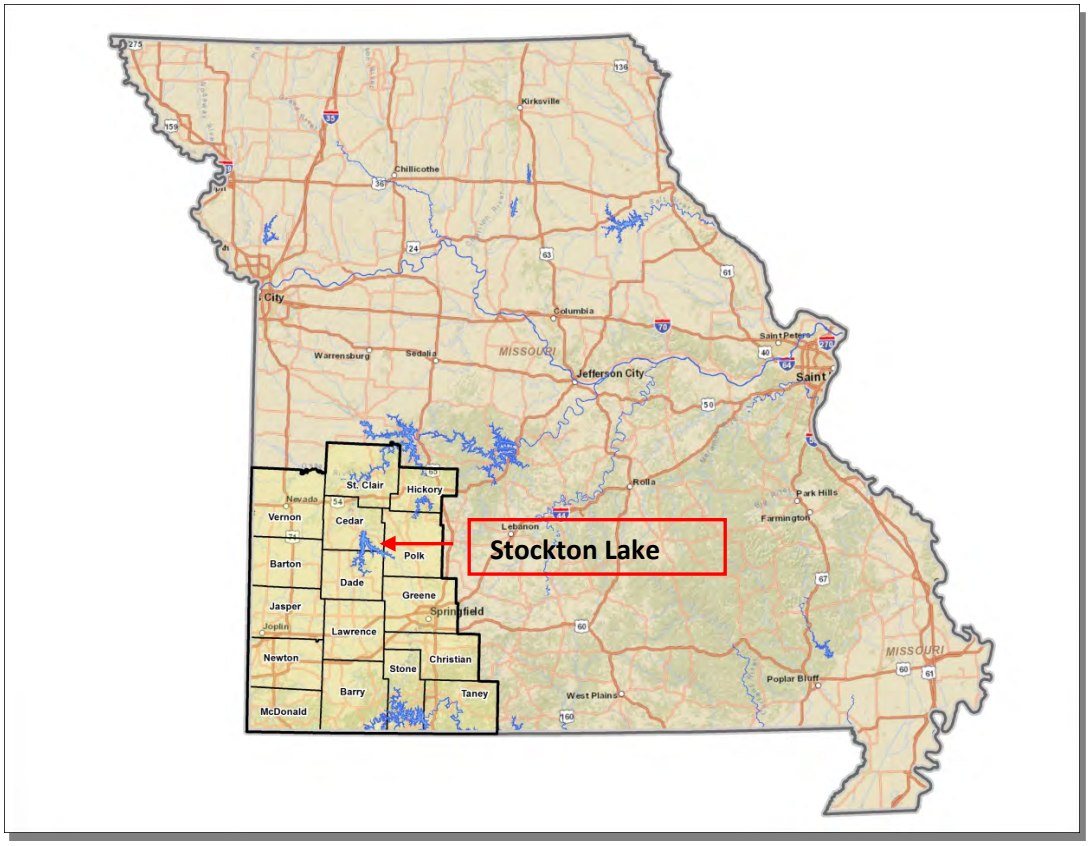
US Army Corps of Engineers ®
Kansas City District

PLANNING BRANCH
Plan Formulation Section
Building Strong

PROJECT NAME: Stockton Lake Project, Water Supply Reallocation Study, Sac River, Cedar/Dade/Polk Counties, Missouri.

FEDERAL ACTION: The Flood Control Act of 1944, the Flood Control Act of 1958, Section 301 (a) and the Water Resource Development Act of 1986, Section 932 relate to the study and the authority for the Corps to participate in finding solutions to water resource planning for municipal and industrial water supply use.

LOCATION: Stockton Lake is owned and operated by the U.S. Army Corps of Engineers (USACE) Kansas City District (NWK) and is located approximately two miles east of Stockton, Missouri, on the Sac River, in Cedar/Dade/Polk Counties, Missouri.



STOCKTON LAKE BACKGROUND INFORMATION: Stockton Lake Project was authorized by the Flood Control Act of 1954 and is a multi-purpose use reservoir that provides flood risk management, water supply, hydropower, recreation and fish and wildlife benefits. The primary purpose of Stockton is for flood risk management. Construction was initiated in fiscal year (FY) 1963 and impoundment was initiated in December 1969. Stockton Lake is one of three reservoirs in the southwest Missouri region that could provide water supply benefits to neighboring communities.

REALLOCATION PROJECT DESCRIPTION: Tri-State Water Resources Coalition is a non-profit (501C4) organization whose mission is to secure adequate, quality water supplies for the next generation in the 16-county region of southwest Missouri. In 2012 and 2014, studies were conducted with the Missouri Department of Natural Resources as the non-Federal cost-sharing partner to identify forecasted water demand and supply within the southwest Missouri area. Due to continued regional growth, the studies identified municipal and industrial water needs in the future that exceed existing supplies. Water supply reallocation at Stockton Lake was identified as a potential solution for future water supply needs in the region.

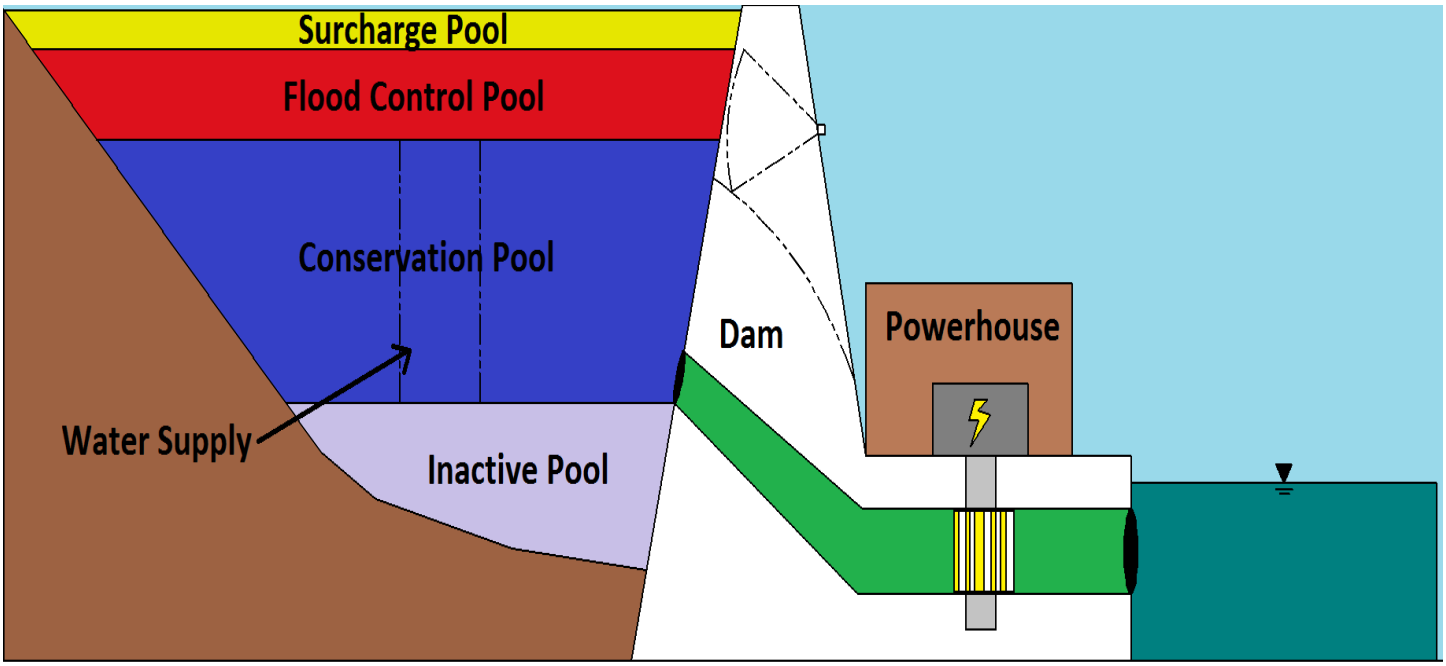
REALLOCATION PROJECT PURPOSE: Kansas City District is preparing a Feasibility Study to assess the viability of potential water supply storage reallocation alternatives at Stockton Lake. The Feasibility Study will also assess the availability of other potential external sources of water supply that could provide the same quality and quantity of water as Stockton Lake. Examples of "external alternatives" besides water supply storage from Stockton Lake that are currently under evaluation include: 1) Construction of a new reservoir; 2) Use of water conservation measures; 3) New groundwater fields; and 4) Reallocations from other reservoirs.

If storage out of Stockton Lake is deemed as the most cost effective alternative, then an evaluation will be conducted on which pool the lake storage should come from, referred to as "internal alternatives". Internal alternatives that will be evaluated include: 1) Storage out of the flood control pool (the lake level rises and the level of water in the conservation pool increases); 2) Storage out of the conservation pool (the lake level remains the same and the amount of water in the conservation pool remains the same); 3) Storage out of the inactive pool (the lake level remains the same, but the bottom of the conservation pool elevation is lowered, thus the amount of water in the conservation pool increases); 4) Storage out of a combination of pools, such as storage out of the flood control pool (pool raise) and the conservation pool.

The Stockton Lake Water Supply Reallocation Study will evaluate potential effects on authorized purposes (i.e. flood risk management, hydropower, recreation, water quality, fish and wildlife, etc.) and potential effects to the environment at Stockton Lake depending on which pool the water supply storage would be reallocated from. The attached map identifies the Corps property boundary at Stockton Lake.

CONSTRUCTION METHOD: If a feasible Stockton Lake reallocation alternative is identified, additional construction of intake(s) and pipeline(s) would be required to carry water from the lake to the communities in need. This requirement will be further developed and analyzed by the Tri-State Water Resources Coalition and included in the Feasibility Study for potential effects within the Kansas City District Corps of Engineers project boundary. Preliminary analysis conducted by Tri-State Water Resources Coalition, Missouri Department of Natural Resources and Kansas City District suggest that the intake would most likely be placed next to the existing intake that is owned by City Utilities of Springfield, Missouri. Additional NEPA and associated permitting under Section 404 and 401 of the Clean Water Act for construction of new water transmission or other related facilities would be required and completed by Tri-State Water Resources Coalition for pipeline(s) alignments located outside of the Stockton Lake project boundary.

WHAT DOES WATER SUPPLY STORAGE LOOK LIKE?



WHAT DOES REALLOCATING WATER SUPPLY STORAGE MEAN?

- **Flood Control Pool Reallocation:** Reallocating water from the flood pool to the conservation pool; would raise the level of the lake, and acre-feet volume in the conservation pool would be larger.
- **Conservation Pool Reallocation:** Reallocating water within the conservation pool; would not result in a pool raise, and acre-feet or volume in the conservation pool remains the same.
- **Inactive Pool Reallocation:** Reallocating water from the inactive pool; would lower the bottom elevation of the conservation pool, and acre-feet or volume in the conservation pool would be larger.
- **Combination Pool Reallocation:** Reallocating water from multiple pools such as the flood control pool and the multipurpose pool; would result in a raise of the level of the lake and a reallocation of storage within the conservation pool.

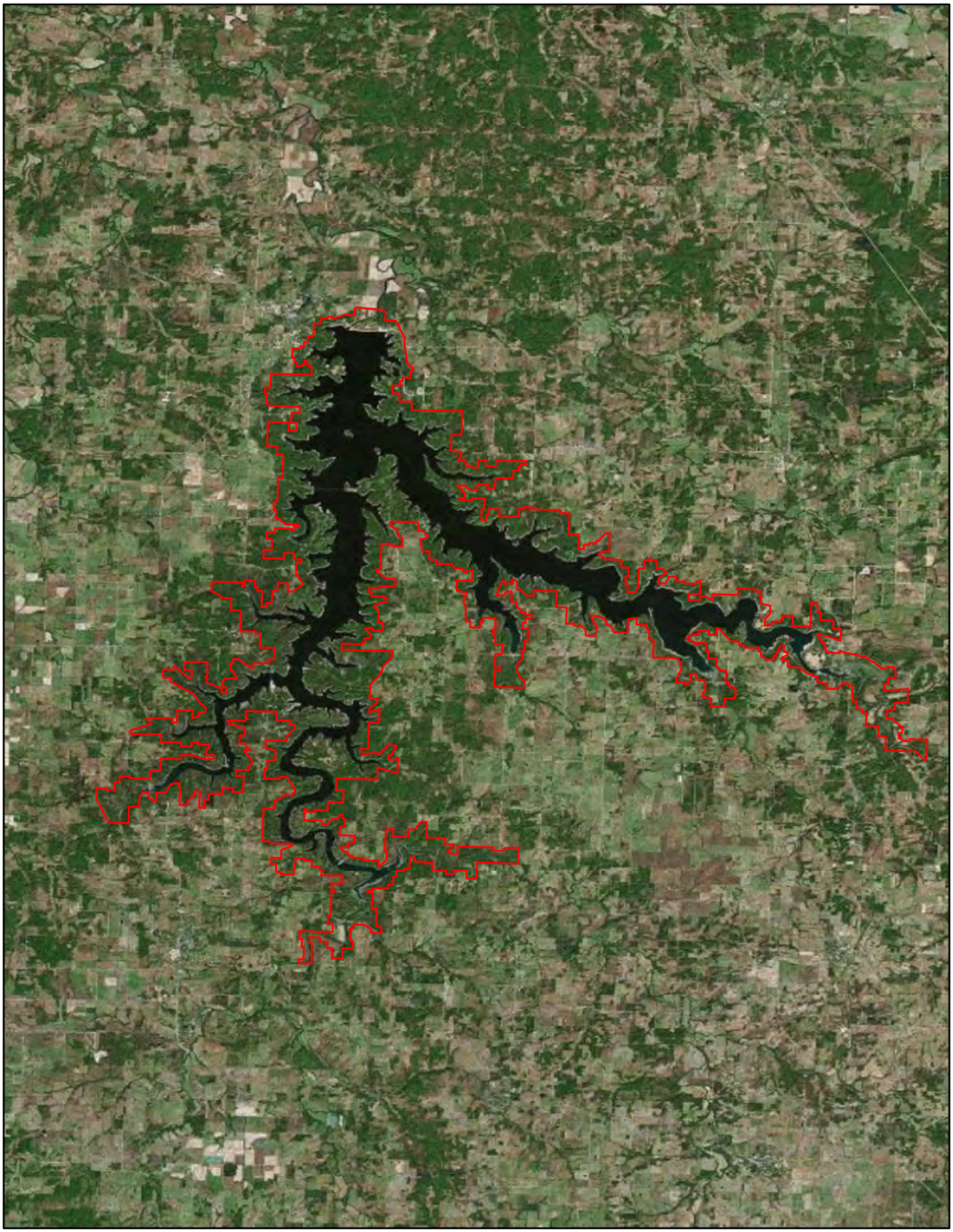
TIMELINE: A draft report is anticipated to be ready in June 2018; the report will be available for public comment.

USACE POINTS OF CONTACT

Planning Branch		
John Grothaus	Chief, Plan Formulation Section	(816) 389-3110
Jennifer Henggeler*	Project Manager	(816) 389-3778
David Hoover	Conservation Biologist / NEPA review	(816) 389-3497
Natural Resources Section		
Tim Meade*	Senior Archaeologist / Tribal Liaison / Cult. Res.	(816) 389-3138
Jeff Tripe*	Environmental Planner	(816) 389-2455

*primary P.O.C.s

Stockton Lake - Corps Boundary



Attachment 4: Meeting Notes

Attachment 4 includes meeting notes from the initial coordination meeting:

- Meeting notes from USFWS and MDC initial coordination meeting, October 2017

STOCKTON LAKE

USFWS COORDINATION MEETING

OCTOBER 10, 2017

Attendees:

USACE
Rich Chiles, Stockton Lake Natural Resources Manager
Jennifer Henggeler, Stockton Lake Reallocation PM
Devin Smith, Economist
Colleen Roberts, Water Management
Chris Name, Biologist

USFWS
Bryan Simmons
Karen Herrington

MDC
Matt Vitello, Policy Coordinator
Allen Brandes, Fisheries Regional Programs Supervisor
Stephen McMurray (via phone), Malacologist

Jen Henggeler gave a presentation to the group on Stockton Lake Reallocation Study.

Questions and discussions that came up:

Can the Hydropower Analysis Center (HAC) report be seen? Yes, after necessary reviews. It will be included in the final draft report that is sent out for public comment.

How could a potential pool raise impact the skimming weir? Potential Issues during summer? Impacts due to water elevation change? Changes to thermocline?

Keep in mind the Aldrich Wildlife Refuge - How is it to be impacted? Any information in previous reallocation study?

Demonstrate the change in longevity and duration from the current condition

Notes on Endangered Species

- There are limitations downstream on data; what kind of effects will happen downstream?
- Will there be changes in wetlands?
- Land use map—how we expect the distribution to change?
- Stratification level—how would that impact the fish reproduction?
- Bats—Do we expect inundation to potentially kill trees that would be habitat for bats?
- Tributaries coming in could be impacted
- Brushy Creek—will there be backwater effects? Bear Creek? Mayes Creek?

What kind of analysis has already been done on downstream releases? We have done preliminary analysis on how a pool raise would potentially impact the downstream gauges. We will provide more information as we finalize the analysis.

Longer [duration?] releases could impact the mussels.

How does a potential reallocation change how the project was originally authorized?

Is migratory bird habitat impacted?

Is less hydropower peaking good?

Action area needs to be defined

List of ongoing analysis (updated Mar 2018):

USACE Dam Safety analysis

HAC has a draft analysis

Yield estimates have been re-run (how many acre-feet of storage would yield a certain amount)

AMM in April timeframe—AMM will be conducted in late May/early June.

*Once funding is rec'd Jeff Tripe, USACE Biologist, will be in touch

Updated schedule:

STOCKTON SCHEDULE		
HQ Milestones	**Dates**	**Notes**
Alternatives Milestone	May- 18	*operating off of FY17 carry over funds
Tentatively Selected Plan	Feb-19	*dependent on when funds are received
Agency Decision Milestone	Oct-19	*dependent on when funds are received

*The study is currently preparing an Environmental Assessment to be integrated into The Feasibility Study. This decision will be reevaluated as the study progresses and more information is available.

Stockton Lake Reallocation Study

Draft Integrated Water Supply Storage Reallocation Report and Environmental Assessment

Appendix G-Cultural Resources: State Historic Preservation Office and Tribal Coordination

June 2020

US Army Corps of Engineers ®
Kansas City District

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1.0 Introduction

The National Environmental Policy Act (NEPA) and the National Historic Preservation Act (NHPA), Section 106 are separate laws which require Federal agencies to evaluate and take in account the impacts of the proposed Federal action. These two laws are independent, but the process can be integrated to create efficiencies.

2.0 Initial Coordination

Coordination begins at the beginning of the study process. Although the study had been active for a couple of years, plan formulation was still in progress. Coordination was initiated prior to the study's Alternative Milestone Meeting (AMM) held in July 2018, where a set of the final array of alternatives was presented to Headquarters USACE, the Northwestern Division USACE, and the Kansas City District project delivery team (PDT). Coordination letters were mailed on August 14, 2017, 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. An in-person coordination meeting with the Osage Nation was held in Pawhuska, Oklahoma on December 19, 2017, and included attendees from the Osage Nation and various disciplines from the Kansas City District. A summary of the discussion points at the in-person were:

- USACE continues to request funding through operations for surveys. Discussion of budget process and need for support to bolster cultural request justifications of funding, etc. Note that budget competition getting greater.
- A decision was made when the study started to complete an EA. Under NEPA every study can start as an EA. An EA would be baseline information applicable to an EIS and can always be expanded to an EIS if the study discovers there will be significant impacts.
- The Tribe mentioned that there are 100s upon 100s of rock shelter sites at Stockton Lake
- Discussed the fluctuations of elevations that the lake typically experiences on an annual basis
- The Tribe stated concern regarding the secondary indirect effect of the reallocation because it involves constructing transmission lines. Concern that cities/municipalities that are in charge may not follow correct process regarding tribal/cultural involvement.
- The Tribe would like to participate as much as possible during the study development and would like frequent updates regarding study progress.
- The Tribe would like to review survey scopes of work when available as well the list of contractors available through the Mandatory Center of Expertise (MCX) for the Curation and Management of Archaeological Collections (CMAC).
- The Tribe requested that the Corps provide mitigation for cultural sites in the report if an area is impacted.

The copies of the letters can be found in Attachment 1, responses to the letters can be found in Attachment 2 and the enclosures to the letters, which were a study factsheet, Stockton Lake project boundary and summary of archeological sites, can be found in Attachment 3.

3.0 Alternative Evaluation

The final array of alternatives for evaluation include the following:

Alternative 1: Federal No Action/ Future Without Project (FWOP) Condition– 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 National Geodetic Vertical Datum (NGVD) of 1929. The total water supply storage reallocation would yield approximately 39 million gallons per day (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.

Stockton Lake was constructed prior to and during the enactment of the National Historic Preservation Act of 1966 (Public Law 89-665) and it's implementing regulations under CFR 800—Protection of Historic Properties. As such, lake lands were not inventoried to the standards that followed enactment of the law and its requirements. In the years since the lake impoundment a number of different archeological inventories, testing, and mitigation projects have been undertaken on Corps fee title and easement lands at Stockton Lake. However, much of the lake shoreline has not been inventoried.

Because of the lack of shoreline data, the PDT conducted an evaluation using geospatial information with regard to pool elevations and the area between the normal pool elevation and the proposed new pool elevation of 868.8 ft NGVD 29 (or 1.8 ft pool raise). Areas surrounding the reservoir that are more likely to be inundated more frequently were identified and a targeted cultural resources survey was completed in those areas in November 2018. The majority of the areas identified were towards the south portion of the reservoir where inflows come in. These areas historically have seen pool fluctuations and have already been inundated many times before. The report, "An Intensive Survey of Selected Shoreline Areas at Stockton Lake in Cedar, Dade, and Polk Counties, Missouri" was finalized May 2019. A summary of the survey results include:

- Under current operations cultural sites have been impacted and require mitigation
- A total of 34 sites require additional evaluation to determine if they are eligible for preservation
- One-third of the shoreline still needs to be surveyed. Approximately one-third of the shoreline has been surveyed and one-third of the reservoir was excluded from a survey due to the topography of the area and steep slopes.

4.0 Continued Coordination

A second round of coordination to initiate a Programmatic Agreement (PA) began after the alternative analysis was complete and a tentatively selected plan (TSP) had been identified. The TSP Milestone Meeting to present the tentatively selected plan was held on January 30, 2020. Alternative 7 is the tentatively selected plan, which includes a reallocation of 45,750 acre-feet of storage from the multi-purpose pool and reallocation of 49,000 acre-feet from the flood control pool, which equates to an approximate 1.8 foot pool raise. To be proactive and prior to the report being posted for public and agency review, another letter initiating the kick-off of the Programmatic Agreement was sent on March 3, 2020 to the Missouri 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. A formal response to participate in the meeting was received from Missouri SHPO, informal responses via acceptance of the kick-off meeting invite were received from the Osage Nation and the Ponca Nation. A formal letter inviting the Advisory Council on Historic Preservation (ACHP) to participate was sent on May 8, 2020; however, the ACHP was informally invited to and attended the virtual meeting to learn more about the Stockton Lake Water Supply Storage Reallocation Feasibility Study. The copies of PA invitation letters and enclosures sent to these entities are located in Attachment 4. The Missouri SHPO response to the invitation letter are located in Attachment 5.

A virtual meeting hosted by the Kansas City District PDT was conducted on April 27th, 2020 to initiate the PA process. Attendees included the Kansas City District, ACHP, Missouri SHPO, the Osage Nation, Ponca Tribe, and the Southwest Missouri Regional Water Coalition. A powerpoint presentation on the background of Stockton Lake, the current authorizations and operations of the lake, and an overview of the Stockton Lake Reallocation study, which included the plan formulation process and tentatively selected plan. Following that, a presentation was given focusing on the background and existing conditions of the cultural resources documented in the Stockton Lake area and the potential impacts that may occur as a result of a water supply storage reallocation action. A timeline and path forward were discussed. The following concerns were discussed:

- The Tribe expressed concern for cultural resources around the lake, including rock shelters, mounds and cairns. Changes in lake elevations has the potential to damage these sites.
- The most recent survey conducted in November 2018 incorporated the Osage Nation's survey standards

- While reviewing the PA, concerns were expressed regarding inadvertent discoveries and USACE's ability to respond quickly. USACE responded to say the PA will contain specific clauses to the response process.
- Missouri SHPO recommended that previous/past determinations of Not Eligible for listing on the National Register should be reviewed for adequacy of the determination under current standards, if the sites had been destroyed. USACE agreed to review past determinations.
- ACHP reminded USACE to be mindful about the current pandemic situation given that many parties participating in the Section 106 process may not be working right now and may be backlogged when they are able to go back to work. USACE agreed to make extra efforts to ensure contact and communication with interested parties. USACE did have trouble reaching some participants due to office closures.
- ACHP stated they are inclined to participate in the PA process.

All attendees received meeting notes on Tuesday, April 28, 2020. Consultation between Missouri SHPO, interested Tribes and the ACHP are ongoing. The Appendix will be updated as more information is developed.

ATTACHMENT 1: Initiation Letters

Attachment 1 includes initiation letters to the following:

- Director and Deputy SHPO, Missouri Department of Natural Resources
- Director/Tribal Historic Preservation Officer, The Osage Nation
- Chairperson, Caddo Nation
- Tribal Historic Preservation Officer, Iowa Tribe of Kansas
- Kaw Nation
- Tribal Historic Preservation Officer, Omaha Tribe
- Culture Director, Ponca Tribe of Nebraska
- Tribal Historic Preservation Officer, Ponca Tribe of Oklahoma
- Chairman, Sac and Fox Nation of Missouri in Kansas and Nebraska

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E. 12TH STREET
KANSAS CITY, MISSOURI 64106-2824

Planning Branch

Dr. Toni M. Prawl
Director and Deputy State Historic Preservation Officer
State Historic Preservation Office
Department of Natural Resources
P. O. Box 176
Jefferson City, Missouri 65102-0176

Dear Dr. Prawl:

The U.S. Army Corps of Engineers Kansas City District (Corps) received a request from the Tri-State Water Resources Coalition of Southwest Missouri to study the feasibility of reallocating water-supply storage at Stockton Lake, Missouri. The project is currently in the feasibility stage which will assess a range of alternatives and ultimately identify a preferred alternative for implementation. No preferred alternative has yet been selected. A project fact sheet is included as an attachment to this letter for additional details on the proposed project. This letter is to inform your office of the proposed undertaking and serves to initiate consultation under Section 106 of the National Historic Preservation Act.

In 2012 and 2014, the Corps Planning Assistance to States program in partnership with Missouri Department of Natural Resources was used to forecast both the water demand and supply for the Southwest Missouri region. Due to continued regional growth there will be municipal and industrial water needs in the future that existing supplies cannot provide. To address this shortfall, Tri-State Water Resources Coalition requested the Kansas City District to study the possibility of a water-supply reallocation at Stockton Lake for the purposes of municipal and industrial use. The Water Supply Resources Act of 1958 allows the Corps to engage with local entities to assist with their water resources planning needs. Studies that date back to 2009 suggest that seeking water from Stockton Lake would be a more cost-effective method than building a new reservoir to serve the communities in need. Since the study is in the preliminary phases, a preferred alternative has not been selected. Once it is confirmed in the screening phase that water storage from Stockton Lake is the most cost-efficient way to obtain a reliable water source, the study team will then evaluate from which pool the water would come. Initial alternatives for the reallocation of water-supply storage include:

- Reallocating water from the flood-control pool means a lake level raise. The lake level raise would not be expected to exceed two feet.

- Reallocating water from the conservation pool means that the normal lake level elevation of 867.0 mean sea level (msl) would not change; however, a portion of the conservation pool would be specifically dedicated to water-supply storage.

- Reallocating water from both the flood control pool and the conversation pool is a combination of the previous two (2) alternatives. Once again, the lake level raise would not be expected to exceed two feet.

The feasibility report will document and evaluate how the preferred alternative would affect other authorized purposes. The report will also discuss any associated out-grant applications that would be necessary in order to design and construct a water-intake structure and pipelines on Corps property to get water to the communities in need. Additional National Environmental Policy Act and associated permitting under Section 404 and 401 of the Clean Water Act would be required and completed by Tri-State Water Resources Coalition for pipeline alignment located off Corps property.

An initial review of the Corps cultural resource files and site location maps found 486 archeological sites recorded on Corps-owned lands at Stockton Lake. However, Corps-owned lands have been only partially inventoried for cultural resources and there is a likelihood that unknown sites are present on Corps lands in unsurveyed areas. A total of 85 archeological sites are recorded along a 13-foot contour elevation band from the current multipurpose pool elevation at 867 to 880 feet above mean sea level (amsl). Of these recorded sites, 22 sites are recorded at the present multipurpose pool elevation or within the potential maximum lake elevation two foot raise to 869 feet amsl. These 22 sites include two sites recorded as potentially eligible for the National Register of Historic Places (NRHP), 18 sites with no NRHP-eligibility determination, and one site determined not eligible for the NRHP. The remaining 63 sites recorded near the lake shore are recorded from one to eleven feet above the highest multipurpose pool in the considered alternatives. It should be noted that all of the 85 recorded sites have been subject to periodic inundation from flooding events since the construction of the dam. The current site condition for most of these sites is unknown. A table of sites recorded along the Stockton Lake shoreline is presented in the attached table.

The Corps will continue consultation with your office as the study progresses. At this time we are requesting your concerns or comments on the proposed project. If you have any questions or concerns, please contact me at timothy.m.meade@usace.army.mil or (816) 389-3138.

Sincerely,

MEADE.TIMOTHY.M.1270866332

Digitally signed by MEADE.TIMOTHY.M.1270866332
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=MEADE.TIMOTHY.M.1270866332
Date: 2017.08.15 15:09:31 -05'00'

Timothy Meade
Senior District Archeologist

Enclosure

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E. 12TH STREET
KANSAS CITY, MISSOURI 64106-2824

Planning Branch

Dr. Andrea Hunter
Tribal Historic Preservation Officer
The Osage Tribe
627 Grandview
Pawhuska, Oklahoma 74056

Dear Dr. Hunter:

The U.S. Army Corps of Engineers Kansas City District (Corps) received a request from the Tri-State Water Resources Coalition of Southwest Missouri to study the feasibility of reallocating water-supply storage at Stockton Lake, Missouri. The project is currently in the feasibility stage which will assess a range of alternatives and ultimately identify a preferred alternative for implementation. No preferred alternative has yet been selected. A project fact sheet is included as an attachment to this letter for additional details on the proposed project. This letter is to inform the Osage Nation of the proposed undertaking and serves to initiate consultation with the Tribe under Section 106 of the National Historic Preservation Act.

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The Corps will continue consultation with your tribe as the study progresses. At this time we are requesting your concerns or comments on the proposed project. If you have any questions or concerns, please contact me at timothy.m.meade@usace.army.mil or (816) 389-3138.

MEADE.TIMOTHY.M.1270866332

Digitally signed by MEADE.TIMOTHY.M.1270866332
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=MEADE.TIMOTHY.M.1270866332
Date: 2017.08.15 14:27:02 -05'00'

Timothy Meade
District Archeologist

Enclosures

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E. 12TH STREET
KANSAS CITY, MISSOURI 64106-2824

Planning Branch

Chairperson Tamara Francis-Fourkiller
Caddo Nation
P.O. Box 487
Binger, Oklahoma 73009

Dear Chairperson Francis-Fourkiller:

The U.S. Army Corps of Engineers Kansas City District (Corps) received a request from the Tri-State Water Resources Coalition of Southwest Missouri to study the feasibility of reallocating water-supply storage at Stockton Lake, Missouri. The project is currently in the feasibility stage which will assess a range of alternatives and ultimately identify a preferred alternative for implementation. No preferred alternative has yet been selected. A project fact sheet is included as an attachment to this letter for additional details on the proposed project. This letter is to inform the Caddo Nation of the proposed undertaking and serves to initiate consultation under Section 106 of the National Historic Preservation Act.

In 2012 and 2014, the Corps Planning Assistance to States program in partnership with Missouri Department of Natural Resources was used to forecast both the water demand and supply for the Southwest Missouri region. Due to continued regional growth there will be municipal and industrial water needs in the future that existing supplies cannot provide. To address this shortfall, Tri-State Water Resources Coalition requested the Kansas City District to study the possibility of a water-supply reallocation at Stockton Lake for the purposes of municipal and industrial use. The Water Supply Resources Act of 1958 allows the Corps to engage with local entities to assist with their water resources planning needs. Studies that date back to 2009 suggest that seeking water from Stockton Lake would be a more cost-effective method than building a new reservoir to serve the communities in need. Since the study is in the preliminary phases, a preferred alternative has not been selected. Once it is confirmed in the screening phase that water storage from Stockton Lake is the most cost-efficient way to obtain a reliable water source, the study team will then evaluate from which pool the water would come. Initial alternatives for the reallocation of water-supply storage include:

- Reallocating water from the flood-control pool means a lake level raise. The lake level raise would not be expected to exceed two feet.

- Reallocating water from the conservation pool means that the normal lake level elevation of 867.0 mean sea level (msl) would not change; however, a portion of the conservation pool would be specifically dedicated to water-supply storage.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E. 12TH STREET
KANSAS CITY, MISSOURI 64106-2824

Planning Branch

Lance Foster
Tribal Historic Preservation Officer
Iowa Tribe of Kansas
3345 B Thrasher Road
White Cloud, Kansas 66094

Dear Mr. Foster:

The U.S. Army Corps of Engineers Kansas City District (Corps) received a request from the Tri-State Water Resources Coalition of Southwest Missouri to study the feasibility of reallocating water-supply storage at Stockton Lake, Missouri. The project is currently in the feasibility stage which will assess a range of alternatives and ultimately identify a preferred alternative for implementation. No preferred alternative has yet been selected. A project fact sheet is included as an attachment to this letter for additional details on the proposed project. This letter is to inform the Iowa Tribe of Kansas of the proposed undertaking and serves to initiate consultation under Section 106 of the National Historic Preservation Act.

In 2012 and 2014, the Corps Planning Assistance to States program in partnership with Missouri Department of Natural Resources was used to forecast both the water demand and supply for the Southwest Missouri region. Due to continued regional growth there will be municipal and industrial water needs in the future that existing supplies cannot provide. To address this shortfall, Tri-State Water Resources Coalition requested the Kansas City District to study the possibility of a water-supply reallocation at Stockton Lake for the purposes of municipal and industrial use. The Water Supply Resources Act of 1958 allows the Corps to engage with local entities to assist with their water resources planning needs. Studies that date back to 2009 suggest that seeking water from Stockton Lake would be a more cost-effective method than building a new reservoir to serve the communities in need. Since the study is in the preliminary phases, a preferred alternative has not been selected. Once it is confirmed in the screening phase that water storage from Stockton Lake is the most cost-efficient way to obtain a reliable water source, the study team will then evaluate from which pool the water would come. Initial alternatives for the reallocation of water-supply storage include:

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The feasibility report will document and evaluate how the preferred alternative would affect other authorized purposes. The report will also discuss any associated out-grant applications that would be necessary in order to design and construct a water-intake structure and pipelines on Corps property to get water to the communities in need. Additional National Environmental Policy Act and associated permitting under Section 404 and 401 of the Clean Water Act would be required and completed by Tri-State Water Resources Coalition for pipeline alignment located off Corps property.

An initial review of the Corps cultural resource files and site location maps found 486 archeological sites recorded on Corps-owned lands at Stockton Lake. However, Corps-owned lands have been only partially inventoried for cultural resources and there is a likelihood that unknown sites are present on Corps lands in unsurveyed areas. A total of 85 archeological sites are recorded along a 13-foot contour elevation band from the current multipurpose pool elevation at 867 to 880 feet above mean sea level (amsl). Of these recorded sites, 22 sites are recorded at the present multipurpose pool elevation or within the potential maximum lake elevation two foot raise to 869 feet amsl. These 22 sites include two sites recorded as potentially eligible for the National Register of Historic Places (NRHP), 18 sites with no NRHP-eligibility determination, and one site determined not eligible for the NRHP. The remaining 63 sites recorded near the lake shore are recorded from one to eleven feet above the highest multipurpose pool in the considered alternatives. It should be noted that all of the 85 recorded sites have been subject to periodic inundation from flooding events since the construction of the dam. The current site condition for most of these sites is unknown. A table of sites recorded along the Stockton Lake shoreline is presented in the attached table.

The Corps will continue consultation with your tribe as the study progresses. At this time we are requesting your concerns or comments on the proposed project. If you have any questions or concerns, please contact me at timothy.m.meade@usace.army.mil or (816) 389-3138.

Sincerely,

Timothy Meade

Timothy Meade
Senior District Archeologist

Enclosure

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E. 12TH STREET
KANSAS CITY, MISSOURI 64106-2824

Planning Branch

Crystal Douglas
Kaw Nation
Drawer 50
Kaw City, Oklahoma 74641

Dear Ms. Douglas:

The U.S. Army Corps of Engineers Kansas City District (Corps) received a request from the Tri-State Water Resources Coalition of Southwest Missouri to study the feasibility of reallocating water-supply storage at Stockton Lake, Missouri. The project is currently in the feasibility stage which will assess a range of alternatives and ultimately identify a preferred alternative for implementation. No preferred alternative has yet been selected. A project fact sheet is included as an attachment to this letter for additional details on the proposed project. This letter is to inform the Kaw Nation of the proposed undertaking and serves to initiate consultation under Section 106 of the National Historic Preservation Act.

In 2012 and 2014, the Corps Planning Assistance to States program in partnership with Missouri Department of Natural Resources was used to forecast both the water demand and supply for the Southwest Missouri region. Due to continued regional growth there will be municipal and industrial water needs in the future that existing supplies cannot provide. To address this shortfall, Tri-State Water Resources Coalition requested the Kansas City District to study the possibility of a water-supply reallocation at Stockton Lake for the purposes of municipal and industrial use. The Water Supply Resources Act of 1958 allows the Corps to engage with local entities to assist with their water resources planning needs. Studies that date back to 2009 suggest that seeking water from Stockton Lake would be a more cost-effective method than building a new reservoir to serve the communities in need. Since the study is in the preliminary phases, a preferred alternative has not been selected. Once it is confirmed in the screening phase that water storage from Stockton Lake is the most cost-efficient way to obtain a reliable water source, the study team will then evaluate from which pool the water would come. Initial alternatives for the reallocation of water-supply storage include:

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An initial review of the Corps cultural resource files and site location maps found 486 archeological sites recorded on Corps-owned lands at Stockton Lake. However, Corps-owned lands have been only partially inventoried for cultural resources and there is a likelihood that unknown sites are present on Corps lands in unsurveyed areas. A total of 85 archeological sites are recorded along a 13-foot contour elevation band from the current multipurpose pool elevation at 867 to 880 feet above mean sea level (amsl). Of these recorded sites, 22 sites are recorded at the present multipurpose pool elevation or within the potential maximum lake elevation two foot raise to 869 feet amsl. These 22 sites include two sites recorded as potentially eligible for the National Register of Historic Places (NRHP), 18 sites with no NRHP-eligibility determination, and one site determined not eligible for the NRHP. The remaining 63 sites recorded near the lake shore are recorded from one to eleven feet above the highest multipurpose pool in the considered alternatives. It should be noted that all of the 85 recorded sites have been subject to periodic inundation from flooding events since the construction of the dam. The current site condition for most of these sites is unknown. A table of sites recorded along the Stockton Lake shoreline is presented in the attached table.

The Corps will continue consultation with your tribe as the study progresses. At this time we are requesting your concerns or comments on the proposed project. If you have any questions or concerns, please contact me at timothy.m.meade@usace.army.mil or (816) 389-3138.

Sincerely,

Timothy Meade

Timothy Meade
Senior District Archeologist

Enclosure

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E. 12TH STREET
KANSAS CITY, MISSOURI 64106-2824

Planning Branch

Thomas Parker
Tribal Historic Preservation Officer
Omaha Tribe
P.O. Box 368
Macy, Nebraska 68039

Dear Mr. Parker:

The U.S. Army Corps of Engineers Kansas City District (Corps) received a request from the Tri-State Water Resources Coalition of Southwest Missouri to study the feasibility of reallocating water-supply storage at Stockton Lake, Missouri. The project is currently in the feasibility stage which will assess a range of alternatives and ultimately identify a preferred alternative for implementation. No preferred alternative has yet been selected. A project fact sheet is included as an attachment to this letter for additional details on the proposed project. This letter is to inform the Omaha Tribe of the proposed undertaking and serves to initiate consultation under Section 106 of the National Historic Preservation Act.

In 2012 and 2014, the Corps Planning Assistance to States program in partnership with Missouri Department of Natural Resources was used to forecast both the water demand and supply for the Southwest Missouri region. Due to continued regional growth there will be municipal and industrial water needs in the future that existing supplies cannot provide. To address this shortfall, Tri-State Water Resources Coalition requested the Kansas City District to study the possibility of a water-supply reallocation at Stockton Lake for the purposes of municipal and industrial use. The Water Supply Resources Act of 1958 allows the Corps to engage with local entities to assist with their water resources planning needs. Studies that date back to 2009 suggest that seeking water from Stockton Lake would be a more cost-effective method than building a new reservoir to serve the communities in need. Since the study is in the preliminary phases, a preferred alternative has not been selected. Once it is confirmed in the screening phase that water storage from Stockton Lake is the most cost-efficient way to obtain a reliable water source, the study team will then evaluate from which pool the water would come. Initial alternatives for the reallocation of water-supply storage include:

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The Corps will continue consultation with your tribe as the study progresses. At this time we are requesting your concerns or comments on the proposed project. If you have any questions or concerns, please contact me at timothy.m.meade@usace.army.mil or (816) 389-3138.

Sincerely,

Timothy Meade

Timothy Meade
Senior District Archeologist

Enclosure

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E. 12TH STREET
KANSAS CITY, MISSOURI 64106-2824

Planning Branch

Shannon Wright
Culture Director
Ponca Tribe of Nebraska
P.O. Box 288
Niobrara, Nebraska 68760

Dear Mr. Wright:

The U.S. Army Corps of Engineers Kansas City District (Corps) received a request from the Tri-State Water Resources Coalition of Southwest Missouri to study the feasibility of reallocating water-supply storage at Stockton Lake, Missouri. The project is currently in the feasibility stage which will assess a range of alternatives and ultimately identify a preferred alternative for implementation. No preferred alternative has yet been selected. A project fact sheet is included as an attachment to this letter for additional details on the proposed project. This letter is to inform the Ponca Tribe of Nebraska of the proposed undertaking and serves to initiate consultation under Section 106 of the National Historic Preservation Act.

In 2012 and 2014, the Corps Planning Assistance to States program in partnership with Missouri Department of Natural Resources was used to forecast both the water demand and supply for the Southwest Missouri region. Due to continued regional growth there will be municipal and industrial water needs in the future that existing supplies cannot provide. To address this shortfall, Tri-State Water Resources Coalition requested the Kansas City District to study the possibility of a water-supply reallocation at Stockton Lake for the purposes of municipal and industrial use. The Water Supply Resources Act of 1958 allows the Corps to engage with local entities to assist with their water resources planning needs. Studies that date back to 2009 suggest that seeking water from Stockton Lake would be a more cost-effective method than building a new reservoir to serve the communities in need. Since the study is in the preliminary phases, a preferred alternative has not been selected. Once it is confirmed in the screening phase that water storage from Stockton Lake is the most cost-efficient way to obtain a reliable water source, the study team will then evaluate from which pool the water would come. Initial alternatives for the reallocation of water-supply storage include:

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The Corps will continue consultation with your tribe as the study progresses. At this time we are requesting your concerns or comments on the proposed project. If you have any questions or concerns, please contact me at timothy.m.meade@usace.army.mil or (816) 389-3138.

Sincerely,

Timothy Meade
Senior District Archeologist

Enclosure

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E. 12TH STREET
KANSAS CITY, MISSOURI 64106-2824

Planning Branch

Halona Cabe, THPO
Ponca Tribe of Oklahoma
20 White Eagle Drive
Ponca City, Oklahoma 74601

Dear Ms. Cabe:

The U.S. Army Corps of Engineers Kansas City District (Corps) received a request from the Tri-State Water Resources Coalition of Southwest Missouri to study the feasibility of reallocating water-supply storage at Stockton Lake, Missouri. The project is currently in the feasibility stage which will assess a range of alternatives and ultimately identify a preferred alternative for implementation. No preferred alternative has yet been selected. A project fact sheet is included as an attachment to this letter for additional details on the proposed project. This letter is to inform the Ponca Tribe of Oklahoma of the proposed undertaking and serves to initiate consultation under Section 106 of the National Historic Preservation Act.

In 2012 and 2014, the Corps Planning Assistance to States program in partnership with Missouri Department of Natural Resources was used to forecast both the water demand and supply for the Southwest Missouri region. Due to continued regional growth there will be municipal and industrial water needs in the future that existing supplies cannot provide. To address this shortfall, Tri-State Water Resources Coalition requested the Kansas City District to study the possibility of a water-supply reallocation at Stockton Lake for the purposes of municipal and industrial use. The Water Supply Resources Act of 1958 allows the Corps to engage with local entities to assist with their water resources planning needs. Studies that date back to 2009 suggest that seeking water from Stockton Lake would be a more cost-effective method than building a new reservoir to serve the communities in need. Since the study is in the preliminary phases, a preferred alternative has not been selected. Once it is confirmed in the screening phase that water storage from Stockton Lake is the most cost-efficient way to obtain a reliable water source, the study team will then evaluate from which pool the water would come. Initial alternatives for the reallocation of water-supply storage include:

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The Corps will continue consultation with your tribe as the study progresses. At this time we are requesting your concerns or comments on the proposed project. If you have any questions or concerns, please contact me at timothy.m.meade@usace.army.mil or (816) 389-3138.

Sincerely,

Timothy Meade
Senior District Archeologist

Enclosure

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E. 12TH STREET
KANSAS CITY, MISSOURI 64106-2824

Planning Branch

Chairman Edmore Green
Sac and Fox Nation of Missouri in Kansas and Nebraska
305 N. Main Street
Reserve, Kansas 66434

Dear Chairman Green:

The U.S. Army Corps of Engineers Kansas City District (Corps) received a request from the Tri-State Water Resources Coalition of Southwest Missouri to study the feasibility of reallocating water-supply storage at Stockton Lake, Missouri. The project is currently in the feasibility stage which will assess a range of alternatives and ultimately identify a preferred alternative for implementation. No preferred alternative has yet been selected. A project fact sheet is included as an attachment to this letter for additional details on the proposed project. This letter is to inform the Sac and Fox Nation of Missouri in Kansas and Nebraska of the proposed undertaking and serves to initiate consultation under Section 106 of the National Historic Preservation Act.

In 2012 and 2014, the Corps Planning Assistance to States program in partnership with Missouri Department of Natural Resources was used to forecast both the water demand and supply for the Southwest Missouri region. Due to continued regional growth there will be municipal and industrial water needs in the future that existing supplies cannot provide. To address this shortfall, Tri-State Water Resources Coalition requested the Kansas City District to study the possibility of a water-supply reallocation at Stockton Lake for the purposes of municipal and industrial use. The Water Supply Resources Act of 1958 allows the Corps to engage with local entities to assist with their water resources planning needs. Studies that date back to 2009 suggest that seeking water from Stockton Lake would be a more cost-effective method than building a new reservoir to serve the communities in need. Since the study is in the preliminary phases, a preferred alternative has not been selected. Once it is confirmed in the screening phase that water storage from Stockton Lake is the most cost-efficient way to obtain a reliable water source, the study team will then evaluate from which pool the water would come. Initial alternatives for the reallocation of water-supply storage include:

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The Corps will continue consultation with your tribe as the study progresses. At this time we are requesting your concerns or comments on the proposed project. If you have any questions or concerns, please contact me at timothy.m.meade@usace.army.mil or (816) 389-3138.

Sincerely,

Timothy Meade

Timothy Meade
Senior District Archeologist

Enclosure

ATTACHMENT 2: Response to Initiation Letters

Attachment 2 includes response letters from the following:

- Director and Deputy SHPO, Missouri Department of Natural Resources
- Director/Tribal Historic Preservation Officer, The Osage Nation

Missouri Department of NATURAL RESOURCES

dnr.mo.gov

Eric R. Greitens, Governor

Carol S. Comer, Director

September 13, 2017

Mr. Timothy M. Meade, Archeologist
Corps of Engineers, Kansas City District
635 Federal Building
601 East 12th Street
Kansas City, MO 64106-2824

Re: Stockton Lake Water Supply Reallocation (COE) Cedar, Dade & Polk Counties, Missouri

Dear Mr. Meade:

Thank you for submitting information on the above referenced project for our review pursuant to Section 106 of the National Historic Preservation Act (P.L. 89-665, as amended) and the Advisory Council on Historic Preservation's regulation 36 CFR Part 800, which requires identification and evaluation of cultural resources.

We have reviewed the information provided concerning the proposed water supply reallocation at Stockton Lake, as requested by the Tri-State Water Resources coalition of Southwest Missouri. We are concerned that changes in water level or water level fluctuation could affect both known and unknown archaeological sites. We understand that there is only a partial inventory on Corps owned lands, and that much of this survey may no longer be considered completely reliable according to modern methodology. We are also concerned about any effects of Stockton Lake State Park, and suggest that the Missouri Department of Natural Resources, Division of State Parks, also be included in this consultation.

We look forward to continuing to consult with you as this project moves forward. If you have any questions, please write Judith Deel at State Historic Preservation Office, P.O. Box 176, Jefferson City, Missouri 65102 or call 573/751-7862. Please be sure to include the SHPO Log Number (**057-MLT-17**) on all future correspondence or inquiries relating to this project.

Sincerely,

STATE HISTORIC PRESERVATION OFFICE

Toni M. Prawl

Toni M. Prawl, Ph.D.
Director and Deputy State
Historic Preservation Officer

TMP:jd

c Ms. Kim Dillon, DNR/MSP
Dr. Michael Ohnersorgen, DRN/MSP

Promoting, Protecting and Enjoying our Natural Resources. Learn more at dnr.mo.gov

Recycled paper

From:	Andrea Hunter
To:	Meade, Timothy M CIV (USA)
Cc:	John Fox; Sarah O"Donnell; Morgan Currey
Subject:	[EXTERNAL] Stockton Lake Project
Date:	Tuesday, September 19, 2017 2:58:48 PM

Good afternoon Tim,

The Osage Nation received the notification of the Stockton Lake Project, Water Supply Reallocation Study. The Osage Nation has a great concern for the impacts this project would have on significant Osage sites and burials. The Osage Nation requests consulting party status, review of the draft EA, and a consultation meeting to discuss options and potential impacts.

Please provide a range of dates for a consultation meeting here in Pawhuska.

Thank you,

Dr. Andrea A. Hunter

Director/THPO

Osage Nation Historic Preservation Office

627 Grandview Avenue

Pawhuska, OK 74056

Office phone: (918) 287-5328

Office fax: (918) 287-5376

Email: ahunter@osagenation-nsn.gov

ATTACHMENT 3: Letter enclosures

Attachment 3 includes the enclosures that were sent with the initial coordination letters. The enclosures are the following:

- Stockton Lake Water Supply Storage Reallocation Study Factsheet
- Stockton Lake Project Boundary
- Stockton Lake Shoreline Table of Archeological Sites

US Army Corps of Engineers ®
Kansas City District

PLANNING BRANCH
Plan Formulation Section
Building Strong

PROJECT NAME: Stockton Lake Project, Water Supply Reallocation Study, Sac River, Cedar/Dade/Polk Counties, Missouri.

FEDERAL ACTION: The Flood Control Act of 1944, the Flood Control Act of 1958, Section 301 (a) and the Water Resource Development Act of 1986, Section 932 relate to the study and the authority for the Corps to participate in finding solutions to water resource planning for municipal and industrial water supply use.

LOCATION: Stockton Lake is owned and operated by the U.S. Army Corps of Engineers (USACE) Kansas City District (NWK) and is located approximately two miles east of Stockton, Missouri, on the Sac River, in Cedar/Dade/Polk Counties, Missouri.

STOCKTON LAKE BACKGROUND INFORMATION: Stockton Lake Project was authorized by the Flood Control Act of 1954 and is a multi-purpose use reservoir that provides flood risk management, water supply, hydropower, recreation and fish and wildlife benefits. The primary purpose of Stockton is for flood risk management. Construction was initiated in fiscal year (FY) 1963 and impoundment was initiated in December 1969. Stockton Lake is one of three reservoirs in the southwest Missouri region that could provide water supply benefits to neighboring communities.

REALLOCATION PROJECT DESCRIPTION: Tri-State Water Resources Coalition is a non-profit (501C4) organization whose mission is to secure adequate, quality water supplies for the next generation in the 16-county region of southwest Missouri. In 2012 and 2014, studies were conducted with the Missouri Department of Natural Resources as the non-Federal cost-sharing partner to identify forecasted water demand and supply within the southwest Missouri area. Due to continued regional growth, the studies identified municipal and industrial water needs in the future that exceed existing supplies. Water supply reallocation at Stockton Lake was identified as a potential solution for future water supply needs in the region.

REALLOCATION PROJECT PURPOSE: Kansas City District is preparing a Feasibility Study to assess the viability of potential water supply storage reallocation alternatives at Stockton Lake. The Feasibility Study will also assess the availability of other potential external sources of water supply that could provide the same quality and quantity of water as Stockton Lake. Examples of "external alternatives" besides water supply storage from Stockton Lake that are currently under evaluation include: 1) Construction of a new reservoir; 2) Use of water conservation measures; 3) New groundwater fields; and 4) Reallocations from other reservoirs.

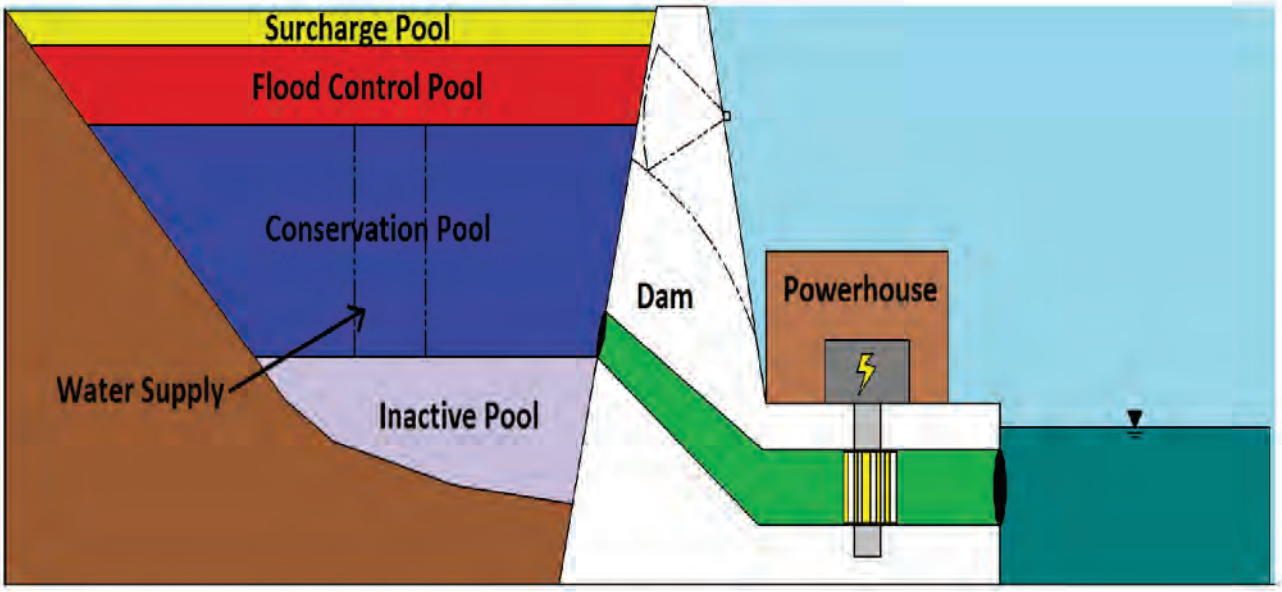
If storage out of Stockton Lake is deemed as the most cost effective alternative, then an evaluation will be conducted on which pool the lake storage should come from, referred to as "internal alternatives". Internal alternatives that will be evaluated include: 1) Storage out of the flood control pool (the lake level rises and the level of water in the conservation pool increases); 2) Storage out of the conservation pool (the lake level remains the same and the amount of water in the conservation pool remains the same); 3) Storage out of the inactive pool (the lake level remains the same, but the bottom of the conservation pool elevation is lowered, thus the amount of water in the conservation pool increases); 4) Storage out of a combination of pools, such as storage out of the flood control pool (pool raise) and the conservation pool.

The Stockton Lake Water Supply Reallocation Study will evaluate potential effects on authorized purposes (i.e. flood risk management, hydropower, recreation, water quality, fish and wildlife, etc.) and potential effects to the environment at Stockton Lake depending on which pool the water supply storage would be reallocated from. The attached map identifies the Corps property boundary at Stockton Lake.

CONSTRUCTION METHOD: If a feasible Stockton Lake reallocation alternative is identified, additional construction of intake(s) and pipeline(s) would be required to carry water from the lake to the communities in need. This requirement will be further developed and analyzed by the Tri-State Water Resources Coalition and included in the Feasibility Study for potential effects within the Kansas City District Corps of Engineers project boundary. Preliminary analysis conducted by Tri-State Water Resources Coalition, Missouri Department of Natural Resources and Kansas City District suggest that the intake would most likely be placed next to the existing intake that is owned by City Utilities of Springfield, Missouri. Additional NEPA and associated permitting under Section 404 and 401 of the Clean Water Act for construction of new water transmission or other related facilities would be required and completed by Tri-State Water Resources Coalition for pipeline(s) alignments located outside of the Stockton Lake project boundary.

3

WHAT DOES WATER SUPPLY STORAGE LOOK LIKE?



WHAT DOES REALLOCATING WATER SUPPLY STORAGE MEAN?

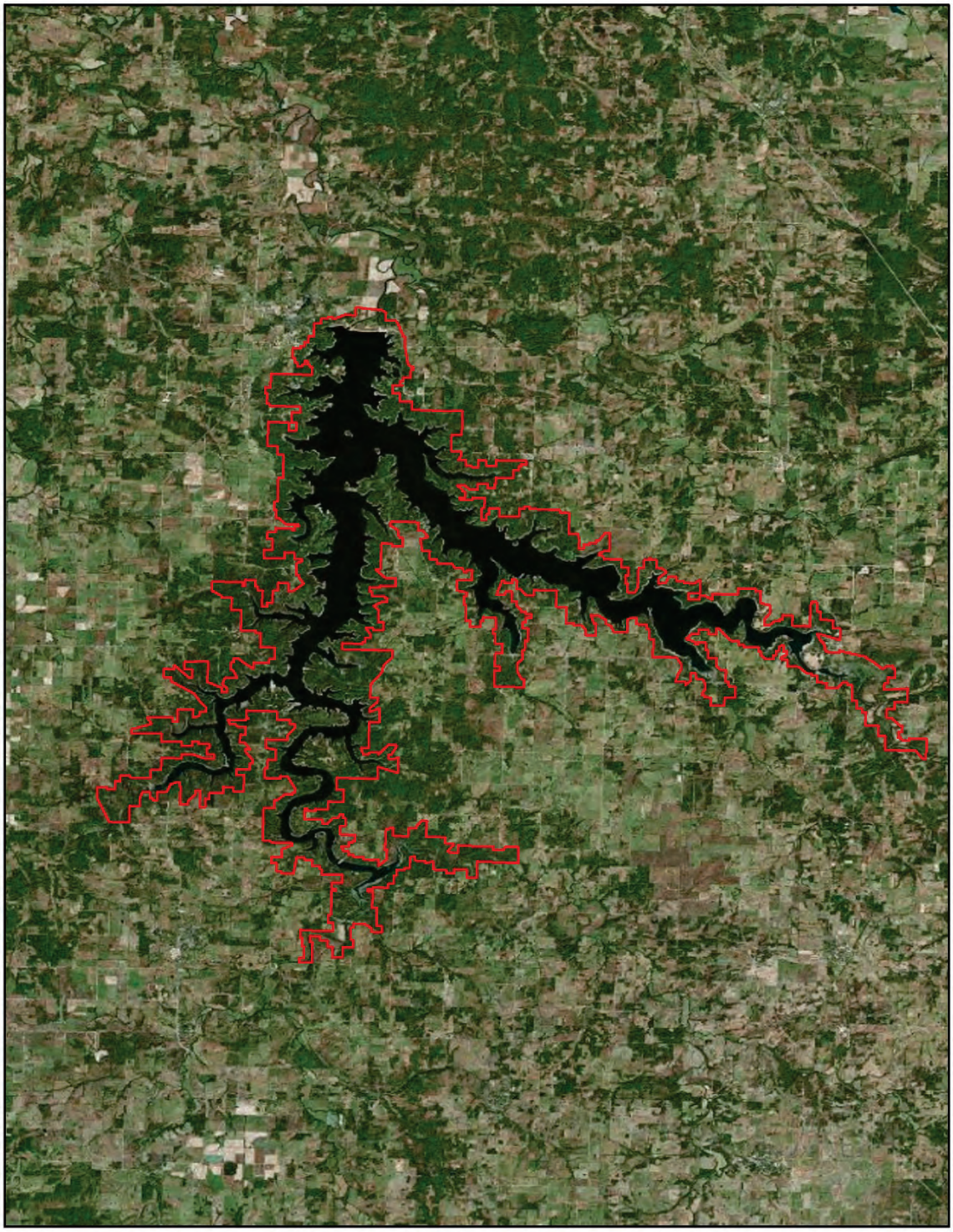
- **Flood Control Pool Reallocation:** Reallocating water from the flood pool to the conservation pool; would raise the level of the lake, and acre-feet volume in the conservation pool would be larger.
- **Conservation Pool Reallocation:** Reallocating water within the conservation pool; would not result in a pool raise, and acre-feet or volume in the conservation pool remains the same.
- **Inactive Pool Reallocation:** Reallocating water from the inactive pool; would lower the bottom elevation of the conservation pool, and acre-feet or volume in the conservation pool would be larger.
- **Combination Pool Reallocation:** Reallocating water from multiple pools such as the flood control pool and the multipurpose pool; would result in a raise of the level of the lake and a reallocation of storage within the conservation pool.

TIMELINE:

STOCKTON SCHEDULE		
HQ Milestones	**Dates**	**Notes**
Alternatives Milestone	MAR-APR 18	*operating off of FY17 carry over funds
Tentatively Selected Plan	Sep-18	*dependent on when funds are received
Agency Decision Milestone	Feb-19	*dependent on when funds are received

*The study is currently preparing an Environmental Assessment to be integrated into The Feasibility Study. This assumption will be reviewed as the study progresses and more information is known regarding the array of alternatives.

Stockton Lake - Corps Boundary



STOCKTON LAKE SHORELINE--TABLE OF ARCHEOLOGICAL SITES

Site number	Elevation	Site Size	Cultural Affiliation	NRHP Eligibility	Recommendation
23CE315	870-890	Undetermined	Historic	Not Eligible	No further work
23CE322	870-880	200-x-100m	Middle to Late Archaic/WoodlandlMississippian/Historic	Not Eligible	No further work
23CE325	870	12-x-4m	Unidentified Prehistoric	Not Eligible	No further work
23CE326	870-880	90-x-50m	Unidentified Prehistoric	Not Eligible	No further work
23CE329	870	70-x-15m	Unidentified Prehistoric	Not Eligible	No further work
23CE341	870-880	165-x-60 m	Unidentified Prehistoric/Historic	Not Eligible	No further work
23CE342	850-920	150-x-130m	Unidentified Prehistoric	Potentially Eligible	Reguire NRHP testing
23CE394	867-975	1,000-x-500 ft.	Unidentified Prehistoric	Not Eligible	No further work
23CE395	867	Undetermined	Unidentified Prehistoric	Undetermined	Resurvey
23CE396	867+	Undetermined	Unidentified Prehistoric	Undetermined	Resurvey
23CE397	867	Undetermined	Unidentified Prehistoric	Undetermined	Resurvey
23CE398	870	91-x-46m	Late Archaic/Woodland/Mississippian	Not Eligible	No further work
23CE436	865	60·x40 ft.	possible Terminal Archaic/possible Late Archaic/possible Woodland	Undetermined	Resurvey
23CE447	870	Undetermined	Late Archaic/Mississippian	Undetermined	Resurvey
23CE448	871-880	Undetermined	Late Archaic/possible Woodland	Undetermined	Resurvey
23CE460	870-880	Undetermined	Unidentified Prehistoric	Undetermined	Resurvey
23DA042	870	Undetermined	Unidentified Prehistoric	Undetermined	Resurvey
23DA045	870	Undetermined	Unidentified Prehistoric	Undetermined	Resurvey
23DA049	870	Undetermined	Unidentified Prehistoric	Undetermined	Resurvey

STOCKTON LAKE SHORELINE--TABLE OF ARCHEOLOGICAL SITES

Site number	Elevation	Site Size	Cultural Affiliation	NRHP Eligibility	Recommendation
23DA050	870	Shelter- 10-40 ft.overhang	Middle Archaic/Middle Woodland/Late Woodland	Not Eligible	No further work
23DA086	870	Shelter- 40-x-20 ft.	Unidentified Prehistoric	Potentially Eligible	Reguire NRHP testing
23DA087	870	Undetermined	Unidentified Prehistoric	Undetermined	Resurvey
23DA112	870	Undetermined	Unidentified Prehistoric	Undetermined	Resurvey
23DA200	870	Shelter-90-x-6 m	Unidentified Prehistoric	Undetermined	Resurvey
23DA232	870	300-x-20 yds	Unidentified Prehistoric	Undetermined	Resurvey
23DA242	870	Shelter	Unidentified Prehistoric	Undetermined	Resurvey
23DA315	870	60-x-30m	Late Woodland	Not Eligible	No further work
23DA359	870-880	Mound- 8 m diameter I m high	Unidentified Prehistoric	Potentially Eligible	Reguire NRHP testing
23DA363	870	30-x-8 ft.	Unidentified Prehistoric	Undetermined	Resurvey
23DA364	870	Undetermined	Late Archaic	Undetermined	Resurvey
23DA368	870	Undetermined	Early Archaic/Late Archaic/Woodland/Mississippian	Undetermined	Resurvey
23DA369	870	Undetermined	Late Archaic/Middle Woodland/Mississippian	Undetermined	Resurvey
23DA370	870	Undetermined	Late to Terminal Archaic/Late Woodland	Undetermined	Resurvey
23DA371	870	Undetermined	Middle to Terminal Archaic/ Middle to Late Woodland/ Early Mississippian	Undetermined	Resurvey
23DA372	870	Undetermined	Unidentified Prehistoric	Undetermined	Resurvey
23DA373	870	Undetermined	Late Archaic	Undetermined	Resurvey
23DA374	870	Undetermined	Late Archaic/Woodland	Undetermined	Resurvey
23DA375	867	Undetermined	Late Archaic	Undetermined	Resurvey

STOCKTON LAKE SHORELINE--TABLE OF ARCHEOLOGICAL SITES

Site number	Elevation	Site Size	Cultural Affiliation	NRHP Eligibility	Recommendation
23DA376	870	15-x-S m	Late Archaic	Undetermined	Resurvey
23DA377	860-870	Undetermined	Late Archaic/Woodland/Mississippian	Undetermined	Resurvey
23DA378	865-880	Undetermined	Late Archaic	Undetermined	Resurvey
23DA379	865-880	Undetermined	Late Archaic	Undetermined	Resurvey
23DA380	870-900	150-x-50 ft.	Late Archaic/Woodland	Undetermined	Resurvey
23DA381	870-900	Undetermined	Late Archaic/Woodland	Undetermined	Resurvey
23DA384	870	Undetermined	Unidentified Prehistoric	Undetermined	Resurvey
23DA389	870	Undetermined	Eary Archaic/ Middle Woodland	Undetermined	Resurvey
23DA390	867	Undetermined	Unidentified Prehistoric	Undetermined	Resurvey
23DA395	870	300 sq m	Late Archaic/Late Woodland	Undetermined	Resurvey
23DA399	870	60-x-7.5m	Unidentified Prehistoric	Undetermined	Resurvey
23DA401	860-870	Undetermined	Late Archaic/Middle to Late Woodland	Undetermined	Resurvey
23DA449	867	Undetermined	Possible Woodland/Historic	Potentially Eligible	Reguire NRHP testing
23PO304	870	1,400-x-100 m	Middle to Late Archaic/Late Woodland/Mississippian	Potentially Eligible	Reguire NRHP testing
23P0320	870-880	900-x-100m	Early/Middle Archaic/Late Archaic/Early Woodland/Late WoodlandlMississippian/Historic	Potentially Eligible	Reguire NRHP testing
23P0351	870	1.000-x-50 m	Early to Late Archaic/Middle to Late Woodland/Mississippian	Not Eligible	No further work
23P0370	870	Undetermined	Middle to Late Archaic/ Middle to Late Woodland/Mississippian	Undetermined	Resurvey
23P0373	870-890	50-x-30m	Late Archaic/Middle to Late Woodland/Mississippian	Undetermined	Resurvey

STOCKTON LAKE SHORELINE--TABLE OF ARCHEOLOGICAL SITES

Site number	Elevation	Site Size	Cultural Affiliation	NRHP Eligibility	Recommendation
23P0374	865-875	40-x-30m	Late Archaic/Late Woodland	Undetermined	Resurvey
23P0375	865-875	2 areas-40-x-20 ft. and 60-x-20ft.	Middle Woodland/ Mississippian	Undetermined	Resurvey
23P0376	865-880	8-x-4m	Middle to Late Archaic/ Middle Woodland	Undetermined	Resurvey
23P0377	865-870	50-x-1O m	Late to Terminal Archaic/Middle to Late Archaic	Undetermined	Resurvey
23PO378	865-880	60-x-8 ft.	Late Archaic/ Late Woodland/ Mississippian	Undetermined	Resurvey
23PO380	870	120-x-70 ft.	Early Archaic/Late Archaic/Late Woodland	Undetermined	Resurvey
23PO387	860-880	125-x-35 ft	Woodland	Undetermined	Resurvey
23PO389	870	50-x-25 ft	Late to Terminal Archaic/ Woodland	Undetermined	Resurvey
23PO391	870	200-x-50 ft	Late Archaic/ Woodland	Undetermined	Resurvey
23PO396	870-880	Undetermined	Unidentified Prehistoric	Undetermined	Resurvey
23PO410	870	Undetermined	Unidentified Prehistoric	Undetermined	Resurvey
23PO411	870-900	Undetermined	Unidentified Prehistoric	Undetermined	Resurvey
23PO412	865-870	1,136 sq. m	Late Archaic/ Late Woodland/ Mississippian	Undetermined	Resurvey
2323PO415	870	91-x-76 m	Unidentified Prehistoric/historic	Undetermined	Resurvey
23PO417	870	234 sq. m	Late Archaic	Undetermined	Resurvey
23PO418	870	50-x-35 m.	Late Archaic/ Woodland	Undetermined	Resurvey
23PO419	860-870	190-x-15 m	Middle Woodland/ Mississippian	Undetermined	Resurvey
23PO427	860-880	Undetermined	Unidentified Prehistoric	Undetermined	Resurvey
23PO428	870	152.4-x-5.2 m	Unidentified Prehistoric	Not Eligible	No further work

Page 4 of 5

STOCKTON LAKE SHORELINE--TABLE OF ARCHEOLOGICAL SITES

Site number	Elevation	Site Size	Cultural Affiliation	NRHP Eligibility	Recommendation
23PO429	870	25-x-9 rn	Unidentified Prehistoric	Potentially Eligible	Reguire NRHP testing
23PO430	870	5,700 sq.m	Late Archaic/ Middle Woodland	Undetermined	Resurvey
23PO435	870	5,500 sq m	Late Archaic	Potentially Eligible	Reguire NRHP testing
23PO436	870	137-x-11 m	Unidentified Prehistoric	Undetermined	Resurvey
23PO440	870	52·x-2.5m	Middle Archaic	Undetermined	Resurvey
23PO441	870-880	38-x-25m	Unidentified Prehistoric	Undetermined	Resurvey
23PO443	870	Undetermined	Late Woodland/ Mississippian	Not Eligible	No further work
23PO446	860-870	125·x-88m	Late Archaic/Woodland	Undetermined	Resurvey
23PO451	870-890	142-x-63.2 m.	Unidentified Prehistoric	Undetermined	Resurvey

SUMMARY	
Not Eligible	13
Undetermined	62
Potentially Eligible	9

ATTACHMENT 4: Continued Coordination Letters

Attachment 4 includes PA initiation letters to the following:

- Director and Deputy SHPO, Missouri Department of Natural Resources
- Advisory Council on Historic Properties
- Director/Tribal Historic Preservation Officer, The Osage Nation
- Chairperson, Caddo Nation
- Tribal Historic Preservation Officer, Iowa Tribe of Kansas
- Kaw Nation
- Tribal Historic Preservation Officer, Omaha Tribe
- Culture Director, Ponca Tribe of Nebraska
- Tribal Historic Preservation Officer, Ponca Tribe of Oklahoma
- Chairman, Sac and Fox Nation of Missouri in Kansas and Nebraska

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E. 12TH STREET
KANSAS CITY, MISSOURI 64106-2824

Planning Branch
Risk Communication Section

Dr. Toni M. Prawl
Director and Deputy State Historic Preservation Officer
State Historic Preservation Office
Department of Natural Resources
P. O. Box 176
Jefferson City, Missouri 65102-0176

Dear Dr. Prawl:

This letter is a follow up to the August 2017 letter informing your office of a request that the U.S. Army Corps of Engineers, Kansas City District (Corps) received from the Tri-State Water Resources Coalition of Southwest Missouri. The Tri-State Water Resources Coalition has requested to study the feasibility of reallocating storage to water-supply storage at Stockton Lake located in Cedar, Dade, and Polk Counties, Missouri. That letter informed your office of a range of alternatives under consideration at that time and requested your comments on the proposed undertaking. Judith Deel, from your office, responded by letter that your office had concerns on potential effects to archeological sites due to changes in the reservoir water level **(057-MLT-17)**. This letter continues consultation with your under Section 106 of the National Historic Preservation Act (NHPA). Attached for your information is a project fact sheet.

The Corps has now selected a preferred alternative for reallocating the water storage at the lake. In sum, the proposed alternative would raise the normal operating pool by 1.8 feet above the current normal operating lake level of 867 feet above mean sea level (amsl) to 868.8 feet amsl. A project fact sheet is included as an attachment to this letter for additional details on the proposed reallocation. The draft Stockton Lake Reallocation Environmental Assessment will be available for public review and comment in May 2020.

The NHPA requires the Corps to consult with interested parties on its undertakings, including the reallocation of water-supply storage. The Area of Potential Effect (APE) for the proposed reallocation are those elevations where shoreline exposure or inundation may increase due to the resulting change in normal operating lake elevation. At present the lake shoreline has not been fully inventoried for cultural resource sites and many identified sites have not been evaluated for their eligibility for the National Register of Historic Places (NRHP). The lack of cultural resource inventories and eligibility assessments on recorded sites make it difficult to determine the effects of the undertaking at this time. As such, the Corps is planning to develop a programmatic agreement (PA) to fulfill its NHPA responsibilities.

At this time we invite your office to participate in the development of the PA. In the near future we plan to hold a webinar regarding the reallocation project and PA. I will be contacting you in the near future regarding the proposed webinar and to discuss the development of the PA. In the meantime, if you have any questions please me at (816) 389-3138 or timothy.m.meade@usace.army.mil. We appreciate your consideration of the matter and look forward to working with you.

Sincerely,

MEADE.TIMOTHY.M.1270866332

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Date: 2020.03.10 13:00:01 -05'00'

Timothy Meade
Senior District Archeologist

Enclosure

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E. 12TH STREET
KANSAS CITY, MISSOURI 64106-2824

Planning Branch

Mr. Reid Nelson
Office of Federal Agency Programs
Advisory Council on Historic Preservation
401 F Street, Suite 308
Washington, D.C. 20001-2637

Dear Mr. Nelson:

The U.S. Army Corps of Engineers, Kansas City District (Corps) received a request from the Tri-State Water Resources Coalition of Southwest Missouri to study the feasibility of reallocating water-supply storage at Stockton Lake, Missouri. The Corps has now completed a draft feasibility study that will be out for public comment by the end of May 2020. The purpose of this letter is to invite the Advisory Council on Historic Preservation to participate in the development of a Programmatic Agreement (PA) and be a signatory on that document.

The Corps has now selected a preferred alternative for reallocating the water storage at the lake. In sum, the proposed alternative would raise the normal operating pool by 1.8 feet above the current normal operating lake level of 867 feet above mean sea level (amsl) to 868.8 feet amsl. A project fact sheet is included as an attachment to this letter for additional details on the proposed reallocation.

The National historic Preservation Act requires the Corps to consult with interested parties on its undertakings, including the reallocation of water-supply storage. The Area of Potential Effect (APE) for the proposed reallocation are those elevations where shoreline exposure or inundation may increase due to the resulting change in normal operating lake elevation. At present, the lake shoreline has not been fully inventoried for historic properties and many identified sites have not been evaluated for their eligibility for the National Register of Historic Places. The lack of cultural resource inventories and eligibility assessments on recorded sites make it difficult to determine the effects of the undertaking at this time. As such, the Corps is planning to develop a programmatic agreement (PA) to fulfill its NHPA responsibilities. The Corps has also invited the Missouri State Historic Preservation Officer and appropriate federally recognized Native American tribes to participate in the development of the PA.

We appreciate your consideration of the matter and look forward to working with you on this important matter. If your office wishes to participate as a signatory or if you have any questions please me at (816) 389-3138 or timothy.m.meade@usace.army.mil.

Sincerely,

MEADE.TIMOTHY.M.1270866332

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Timothy Meade
Senior District Archeologist

Enclosure

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E. 12TH STREET
KANSAS CITY, MISSOURI 64106-2824

Planning Branch
Risk Communication Section

Dr. Andrea Hunter
Tribal Historic Preservation Officer
The Osage Nation
P.O. Box 779
Pawhuska, Oklahoma 74056

Dear Dr. Hunter:

This letter is a follow up to the August 2017 letter and December 2017 meeting with you on the request that the U.S. Army Corps of Engineers, Kansas City District (Corps) received from the Tri-State Water Resources Coalition of Southwest Missouri to study the feasibility of reallocating storage to water-supply storage at Stockton Lake located in Cedar, Dade, and Polk Counties, Missouri. The letter and informed your office of a range of alternatives under consideration at that time and requested your comments on the proposed undertaking. The alternatives were presented at the subsequent meeting at which time you expressed concern on potential effects to cultural resource sites of importance to the Osage Nation. This letter continues consultation with the Osage Nation under Section 106 of the National Historic Preservation Act (NHPA).

The Corps has now selected a preferred alternative for reallocating the water storage at the lake. In sum, the proposed alternative would raise the normal operating pool by 1.8 feet above the current normal operating lake level of 867 feet above mean sea level (amsl) to 868.8 feet amsl. A project fact sheet is included as an attachment to this letter for additional details on the proposed reallocation. The draft Stockton Lake Reallocation Environmental Assessment will be available for public review and comment in May 2020.

The NHPA requires the Corps to consult with interested parties on its undertakings, including the reallocation of water-supply storage. The Area of Potential Effect (APE) for the proposed reallocation are those elevations where shoreline exposure or inundation may increase due to the resulting change in normal operating lake elevation. At present the lake shoreline has not been fully inventoried for cultural resource sites and many identified sites have not been evaluated for their eligibility for the National Register of Historic Places (NRHP). The lack of cultural resource inventories and eligibility assessments on recorded sites make it difficult to determine the effects of the undertaking at this time. As such, the Corps is planning to develop a programmatic agreement (PA) to fulfill its NHPA responsibilities.

At this time we invite your office to participate in the development of the PA. In the near future we plan to hold a webinar regarding the reallocation project and PA. I will

be contacting you in the near future regarding the proposed webinar and to discuss the development of the PA. In the meantime, if you have any questions please me at (816) 389-3138 or timothy.m.meade@usace.army.mil. We appreciate your consideration of the matter and look forward to working with you.

Sincerely,

MEADE.TIMOTHY.M.1270866332

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Timothy Meade
Senior District Archeologist

Enclosure

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E. 12TH STREET
KANSAS CITY, MISSOURI 64106-2824

Planning Branch
Risk Communication Section

Chairperson Tamara Francis-Fourkiller
Caddo Nation
P.O. Box 487
Binger, Oklahoma 73009

Dear Chairperson Francis-Fourkiller:

This letter is a follow up to the January 2018 letter on the request that the U.S. Army Corps of Engineers, Kansas City District (Corps) received from the Tri-State Water Resources Coalition of Southwest Missouri to study the feasibility of reallocating storage to water-supply storage at Stockton Lake located in Cedar, Dade, and Polk Counties, Missouri. That letter informed you of a range of alternatives under consideration at that time and requested your comments on the proposed undertaking. This letter continues consultation with the Caddo Nation under Section 106 of the National Historic Preservation Act (NHPA). Attached for your review is a project fact sheet.

The Corps has now selected a preferred alternative for reallocating the water storage at the lake. In sum, the proposed alternative would raise the normal operating pool by 1.8 feet above the current normal operating lake level of 867 feet above mean sea level (amsl) to 868.8 feet amsl. A project fact sheet is included as an attachment to this letter for additional details on the proposed reallocation. The draft Stockton Lake Reallocation Environmental Assessment will be available for public review and comment in May 2020.

The NHPA requires the Corps to consult with interested parties on its undertakings, including the reallocation of water-supply storage. The Area of Potential Effect (APE) for the proposed reallocation are those elevations where shoreline exposure or inundation may increase due to the resulting change in normal operating lake elevation. At present the lake shoreline has not been fully inventoried for cultural resource sites and many identified sites have not been evaluated for their eligibility for the National Register of Historic Places (NRHP). The lack of cultural resource inventories and eligibility assessments on recorded sites make it difficult to determine the effects of the undertaking at this time. As such, the Corps is planning to develop a programmatic agreement (PA) to fulfill its NHPA responsibilities.

At this time we invite your office to participate in the development of the PA. In the near future we plan to hold a webinar regarding the reallocation project and PA. I will be contacting you in the near future regarding the proposed webinar and to discuss the development of the PA. In the meantime, if you have any questions please me at (816)

389-3138 or timothy.m.meade@usace.army.mil. We appreciate your consideration of the matter and look forward to working with you.

Sincerely,

MEADE.TIMOTHY.M.1270866332

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Timothy Meade
Senior District Archeologist

Enclosure

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E. 12TH STREET
KANSAS CITY, MISSOURI 64106-2824

Planning Branch
Risk Communication Section

Lance Foster
Tribal Historic Preservation Officer
Iowa Tribe of Kansas
3345 B Thrasher Road
White Cloud, Kansas 66094

Dear Mr. Foster:

This letter is a follow up to the January 2018 letter on the request that the U.S. Army Corps of Engineers, Kansas City District (Corps) received from the Tri-State Water Resources Coalition of Southwest Missouri to study the feasibility of reallocating storage to water-supply storage at Stockton Lake located in Cedar, Dade, and Polk Counties, Missouri. That letter informed you of a range of alternatives under consideration at that time and requested your comments on the proposed undertaking. This letter continues consultation with the Iowa Tribe of Kansas and Nebraska under Section 106 of the National Historic Preservation Act (NHPA). Attached for your review is a project fact sheet.

The Corps has now selected a preferred alternative for reallocating the water storage at the lake. In sum, the proposed alternative would raise the normal operating pool by 1.8 feet above the current normal operating lake level of 867 feet above mean sea level (amsl) to 868.8 feet amsl. A project fact sheet is included as an attachment to this letter for additional details on the proposed reallocation. The draft Stockton Lake Reallocation Environmental Assessment will be available for public review and comment in May 2020.

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Sincerely,

MEADE.TIMOTHY.M.1270866332

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Date: 2020.03.10 12:44:06 -05'00'

Timothy Meade
Senior District Archeologist

Enclosure

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E. 12TH STREET
KANSAS CITY, MISSOURI 64106-2824

Planning Branch
Risk Communication Section

Crystal Douglas
Kaw Nation
Drawer 50
Kaw City, Oklahoma 74641

Dear Ms. Douglas:

This letter is a follow up to the January 2018 letter on the request that the U.S. Army Corps of Engineers, Kansas City District (Corps) received from the Tri-State Water Resources Coalition of Southwest Missouri to study the feasibility of reallocating storage to water-supply storage at Stockton Lake located in Cedar, Dade, and Polk Counties, Missouri. That letter informed you of a range of alternatives under consideration at that time and requested your comments on the proposed undertaking. This letter continues consultation with the Kaw Nation under Section 106 of the National Historic Preservation Act (NHPA). Attached for your review is a project fact sheet.

The Corps has now selected a preferred alternative for reallocating the water storage at the lake. In sum, the proposed alternative would raise the normal operating pool by 1.8 feet above the current normal operating lake level of 867 feet above mean sea level (amsl) to 868.8 feet amsl. A project fact sheet is included as an attachment to this letter for additional details on the proposed reallocation. The draft Stockton Lake Reallocation Environmental Assessment will be available for public review and comment in May 2020.

The NHPA requires the Corps to consult with interested parties on its undertakings, including the reallocation of water-supply storage. The Area of Potential Effect (APE) for the proposed reallocation are those elevations where shoreline exposure or inundation may increase due to the resulting change in normal operating lake elevation. At present the lake shoreline has not been fully inventoried for cultural resource sites and many identified sites have not been evaluated for their eligibility for the National Register of Historic Places (NRHP). The lack of cultural resource inventories and eligibility assessments on recorded sites make it difficult to determine the effects of the undertaking at this time. As such, the Corps is planning to develop a programmatic agreement (PA) to fulfill its NHPA responsibilities.

At this time we invite your office to participate in the development of the PA. In the near future we plan to hold a webinar regarding the reallocation project and PA. I will be contacting you in the near future regarding the proposed webinar and to discuss the development of the PA. In the meantime, if you have any questions please me at (816)

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Sincerely,

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CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E. 12TH STREET
KANSAS CITY, MISSOURI 64106-2824

Planning Branch
Risk Communication Section

Thomas Parker
Tribal Historic Preservation Officer
Omaha Tribe
P.O. Box 368
Macy, Nebraska 68039

Dear Mr. Parker:

This letter is a follow up to the January 2018 letter on the request that the U.S. Army Corps of Engineers, Kansas City District (Corps) received from the Tri-State Water Resources Coalition of Southwest Missouri to study the feasibility of reallocating storage to water-supply storage at Stockton Lake located in Cedar, Dade, and Polk Counties, Missouri. That letter informed you of a range of alternatives under consideration at that time and requested your comments on the proposed undertaking. This letter continues consultation with the Omaha Tribe under Section 106 of the National Historic Preservation Act (NHPA). Attached for your review is a project fact sheet.

The Corps has now selected a preferred alternative for reallocating the water storage at the lake. In sum, the proposed alternative would raise the normal operating pool by 1.8 feet above the current normal operating lake level of 867 feet above mean sea level (amsl) to 868.8 feet amsl. A project fact sheet is included as an attachment to this letter for additional details on the proposed reallocation. The draft Stockton Lake Reallocation Environmental Assessment will be available for public review and comment in May 2020.

The NHPA requires the Corps to consult with interested parties on its undertakings, including the reallocation of water-supply storage. The Area of Potential Effect (APE) for the proposed reallocation are those elevations where shoreline exposure or inundation may increase due to the resulting change in normal operating lake elevation. At present the lake shoreline has not been fully inventoried for cultural resource sites and many identified sites have not been evaluated for their eligibility for the National Register of Historic Places (NRHP). The lack of cultural resource inventories and eligibility assessments on recorded sites make it difficult to determine the effects of the undertaking at this time. As such, the Corps is planning to develop a programmatic agreement (PA) to fulfill its NHPA responsibilities.

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Sincerely,

MEADE.TIMOTHY.M.1270866332

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Timothy Meade
Senior District Archeologist

Enclosure

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E. 12TH STREET
KANSAS CITY, MISSOURI 64106-2824

Planning Branch
Risk Communication Section

Nicholas Mauro
Tribal Historic Preservation Officer
Ponca Tribe of Nebraska
P.O. Box 288
Niobrara, Nebraska 68760

Dear Mr. Mauro:

This letter is a follow up to the January 2018 letter on the request that the U.S. Army Corps of Engineers, Kansas City District (Corps) received from the Tri-State Water Resources Coalition of Southwest Missouri to study the feasibility of reallocating storage to water-supply storage at Stockton Lake located in Cedar, Dade, and Polk Counties, Missouri. That letter informed you of a range of alternatives under consideration at that time and requested your comments on the proposed undertaking. This letter continues consultation with the Ponca Tribe of Nebraska under Section 106 of the National Historic Preservation Act (NHPA). Attached for your review is a project fact sheet.

The Corps has now selected a preferred alternative for reallocating the water storage at the lake. In sum, the proposed alternative would raise the normal operating pool by 1.8 feet above the current normal operating lake level of 867 feet above mean sea level (amsl) to 868.8 feet amsl. A project fact sheet is included as an attachment to this letter for additional details on the proposed reallocation. The draft Stockton Lake Reallocation Environmental Assessment will be available for public review and comment in May 2020.

The NHPA requires the Corps to consult with interested parties on its undertakings, including the reallocation of water-supply storage. The Area of Potential Effect (APE) for the proposed reallocation are those elevations where shoreline exposure or inundation may increase due to the resulting change in normal operating lake elevation. At present the lake shoreline has not been fully inventoried for cultural resource sites and many identified sites have not been evaluated for their eligibility for the National Register of Historic Places (NRHP). The lack of cultural resource inventories and eligibility assessments on recorded sites make it difficult to determine the effects of the undertaking at this time. As such, the Corps is planning to develop a programmatic agreement (PA) to fulfill its NHPA responsibilities.

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Date: 2020.03.10 12:55:07 -05'00'

Timothy Meade
Senior District Archeologist

Enclosure

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E. 12TH STREET
KANSAS CITY, MISSOURI 64106-2824

Planning Branch
Risk Communication Section

Chairperson Tiauna Carnes
Sac and Fox Nation of Missouri in Kansas and Nebraska
305 N. Main Street
Reserve, Kansas 66434

Dear Chairperson Carnes:

This letter is a follow up to the January 2018 letter on the request that the U.S. Army Corps of Engineers, Kansas City District (Corps) received from the Tri-State Water Resources Coalition of Southwest Missouri to study the feasibility of reallocating storage to water-supply storage at Stockton Lake located in Cedar, Dade, and Polk Counties, Missouri. That letter informed you of a range of alternatives under consideration at that time and requested your comments on the proposed undertaking. This letter continues consultation with the Sac and Fox Nation of Missouri in Kansas and Nebraska under Section 106 of the National Historic Preservation Act (NHPA). Attached for your review is a project fact sheet.

The Corps has now selected a preferred alternative for reallocating the water storage at the lake. In sum, the proposed alternative would raise the normal operating pool by 1.8 feet above the current normal operating lake level of 867 feet above mean sea level (amsl) to 868.8 feet amsl. A project fact sheet is included as an attachment to this letter for additional details on the proposed reallocation. The draft Stockton Lake Reallocation Environmental Assessment will be available for public review and comment in May 2020.

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389-3138 or timothy.m.meade@usace.army.mil. We appreciate your consideration of the matter and look forward to working with you.

Sincerely,

MEADE.TIMOTHY.M.1270866332

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Timothy Meade
Senior District Archeologist

Enclosure

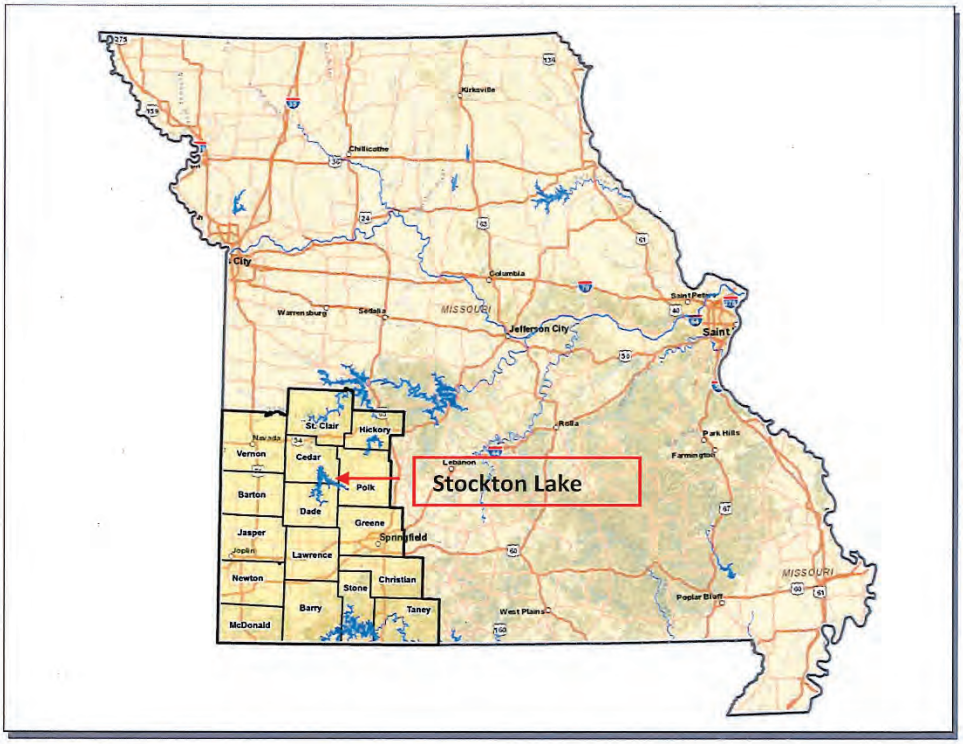
US Army Corps of Engineers ®
Kansas City District

PLANNING BRANCH
Plan Formulation Section
Building Strong

PROJECT NAME: Stockton Lake Project, Water Supply Reallocation Study, Sac River, Cedar/Dade/Polk Counties, Missouri.

FEDERAL ACTION: The Flood Control Act of 1944, the Flood Control Act of 1958, Section 301 (a) and the Water Resource Development Act of 1986, Section 932 relate to the study and the authority for the Corps to participate in finding solutions to water resource planning for municipal and industrial water supply use.

LOCATION: Stockton Lake is owned and operated by the U.S. Army Corps of Engineers (USACE) Kansas City District (NWK) and is located approximately two miles east of Stockton, Missouri, on the Sac River, in Cedar/Dade/Polk Counties, Missouri.



STOCKTON LAKE BACKGROUND INFORMATION: Stockton Lake Project was authorized by the Flood Control Act of 1954 and is a multi-purpose use reservoir that provides flood risk management, water supply, hydropower, recreation and fish and wildlife benefits. The primary purpose of Stockton is for flood risk management. Construction was initiated in fiscal year (FY) 1963 and impoundment was initiated in December 1969. Stockton Lake is one of three reservoirs in the southwest Missouri region that could provide water supply benefits to neighboring communities.

REALLOCATION PROJECT DESCRIPTION: Tri-State Water Resources Coalition is a non-profit (501C4) organization whose mission is to secure adequate, quality water supplies for the next generation in the 16-county region of southwest Missouri. In 2012 and 2014, studies were conducted with the Missouri Department of Natural Resources as the non-Federal cost-sharing partner to identify forecasted water demand and supply within the southwest Missouri area. Due to continued regional growth, the studies identified municipal and industrial water needs in the future that exceed existing supplies. Water supply reallocation at Stockton Lake was identified as a potential solution for future water supply needs in the region.

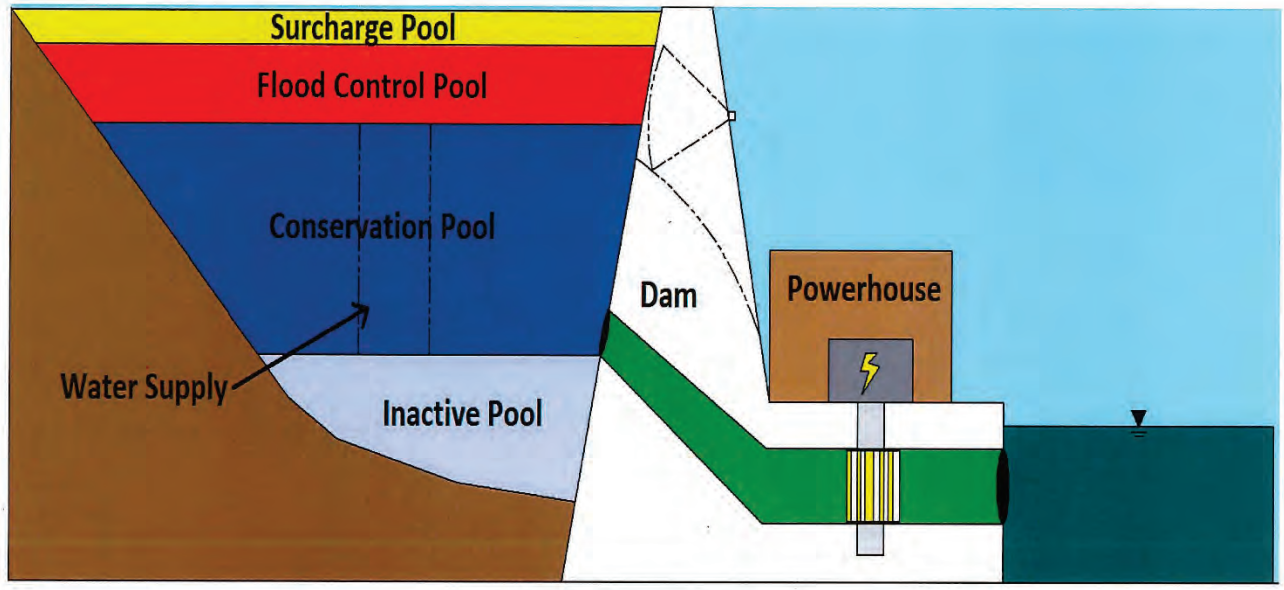
REALLOCATION PROJECT PURPOSE: Kansas City District is preparing a Feasibility Study to assess the viability of potential water supply storage reallocation alternatives at Stockton Lake. The Feasibility Study will also assess the availability of other potential external sources of water supply that could provide the same quality and quantity of water as Stockton Lake. Examples of "external alternatives" besides water supply storage from Stockton Lake that are currently under evaluation include: 1) Construction of a new reservoir; 2) Use of water conservation measures; 3) New groundwater fields; and 4) Reallocations from other reservoirs.

If storage out of Stockton Lake is deemed as the most cost effective alternative, then an evaluation will be conducted on which pool the lake storage should come from, referred to as "internal alternatives". Internal alternatives that will be evaluated include: 1) Storage out of the flood control pool (the lake level rises and the level of water in the conservation pool increases); 2) Storage out of the conservation pool (the lake level remains the same and the amount of water in the conservation pool remains the same); 3) Storage out of the inactive pool (the lake level remains the same, but the bottom of the conservation pool elevation is lowered, thus the amount of water in the conservation pool increases); 4) Storage out of a combination of pools, such as storage out of the flood control pool (pool raise) and the conservation pool.

The Stockton Lake Water Supply Reallocation Study will evaluate potential effects on authorized purposes (i.e. flood risk management, hydropower, recreation, water quality, fish and wildlife, etc.) and potential effects to the environment at Stockton Lake depending on which pool the water supply storage would be reallocated from. The attached map identifies the Corps property boundary at Stockton Lake.

CONSTRUCTION METHOD: If a feasible Stockton Lake reallocation alternative is identified, additional construction of intake(s) and pipeline(s) would be required to carry water from the lake to the communities in need. This requirement will be further developed and analyzed by the Tri-State Water Resources Coalition and included in the Feasibility Study for potential effects within the Kansas City District Corps of Engineers project boundary. Preliminary analysis conducted by Tri-State Water Resources Coalition, Missouri Department of Natural Resources and Kansas City District suggest that the intake would most likely be placed next to the existing intake that is owned by City Utilities of Springfield, Missouri. Additional NEPA and associated permitting under Section 404 and 401 of the Clean Water Act for construction of new water transmission or other related facilities would be required and completed by Tri-State Water Resources Coalition for pipeline(s) alignments located outside of the Stockton Lake project boundary.

WHAT DOES WATER SUPPLY STORAGE LOOK LIKE?



WHAT DOES REALLOCATING WATER SUPPLY STORAGE MEAN?

- **Flood Control Pool Reallocation:** Reallocating water from the flood pool to the conservation pool; would raise the level of the lake, and acre-feet volume in the conservation pool would be larger.
- **Conservation Pool Reallocation:** Reallocating water within the conservation pool; would not result in a pool raise, and acre-feet or volume in the conservation pool remains the same.
- **Inactive Pool Reallocation:** Reallocating water from the inactive pool; would lower the bottom elevation of the conservation pool, and acre-feet or volume in the conservation pool would be larger.
- **Combination Pool Reallocation:** Reallocating water from multiple pools such as the flood control pool and the multipurpose pool; would result in a raise of the level of the lake and a reallocation of storage within the conservation pool.

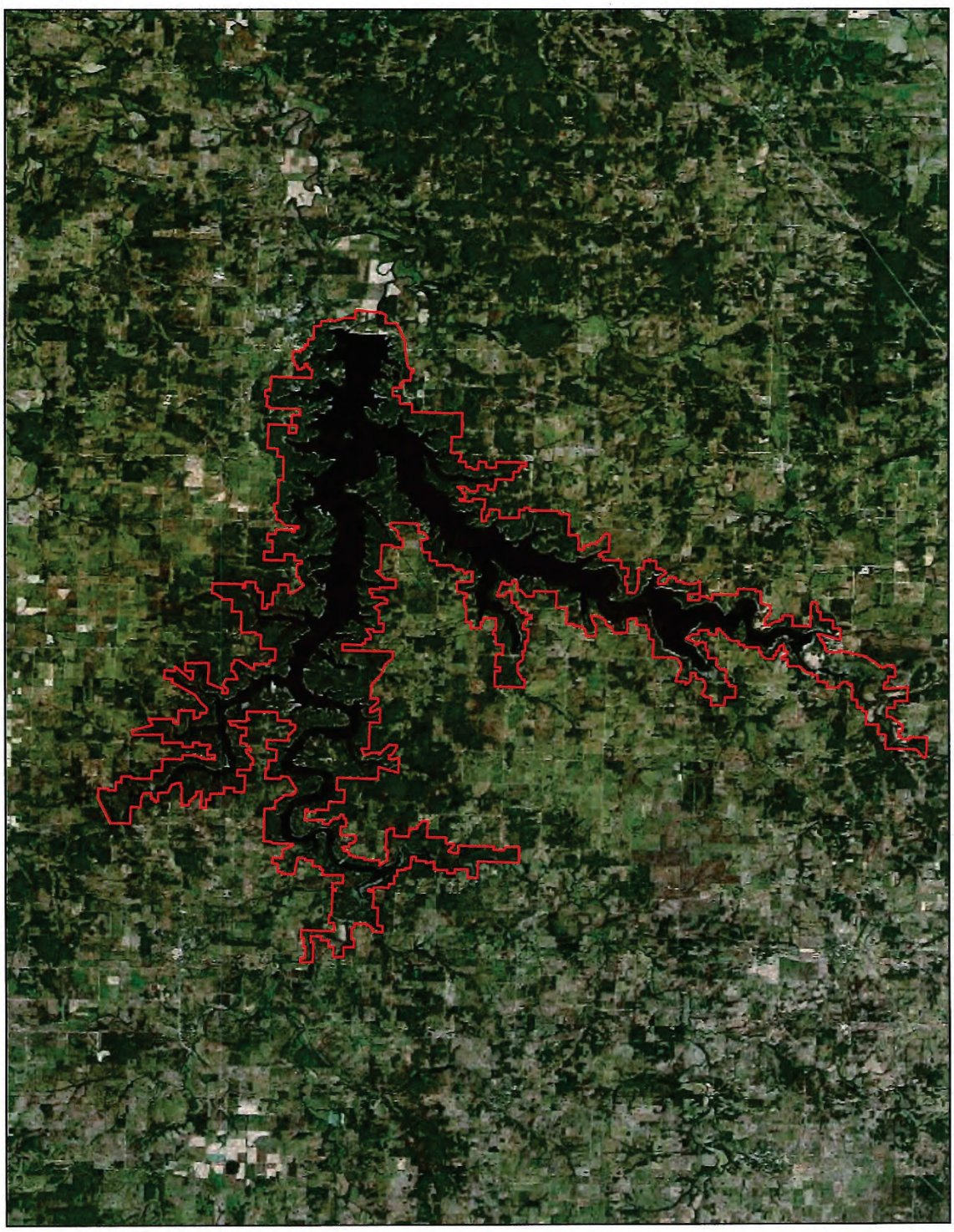
TIMELINE: A draft report is anticipated to be ready in June 2018; the report will be available for public comment.

USACE POINTS OF CONTACT

Planning Branch		
John Grothaus	Chief, Plan Formulation Section	(816) 389-3110
Jennifer Henggeler*	Project Manager	(816) 389-3778
David Hoover	Conservation Biologist / NEPA review	(816) 389-3497
Natural Resources Section		
Tim Meade*	Senior Archaeologist / Tribal Liaison / Cult. Res.	(816) 389-3138
Jeff Tripe*	Environmental Planner	(816) 389-2455

*primary P.O.C.s

Stockton Lake - Corps Boundary



ATTACHMENT 5: Response to Initiation Letters

Attachment 5 includes formal response letters from the following:

- Director and Deputy SHPO, Missouri Department of Natural Resources
- Executive Director, Advisory Council on Historic Properties

Missouri Department of NATURAL RESOURCES

dnr.mo.gov

Michael L. Parson, Governor

Carol S. Comer, Director

April 9, 2020

U.S. Army Corps of Engineers
Kansas City District
Attn: Timothy Meade
601 East 12th Street, RM 402
Kansas City, MO 64103

RE: **SHPO Number: 057-MLT-17** – Tri-State Water Resources Coalition Feasibility study of Reallocating Water Levels on Stockton Lake, Cedar, Dade, and Polk Counties, Missouri

Dear Mr. Meade:

Thank you for submitting the additional monitoring report requested by my office, regarding the above-referenced project, for our records pursuant to Section 106 of the National Historic Preservation Act (P.L. 89-665, as amended) and the Advisory Council on Historic Preservation's regulation 36 CFR Part 800, which require identification and evaluation of cultural resources.

Based on the information provided, we continue to have concerns regarding the potential effects of the proposed project on the archaeological sites in the project area. We look forward to working with your office to develop a programmatic agreement to address the Corps responsibilities under the National Historic Preservation Act.

If you have any questions please write Missouri Department of Natural Resources, State Historic Preservation Office, Attn: Review and Compliance, P.O. Box 176, Jefferson City, Missouri 65102, or call Amy Rubingh (573) 751-4589. Please be sure to include the SHPO Project Number (008-LE-16) on all future correspondence relating to this project.

Sincerely,

STATE HISTORIC PRESERVATION OFFICE

Toni M. Prawl

Toni M. Prawl, PhD
Director and Deputy
State Historic Preservation Officer

CC: Dr. Michael Ohnersorgen and Kim Dillon – Missouri State Parks

Recycled paper

Hon. Aimee K. Jorjani
Chairman

Leonard A. Forsman
Vice Chairman

John M. Fowler
Executive Director

May 22, 2020

The Honorable R.D. James
Assistant Secretary for the Army for Civil Works
Office of the Assistant Secretary of the Army (Civil Works)
108 Army Pentagon
Washington, DC 20310-0108

Ref: *Stockton Lake, Missouri Water Supply Storage Reallocation Feasibility Study*
Cedar, Dade, and Polk Counties, Missouri
ACHP Project Number: 015408

Dear Mr. James:

In response to the recent notification by the U.S. Army Corps of Engineers, Kansas City District, the Advisory Council on Historic Preservation (ACHP) will participate in consultation to develop a Section 106 agreement document for the referenced undertaking. Our decision to participate in this consultation is based on the *Criteria for Council Involvement in Reviewing Individual Section 106 Cases*, contained within the regulations, "Protection of Historic Properties" (36 CFR Part 800) implementing Section 106 of the National Historic Preservation Act. The criteria are met for this proposed undertaking because it has the potential for presenting procedural problems and presents issues of concern to Indian tribes.

Section 800.6(a)(1)(iii) of these regulations requires that we notify you as the head of the agency of our decision to participate in consultation. By copy of this letter, we are also notifying Colonel William B. Hannan, Kansas City District Commander, of this decision.

Our participation in this consultation will be handled by Mr. Christopher Daniel who can be reached at (202) 517-0223 or via email at cdaniel@achp.gov. We look forward to working with your agency and other consulting parties to reach agreement on ways to avoid, reduce, or mitigate adverse effects on historic properties.

Sincerely,

John M. Fowler
Executive Director

ADVISORY COUNCIL ON HISTORIC PRESERVATION
401 F Street NW, Suite 308 • Washington, DC 20001-2637
Phone: 202-517-0200 • Fax: 202-517-6381 • achp@achp.gov • www.achp.gov

Stockton Lake Reallocation Study

Draft Integrated Water Supply Storage Reallocation Report and Environmental Assessment

Appendix H-Real Estate Plan

June 2020

US Army Corps of Engineers ®
Kansas City District

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1.0 Purpose

This Real Estate Plan (REP) is developed in support of the Integrated Feasibility Report for the subject project under authority of the Water Supply Act of 1958. Authority for the Corps to reallocate existing storage space to include municipal and industrial (M&I) water supply is contained in Public Law 85-500, Title III, Water Supply Act of 1958, as amended. Section 301(a), established a policy of cooperation in development of water supplies for domestic, municipal, industrial and other purposes. Section 301(b) is the authority of the Corps to include M&I water storage in reservoir projects and to reallocate storage in existing projects to M&I water supply. The purpose of this plan is to include information on any real estate activities that may be involved for the identified project. The project is located in Cedar County, Dade County, and Polk County, Missouri. The non-Federal sponsor (NFS) for this project is the Tri-State Water Resources Coalition.

The federally owned Stockton Lake project was authorized for flood control, power generation, recreation and fish and wildlife by the Flood Control Act of 1954, Public Law 780, Title II, Section 203, 83rd Congress 2nd session as recommended by the Chief of Engineers in House Document 549 for the 81st Congress 2nd session. Stockton Lake is the second largest lake of a system of Federal multi-purpose lakes in the Osage River Basin.

The NFS requested Corps assistance to reallocate water storage in Stockton Lake. This reallocation aims to purchase enough storage to yield between 30 million gallons of water per day (mgd) and 39 mgd to meet immediate and future water supply storage needs of the Tri-State Water Resources Coalition and reduce, to the extent practicable, water supply shortages forecasted over the next 50 years.

The recommended plan is a reallocation from a combination of the flood pool and the multipurpose pool. The plan is to reallocate 45,750 acre-feet from the multipurpose to water supply storage and 49,000 acre-feet of storage from the flood pool. Reallocating storage from the flood pool means that the normal pool elevation will be raised from 867.00 ft (National Geodetic Vertical Datum of 1929, (NGVD 29)) to 868.8 ft (NGVD 29) or a 1.8 foot pool raise. The total reallocation of 94,750 acre-feet will yield approximately 39 million gallons per day (MGD) during the drought of record. This plan is recommended as the Tentatively Selected Plan (TSP) because it minimized drawdown effects on the reservoir and subsequently other authorized purposes during drought.

2.0 Description of Lands, Easements, Rights of Way, Relocation and Disposal (LERRD)

At this time there are no lands to be acquired for the project. The project will be operated and maintained by USACE. All proposed work will be conducted land owned by USACE. A takings analysis was performed by the Office of Council to ensure adjacent property owners are not impacted by the pool raise. It is the opinion of the Office of Council that no further real estate interests are required to facilitate the current project design.

3.0 LERRD Owned by Non-Federal Sponsor

There is no land within the project boundary that is owned by the NFS.

4.0 Non-Standard Estates

No non-standard estates will be proposed for this project area.

5.0 Existing Federal Projects in the Area

Stockton Lake is an authorized federal project under the Flood Control Act of 1954. This reallocation project is within the project footprint.

6.0 Federally Owned Land in Project Area

The project area consists entirely of federal lands that are a part of the greater Stockton Lake Project.

7.0 Navigational Servitude

Navigational Servitude will not apply because Stockton Lake is not a navigable waterway which is under the control of the federal government due to commerce regulation.

8.0 Real Estate Maps

Figure 8-1 shows a map of the proposed project area.

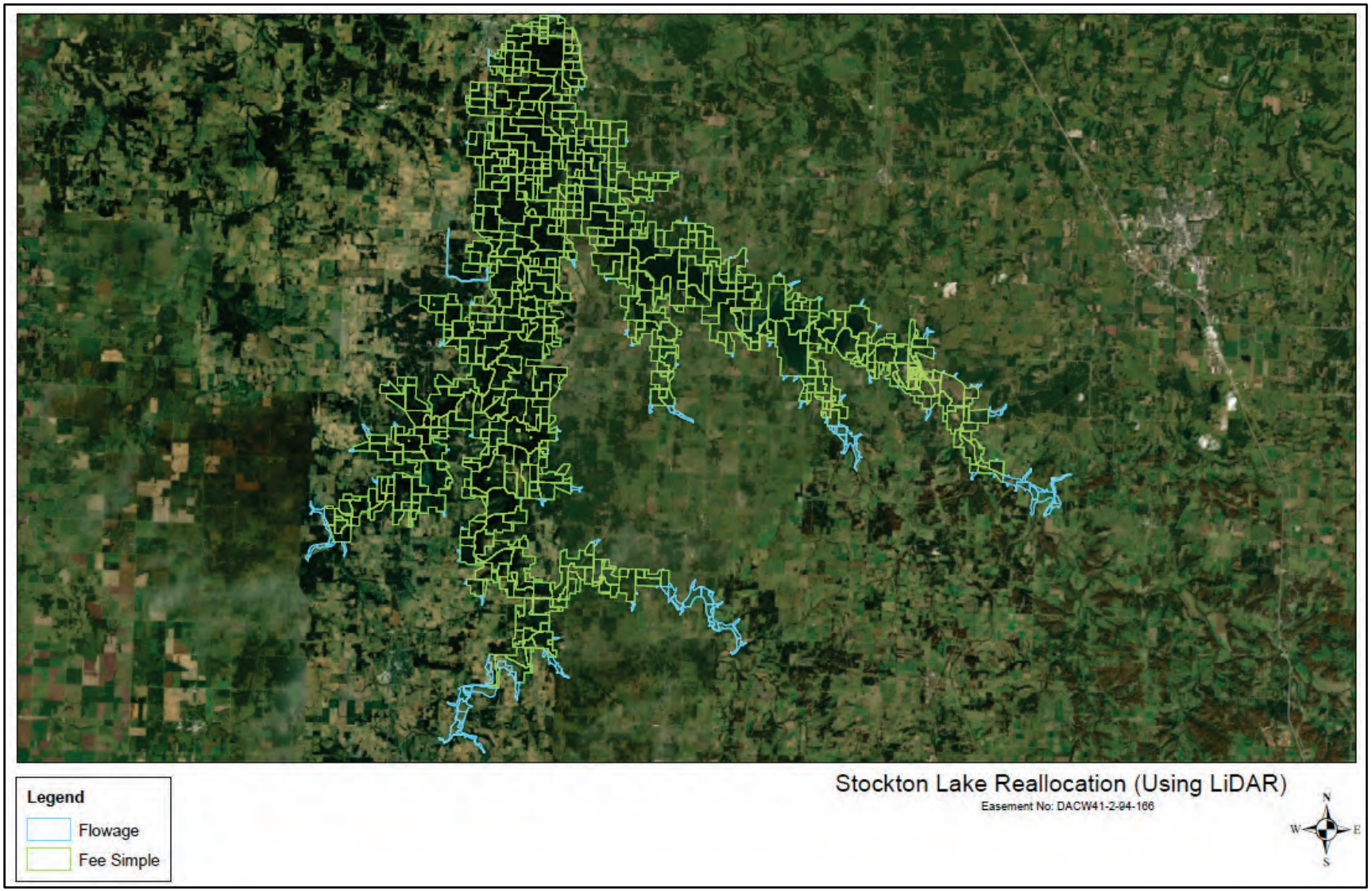

Figure 8-1: Vicinity Map of Stockton Lake Project.

9.0 Flooding Induced by Project

Significant flooding induced by the current project design is presumed to be unlikely. LiDAR surveys of the project identified two flowage easement parcels, shown in Figure 9-1 and Figure 9-2, on which additional discharge or pooling may take place. The Hydrology and Hydraulics section provided Office of Council with the depth, duration, and frequency of the expected inundation on the subject parcels. The Office of Council has performed a takings analysis and provided the project team with a post-acquisition title opinion. It is the opinion of the Office of Council that the current flowage easements held by USACE on the affected parcels are sufficient to account for increased flowage and discharge projected by the hydrological models. The Office of Council has determined that no further real estate interests will be required to facilitate the current project design.

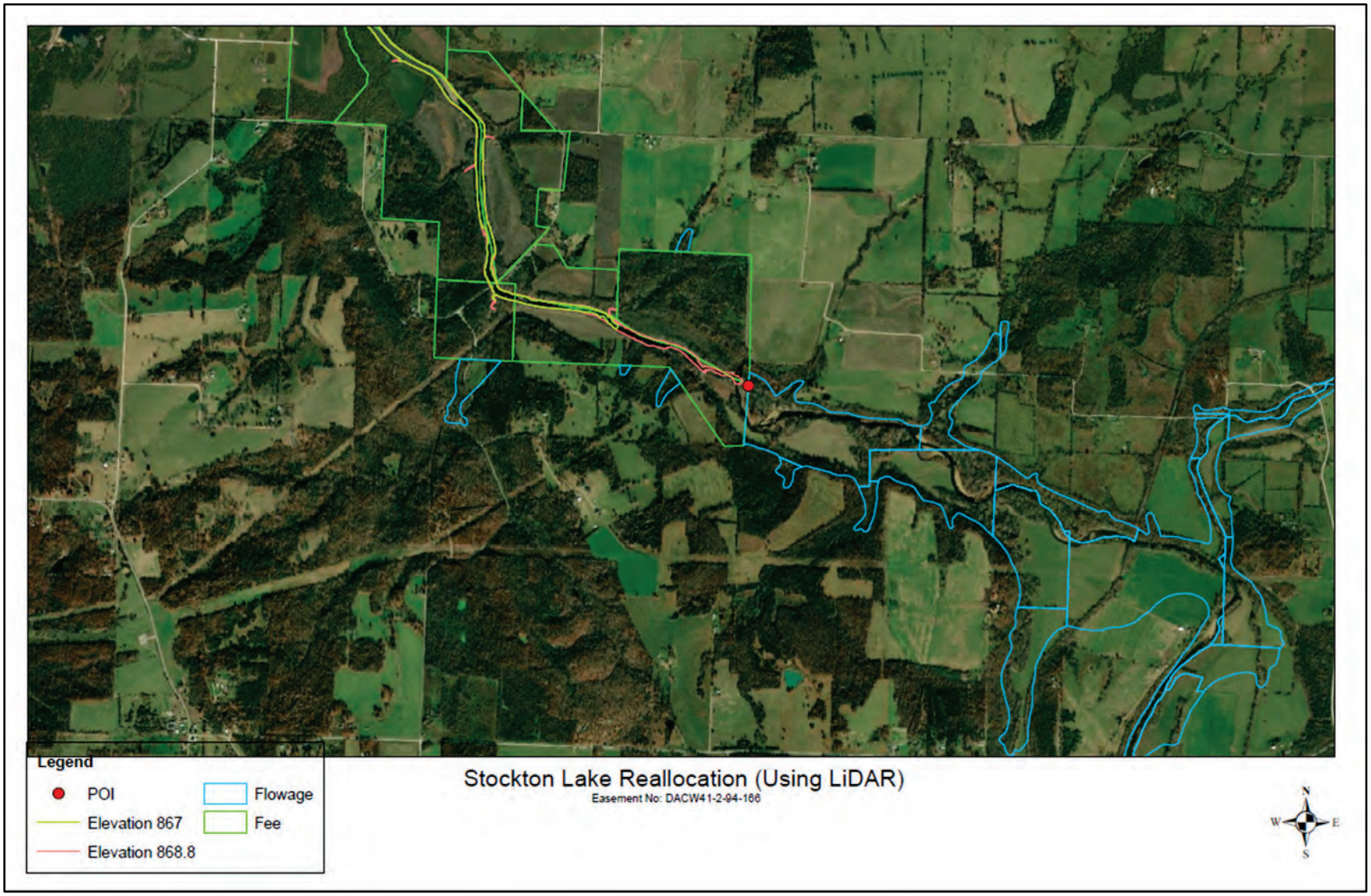

Figure 9-1: Flowage Easement Parcel "Location 3" with Possible Inundation.

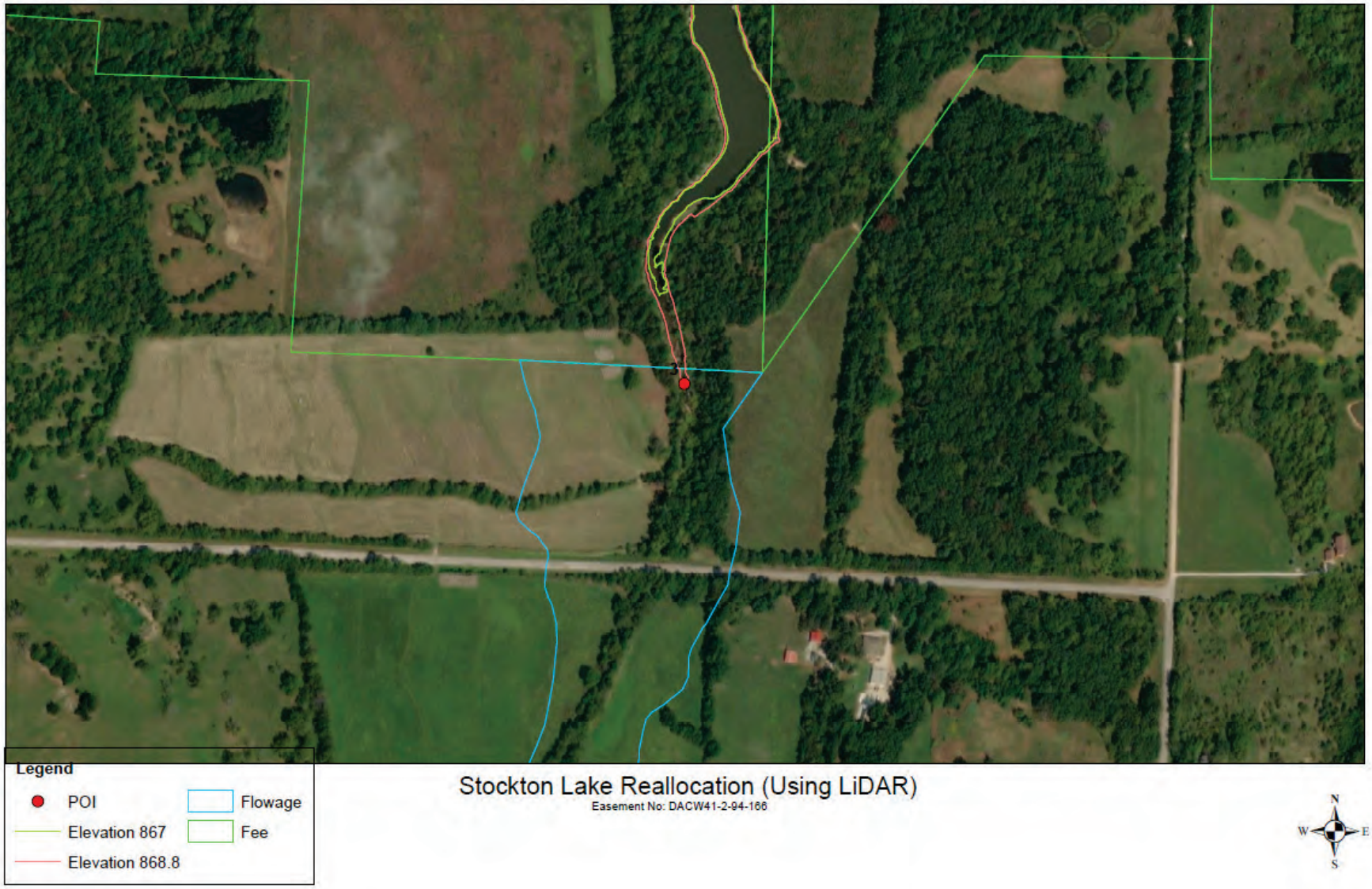

Figure 9-2: Flowage Easement Parcel "Location 4" with Possible Inundation.

10.0 Baseline Cost Estimate on Acquisition of LERRD

All property within the project boundary is presently owned in fee by the United States of America. Therefore, the NFS will not incur any real estate or incidental acquisition costs for lands, easements, right of entry, relocations or disposal areas.

11.0 Relocation Assistance (P.L. 91-646)

There are no displaced persons, businesses, or farms entitled to relocation assistance as defined in the uniform Relocation Assistance and Real Property Acquisitions Policies Act of 1948, as amended (Public Law 91-646) necessary for this project.

12.0 Mineral Activity Impacted Present/Future

There is no current or anticipated mineral activity or timber value impact in the vicinity of the proposed project.

13.0 Assessment of Non-Federal Sponsor Legal Capability

The project is located on federally owned property. No acquisition of LERRD is currently required.

14.0 Zoning Ordinances Considered in Support of LERRD Requirements

There are no zoning ordinances in place or proposed in connection with the project.

15.0 Acquisition Schedule

There is no acquisition for this project; therefore, no schedule has been developed.

16.0 Facility/Utility Relocation

The preliminary project design, for which this report has been drafted, indicates that no facility or utility relocations will be required for this project.

17.0 Impact of Hazardous, Toxic and Radioactive Waste (HTRW)

No observations or findings were identified to indicate any previous contamination of any kind, or waste dumping activity. The Corps has no reason to believe that there is any presence of any HTRW materials or special category wastes in the area, located either above or below ground on the site or within the project area.

18.0 Opposition/Support of Project by Local Landowners

This project takes place on federally owned land. There are no private land owners within the project area. There is no LERRD acquisition process planned at this time.

19.0 Notification to Non-Federal Sponsor of Risk and Early Acquisition of LERRD

The current project plan does not require the acquisition of land. No risk letter regarding acquisitions was sent to the NFS.

20.0 Other Real Estate Issues

There are no other known real estate issues regarding the subject reallocation project.

Stockton Lake Reallocation Study

Draft Integrated Water Supply Storage Reallocation Report and Environmental Assessment

Appendix J-Environmental Appendix

June- 2020

US Army Corps of Engineers ®
Kansas City District

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Introduction

As part of the environmental analysis, the EPA's NEPAssit website and environmental data resources (EDR) reports was conducted to identify known hazardous, toxic, and radioactive waste sites near Stockton Lake and is discussed in the main report in Section 4.12. Due to its size, the summary of the EDR report can be found in Attachment 1.

In order to identify the potential threatened and endangered species in the Stockton Lake Study area, the United States Fish and Wildlife Information for Planning and Consultation (iPAC) was evaluated. Section 4.6 Threatened and Endangered Species of the main report and Table 4.4 Potential Threatened and Endangered Species in Stockton Lake Study Area includes a summary of the results. Attachment 2 is the entire iPAC report.

Attachment 1

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Stockton Lake
Stockton Lake
Bolivar, MO 65613

Inquiry Number: 5794630.7s
September 20, 2019

EDR Area / Corridor Report

6 Armstrong Road, 4th floor
Shelton, CT 06484
Toll Free: 800.352.0050
www.edrnet.com

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Thank you for your business.
Please contact EDR at 1-800-352-0050
with any questions or comments.

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EXECUTIVE SUMMARY

A search of available environmental records was conducted by Environmental Data Resources, Inc (EDR). The report was designed to assist parties seeking to meet the search requirements of EPA's Standards and Practices for All Appropriate Inquiries (40 CFR Part 312), the ASTM Standard Practice for Environmental Site Assessments (E 1527-13), the ASTM Standard Practice for Environmental Site Assessments for Forestland or Rural Property (E 2247-16), the ASTM Standard Practice for Limited Environmental Due Diligence: Transaction Screen Process (E 1528-14) or custom requirements developed for the evaluation of environmental risk associated with a parcel of real estate.

SUBJECT PROPERTY INFORMATION

ADDRESS

STOCKTON LAKE
BOLIVAR, MO 65613

TARGET PROPERTY SEARCH RESULTS

The Target Property was identified in the following databases.

Page Numbers and Map Identifcations refer to the EDR Area/Corridor Report where detailed data on individual sites can be reviewed.

Sites listed in ***bold italics*** are in multiple databases.

STANDARD ENVIRONMENTAL RECORDS

Federal ERNS list

ERNS: Emergency Response Notification System

A review of the ERNS list, as provided by EDR, and dated 03/25/2019 has revealed that there is 1 ERNS site within the requested target property.

Site	Address	Map ID / Focus Map(s)	Page
Not reported NRC Report #: 1172637	15857 S. 1525 ROAD	B14 / 6	113

State and tribal leaking storage tank lists

LAST: Leaking Aboveground Storage Tanks

A review of the LAST list, as provided by EDR, and dated 08/13/2019 has revealed that there is 1 LAST site within the requested target property.

Site	Address	Map ID / Focus Map(s)	Page
STOCKTON STATE PARK Facility Id: ST0007643	***19100 S HWY 215***	***C22 / 10***	***120***

State and tribal registered storage tank lists

UST: Petroleum Storage Tanks

A review of the UST list, as provided by EDR, and dated 08/13/2019 has revealed that there are 2 UST sites within the requested target property.

Site	Address	Map ID / Focus Map(s)	Page
US ARMY CORPS OF ENG Facility Id: ST0007344 Tank Status: Curently in use Tank Status: Removed	16435 E STOCKTON LAK	3 / 3	97
STOCKTON STATE PARK Facility Id: ST0007643 Tank Status: Removed	***19100 S HWY 215***	***C22 / 10***	***120***

AST: Aboveground Petroleum Storage Tanks

A review of the AST list, as provided by EDR, and dated 06/04/2019 has revealed that there are 4 AST sites within the requested target property.

Site	Address	Map ID / Focus Map(s)	Page
ORLEANS TRAIL MARINA Facility Id: 7469	15857 S 1525 RD	B15 / 6	114
STOCKTON STATE PARK Facility Id: 7468	18610 E 2000 RD	D28 / 11	130
LAKEYS BAIT SHOP Facility Id: 8172	5032 HWY 123	37 / 27	140
MUTTON CREEK MARINA Facility Id: 1364	18 MUTTON CREEK LOOP	38 / 23	141

ADDITIONAL ENVIRONMENTAL RECORDS

Records of Emergency Release Reports

SPILLS: Environmental Response Tracking Database

A review of the SPILLS list, as provided by EDR, and dated 08/01/2019 has revealed that there are 16 SPILLS sites within the requested target property.

Site	Address	Map ID / Focus Map(s)	Page
Not reported Facility Id: 9408011238BJA Spill Number: 9408011238BJA	STOCKTON DAM - POWER	A4 / 3	104
Not reported Facility Id: 1402251421BJA Spill Number: 1402251421BJA	STOCKTON LAKE	6 / 3	106
Not reported	15857 SOUTH 1525 ROA	B16 / 6	114

Facility Id: 1703071225ECT Spill Number: 1703071225ECT			
Not reported Facility Id: 1208230828SMC Spill Number: 1208230828SMC	15660 SOUTH 1801 ROA	17 / 7	115
STOCKTON STATE PARK Facility Id: 1604261454ESM Spill Number: 1604261454ESM	***19100 S HWY 215***	***C22 / 10***	***120***
Not reported Facility Id: 0705041025DLT Spill Number: 0705041025DLT	STOCKTON STATE PARK	24 / 10	125
Not reported Facility Id: 0207051140GEV Spill Number: 0207051140GEV	WATER TOWER AT STATE	25 / 11	127
Not reported Facility Id: 1210291739RLG Spill Number: 1210291739RLG	STOCKTON LAKE STATE	D27 / 11	129
Not reported Facility Id: 0102081450RDS Spill Number: 0102081450RDS	STOCKTON LAKE, STOCK	D29 / 11	131
Not reported Facility Id: 1006021012BFD Spill Number: 1006021012BFD	STOCKTON LAKE BOAT R	31 / 16	133
Not reported Facility Id: 1704051225EJS Spill Number: 1704051225EJS	STOCKTON LAKE	32 / 17	134
Not reported Facility Id: 1307261430EJS Spill Number: 1307261430EJS	1126 STATE HIGHWAY 2	33 / 17	136
Not reported Facility Id: 1202090944SDN Spill Number: 1202090944SDN	STOCKTON LAKE	35 / 25	138
Not reported Facility Id: 1712051000RDH Spill Number: 1712051000RDH	5895 WEST FARM ROAD	40 / 27	142
Not reported Facility Id: 1405051308DLK Spill Number: 1405051308DLK	FARM ROAD 113	47 / 29	146
Not reported Facility Id: 0211270908BJA Spill Number: 0211270908BJA	PASTURE OFF OF ROUTE	49 / 39	149

Other Ascertainable Records

DOD: Department of Defense Sites

A review of the DOD list, as provided by EDR, and dated 12/31/2005 has revealed that there is 1 DOD

site within the requested target property.

Site	Address	Map ID / Focus Map(s)	Page
STOCKTON LAKE		Region / **********	95

FINDS: Facility Index System/Facility Registry System

A review of the FINDS list, as provided by EDR, and dated 05/03/2019 has revealed that there are 15 FINDS sites within the requested target property.

Site	Address	Map ID / Focus Map(s)	Page
USCOE STOCKTON LAKE Registry ID:: 110017991324	***16435 E STOCKTON DR***	***A5 / 3***	***105***
ORLEANS TRAIL RESTAU Registry ID:: 110042753945	15828 S. 1525 RD.	B12 / 6	112
ORLEANS TRAIL RESORT Registry ID:: 110040342894	***15857 SOUTH 1525 ROA***	***B13 / 6***	***113***
USACE ORLEANS TRAIL Registry ID:: 110017986483	***ROUTE 3 BOX 260C***	***18 / 6***	***117***
STOCKTON LAKE Registry ID:: 110041610717	UNKNOWN	19 / 6	117
MDNR, STOCKTON STATE Registry ID:: 110015895708	***19100 SOUTH HIGHWAY***	***C23 / 10***	***125***
CEDAR OAK LODGE & GO Registry ID:: 110042596170	20225 S 1527 ROAD	26 / 10	129
MOUNT CARMEL INN SWI Registry ID:: 110011106757	***20515 S. 1851 ROAD***	***30 / 16***	***132***
USCOE MUTTON CREEK M Registry ID:: 110009162789	***HIGHWAY Y***	***36 / 23***	***140***
USCOE MUTTON CREEK P Registry ID:: 110006888895	***ROUTE 3, BOX 260-C***	***39 / 23***	***141***
USACE, RUARK BLUFF E Registry ID:: 110042811286	802 RT. H	E41 / 23	143
USCOE RUARK BLUFF E Registry ID:: 110042799932	802 RT H	E42 / 23	143
SOUTHWINDS RV PARK Registry ID:: 110042771658	766 ROUTE H	43 / 23	144
USCOE RUARK BLUFF NE Registry ID:: 110064268947	***1.23 MILES SOUTH OF***	***44 / 23***	***144***
HANDY HUT Registry ID:: 110037080333	508 N. HIGHWAY 160	F52 / 39	151

EXECUTIVE SUMMARY

ECHO: Enforcement & Compliance History Information

A review of the ECHO list, as provided by EDR, and dated 04/07/2019 has revealed that there are 8 ECHO sites within the requested target property.

Site	Address	Map ID / Focus Map(s)	Page
USCOE STOCKTON LAKE Registry ID: 110017991324	***16435 E STOCKTON DR***	***A5 / 3***	***105***
ORLEANS TRAIL RESORT Registry ID: 110040342894	***15857 SOUTH 1525 ROA***	***B13 / 6***	***113***
USACE ORLEANS TRAIL Registry ID: 110017986483	***ROUTE 3 BOX 260C***	***18 / 6***	***117***
MDNR, STOCKTON STATE Registry ID: 110015895708	***19100 SOUTH HIGHWAY***	***C23 / 10***	***125***
MOUNT CARMEL INN SWI Registry ID: 110011106757	***20515 S. 1851 ROAD***	***30 / 16***	***132***
USCOE MUTTON CREEK M Registry ID: 110009162789	***HIGHWAY Y***	***36 / 23***	***140***
USCOE MUTTON CREEK P Registry ID: 110006888895	***ROUTE 3, BOX 260-C***	***39 / 23***	***141***
USCOE RUARK BLUFF NE Registry ID: 110064268947	***1.23 MILES SOUTH OF***	***44 / 23***	***144***

MINES: Industrial Mineral Mines Database

A review of the MINES list, as provided by EDR, and dated 01/18/2019 has revealed that there are 12 MINES sites within the requested target property.

Site	Address	Map ID / Focus Map(s)	Page
Not reported		1 / 3	95
PRESTON QUARRY		7 / 6	107
Not reported		9 / 7	109
Not reported		10 / 7	110
Not reported		11 / 6	111
P M EDGE QUARRY		20 / 6	118
Not reported		21 / 11	119
Not reported		34 / 15	137
Not reported		45 / 31	144
Not reported		46 / 30	145
PEMBERTON MINES; PEM		48 / 40	148
Not reported		50 / 40	150

NPDES: Permitted Facility Listing

A review of the NPDES list, as provided by EDR, and dated 04/01/2019 has revealed that there is 1 NPDES site within the requested target property.

Site	Address	Map ID / Focus Map(s)	Page
STOCKTON STATE PARK Permit Status: Effective	***19100 S HWY 215***	***C22 / 10***	***120***

Permit Number: MO0135933

UIC: Underground Injection Wells Database

A review of the UIC list, as provided by EDR, and dated 12/31/2018 has revealed that there are 2 UIC sites within the requested target property.

Site	Address	Map ID / Focus Map(s)	Page
TRAIL DRIVE INN REST Facility Status: Abandoned - Unapproved		2 / 3	96
JOE DEYAEGHERE Facility Status: Temporarily Abandoned (Idle)		8 / 7	108

EDR HIGH RISK HISTORICAL RECORDS

EDR Exclusive Records

EDR Hist Auto: EDR Exclusive Historical Auto Stations

A review of the EDR Hist Auto list, as provided by EDR, has revealed that there is 1 EDR Hist Auto site within the requested target property.

Site	Address	Map ID / Focus Map(s)	Page
HANDY HUT LLC	508 N HIGHWAY 160	F51 / 39	151

SURROUNDING SITES: SEARCH RESULTS

Surrounding sites were identified in the following databases.

Page Numbers and Map Identifcations refer to the EDR Area/Corridor Report where detailed data on individual sites can be reviewed.

Sites listed in ***bold italics*** are in multiple databases.

Unmappable (orphan) sites are not considered in the foregoing analysis.

STANDARD ENVIRONMENTAL RECORDS

State and tribal leaking storage tank lists

LUST: Leaking Underground Storage Tanks

A review of the LUST list, as provided by EDR, and dated 08/13/2019 has revealed that there are 3 LUST sites within approximately 0.5 miles of the requested target property.

Site	Address	Direction / Distance	Map ID / Focus Map(s)	Page
FORMER GAS STATION	***RT 1 BOX 83G***	***W 0 - 1/8 (0.114 mi.)***	***G57 / 1***	***158***

Facility Id: ST0020704				
PJ'S FAST STOP	***HWY 32 AND J***	***NNW 1/4 - 1/2 (0.302 mi.)***	***65 / 3***	***174***
Facility Id: ST0019017 Date Of NFA Letter From DNR: 2008-11-20 00:00:00				
MERLE ROBY	***101 MAIN ST***	***NW 1/4 - 1/2 (0.474 mi.)***	***66 / 3***	***177***
Facility Id: ST0000238				

State and tribal registered storage tank lists

UST: Petroleum Storage Tanks

A review of the UST list, as provided by EDR, and dated 08/13/2019 has revealed that there are 3 UST sites within approximately 0.25 miles of the requested target property.

Site	Address	Direction / Distance	Map ID / Focus Map(s)	Page
ELMER CORNELIUS Facility Id: ST0000861 Tank Status: Removed	RT 1	ESE 0 - 1/8 (0.016 mi.)	53 / 23	152
FORMER GAS STATION Facility Id: ST0020704 Tank Status: Removed	***RT 1 BOX 83G***	***W 0 - 1/8 (0.114 mi.)***	***G57 / 1***	***158***
JERRY'S SINCLAIR Facility Id: ST0006632 Tank Status: Removed	304 SOUTH RB RD	NW 1/8 - 1/4 (0.170 mi.)	H63 / 6	168

AST: Aboveground Petroleum Storage Tanks

A review of the AST list, as provided by EDR, and dated 06/04/2019 has revealed that there is 1 AST site within approximately 0.25 miles of the requested target property.

Site	Address	Direction / Distance	Map ID / Focus Map(s)	Page
HAWKER POINT STORE Facility Id: 527	15425 E HWY H	W 1/8 - 1/4 (0.148 mi.)	61 / 15	167

ADDITIONAL ENVIRONMENTAL RECORDS

Other Ascertainable Records

RCRA NonGen / NLR: RCRA - Non Generators / No Longer Regulated

A review of the RCRA NonGen / NLR list, as provided by EDR, and dated 03/25/2019 has revealed that there are 2 RCRA NonGen / NLR sites within approximately 0.25 miles of the requested target property.

Site	Address	Direction / Distance	Map ID / Focus Map(s)	Page
GARLAND PROPERTY	***14505 E 676 RD***	***W 1/8 - 1/4 (0.138 mi.)***	***G60 / 1***	***165***

EPA ID:: MOP000041459				
JERRYS SINCLAIR SER EPA ID:: MOP000021782	304 S RB ROAD	NW 1/8 - 1/4 (0.170 mi.)	H62 / 6	167

MINES: Industrial Mineral Mines Database

A review of the MINES list, as provided by EDR, and dated 01/18/2019 has revealed that there are 5 MINES sites within approximately 0.25 miles of the requested target property.

Site	Address	Direction / Distance	Map ID / Focus Map(s)	Page
Not reported		NNE 0 - 1/8 (0.059 mi.)	55 / 29	156
CARLOCK LAND		E 0 - 1/8 (0.067 mi.)	56 / 30	157
Not reported		N 0 - 1/8 (0.119 mi.)	58 / 32	163
Not reported		WNW 1/8 - 1/4 (0.131 mi.)	59 / 30	164
Not reported		S 1/8 - 1/4 (0.247 mi.)	64 / 23	173

MAPPED SITES SUMMARY

Target Property:
STOCKTON LAKE
BOLIVAR, MO 65613

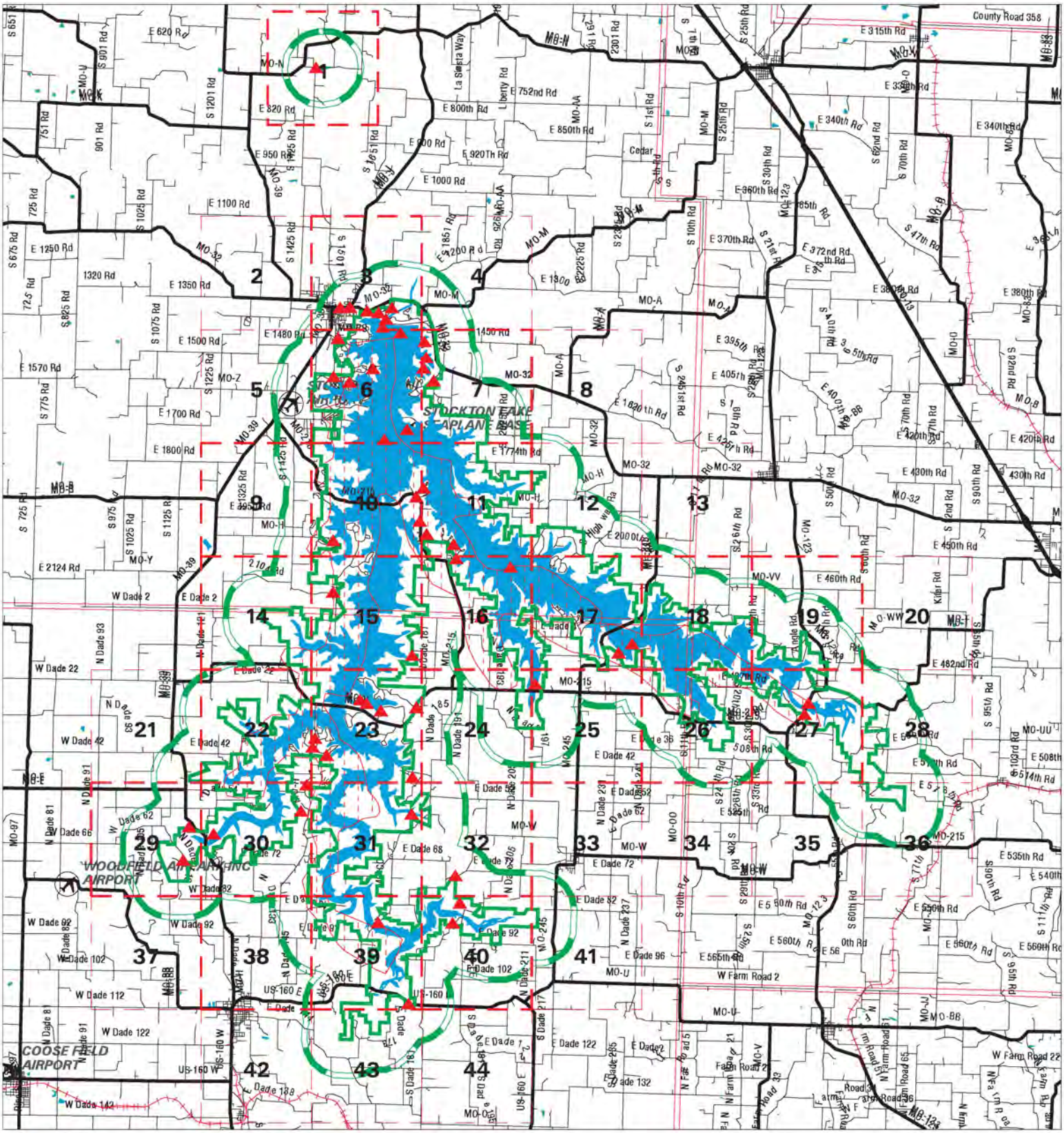
MAP ID / FOCUS MAP	SITE NAME	ADDRESS	DATABASE ACRONYMS	DIST (ft. & mi.) DIRECTION
Reg / **********	STOCKTON LAKE *****		DOD	TP
1 / 3			MINES	TP
2 / 3	TRAIL DRIVE INN REST		UIC	TP
3 / 3	US ARMY CORPS OF ENG	16435 E STOCKTON LAK	UST	TP
A4 / 3		STOCKTON DAM - POWER	SPILLS	TP
A5 / 3	USCOE STOCKTON LAKE	16435 E STOCKTON DR	FINDS, ECHO	TP
6 / 3		STOCKTON LAKE	SPILLS	TP
7 / 6	PRESTON QUARRY		MINES	TP
8 / 7	JOE DEYAEGHERE		UIC	TP
9 / 7			MINES	TP
10 / 7			MINES	TP
11 / 6			MINES	TP
B12 / 6	ORLEANS TRAIL RESTAU	15828 S. 1525 RD.	FINDS	TP
B13 / 6	ORLEANS TRAIL RESORT	15857 SOUTH 1525 ROA	FINDS, ECHO	TP
B14 / 6		15857 S. 1525 ROAD	ERNS	TP
B15 / 6	ORLEANS TRAIL MARINA	15857 S 1525 RD	AST	TP
B16 / 6		15857 SOUTH 1525 ROA	SPILLS	TP
17 / 7		15660 SOUTH 1801 ROA	SPILLS	TP
18 / 6	USACE ORLEANS TRAIL	ROUTE 3 BOX 260C	FINDS, ECHO	TP
19 / 6	STOCKTON LAKE	UNKNOWN	FINDS	TP
20 / 6	P M EDGE QUARRY		MINES	TP
21 / 11			MINES	TP
C22 / 10	STOCKTON STATE PARK	19100 S HWY 215	LAST, UST, SPILLS, NPDES	TP
C23 / 10	MDNR, STOCKTON STATE	19100 SOUTH HIGHWAY	FINDS, ECHO	TP
24 / 10		STOCKTON STATE PARK	SPILLS	TP
25 / 11		WATER TOWER AT STATE	SPILLS	TP
26 / 10	CEDAR OAK LODGE & GO	20225 S 1527 ROAD	FINDS	TP
D27 / 11		STOCKTON LAKE STATE	SPILLS	TP
D28 / 11	STOCKTON STATE PARK	18610 E 2000 RD	AST	TP
D29 / 11		STOCKTON LAKE, STOCK	SPILLS	TP
30 / 16	MOUNT CARMEL INN SWI	20515 S. 1851 ROAD	FINDS, ECHO	TP
31 / 16		STOCKTON LAKE BOAT R	SPILLS	TP
32 / 17		STOCKTON LAKE	SPILLS	TP
33 / 17		1126 STATE HIGHWAY 2	SPILLS	TP
34 / 15			MINES	TP
35 / 25		STOCKTON LAKE	SPILLS	TP
36 / 23	USCOE MUTTON CREEK M	HIGHWAY Y	FINDS, ECHO	TP
37 / 27	LAKEYS BAIT SHOP	5032 HWY 123	AST	TP
38 / 23	MUTTON CREEK MARINA	18 MUTTON CREEK LOOP	AST	TP

MAPPED SITES SUMMARY

Target Property:
STOCKTON LAKE
BOLIVAR, MO 65613

MAP ID / FOCUS MAP	SITE NAME	ADDRESS	DATABASE ACRONYMS	DIST (ft. & mi.) DIRECTION		
39 / 23	USCOE MUTTON CREEK P	ROUTE 3, BOX 260-C	FINDS, ECHO	TP		
40 / 27		5895 WEST FARM ROAD	SPILLS	TP		
E41 / 23	USACE, RUARK BLUFF E	802 RT. H	FINDS	TP		
E42 / 23	USCOE RUARK BLUFF E	802 RT H	FINDS	TP		
43 / 23	SOUTHWINDS RV PARK	766 ROUTE H	FINDS	TP		
44 / 23	USCOE RUARK BLUFF NE	1.23 MILES SOUTH OF	FINDS, ECHO	TP		
45 / 31			MINES	TP		
46 / 30			MINES	TP		
47 / 29		FARM ROAD 113	SPILLS	TP		
48 / 40	PEMBERTON MINES; PEM		MINES	TP		
49 / 39		PASTURE OFF OF ROUTE	SPILLS	TP		
50 / 40			MINES	TP		
F51 / 39	HANDY HUT LLC	508 N HIGHWAY 160	EDR Hist Auto	TP		
F52 / 39	HANDY HUT	508 N. HIGHWAY 160	FINDS	TP		
53 / 23	ELMER CORNELIUS	RT 1	UST	84	0.016	ESE
55 / 29			MINES	312	0.059	NNE
56 / 30	CARLOCK LAND		MINES	353	0.067	East
G57 / 1	FORMER GAS STATION	RT 1 BOX 83G	LUST, UST	604	0.114	West
58 / 32			MINES	630	0.119	North
59 / 30			MINES	691	0.131	WNW
G60 / 1	GARLAND PROPERTY	14505 E 676 RD	RCRA NonGen / NLR, FINDS, ECHO	728	0.138	West
61 / 15	HAWKER POINT STORE	15425 E HWY H	AST	780	0.148	West
H62 / 6	JERRYS SINCLAIR SER	304 S RB ROAD	RCRA NonGen / NLR	899	0.170	NW
H63 / 6	JERRY'S SINCLAIR	304 SOUTH RB RD	UST	899	0.170	NW
64 / 23			MINES	1306	0.247	South
65 / 3	PJ'S FAST STOP	HWY 32 AND J	LUST, UST	1595	0.302	NNW
66 / 3	MERLE ROBY	101 MAIN ST	LUST, UST	2505	0.474	NW

Key Map - 5794630.7s



▲ Sites	Focus Map - Sites
Target Property	National Priority List Sites
Search Buffer	Dept. Defense Sites
Focus Map - No Sites	Indian Reservations BIA

0 3 1/2 7 Miles

SITE NAME: Stockton Lake ADDRESS: Stockton Lake CITY/STATE: Bolivar MO ZIP: 65613	CLIENT: CDM Smith CONTACT: Kelley, Laura INQUIRY #: 5794630.7s DATE: 09/20/19 11:28 AM

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MAP FINDINGS SUMMARY

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
STANDARD ENVIRONMENTAL RECORDS								
Federal NPL site list								
NPL	1.000		0	0	0	0	NR	0
Proposed NPL	1.000		0	0	0	0	NR	0
NPL LIENS	1.000		0	0	0	0	NR	0
Federal Delisted NPL site list								
Delisted NPL	1.000		0	0	0	0	NR	0
Federal CERCLIS list								
FEDERAL FACILITY	0.500		0	0	0	NR	NR	0
SEMS	0.500		0	0	0	NR	NR	0
Federal CERCLIS NFRAP site list								
SEMS-ARCHIVE	0.500		0	0	0	NR	NR	0
Federal RCRA CORRACTS facilities list								
CORRACTS	1.000		0	0	0	0	NR	0
Federal RCRA non-CORRACTS TSD facilities list								
RCRA-TSDF	0.500		0	0	0	NR	NR	0
Federal RCRA generators list								
RCRA-LQG	0.250		0	0	NR	NR	NR	0
RCRA-SQG	0.250		0	0	NR	NR	NR	0
RCRA-VSQG	0.250		0	0	NR	NR	NR	0
Federal institutional controls / engineering controls registries								
LUCIS	0.500		0	0	0	NR	NR	0
US ENG CONTROLS	0.500		0	0	0	NR	NR	0
US INST CONTROL	0.500		0	0	0	NR	NR	0
Federal ERNS list								
ERNS	TP	1	NR	NR	NR	NR	NR	1
State- and tribal - equivalent CERCLIS								
SHWS	1.000		0	0	0	0	NR	0
State and tribal landfill and/or solid waste disposal site lists								
SWF/LF	0.500		0	0	0	NR	NR	0
State and tribal leaking storage tank lists								
LUST	0.500		1	0	2	NR	NR	3
LAST	0.500	1	0	0	0	NR	NR	1
INDIAN LUST	0.500		0	0	0	NR	NR	0
State and tribal registered storage tank lists								
FEMA UST	0.250		0	0	NR	NR	NR	0

MAP FINDINGS SUMMARY

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
UST	0.250	2	2	1	NR	NR	NR	5
AST	0.250	4	0	1	NR	NR	NR	5
INDIAN UST	0.250		0	0	NR	NR	NR	0
State and tribal institutional control / engineering control registries								
AUL	0.500		0	0	0	NR	NR	0
State and tribal voluntary cleanup sites								
INDIAN VCP	0.500		0	0	0	NR	NR	0
VCP	0.500		0	0	0	NR	NR	0
State and tribal Brownfields sites								
BROWNFIELDS	0.500		0	0	0	NR	NR	0
ADDITIONAL ENVIRONMENTAL RECORDS								
Local Brownfield lists								
US BROWNFIELDS	0.500		0	0	0	NR	NR	0
Local Lists of Landfill / Solid Waste Disposal Sites								
SWRCY	0.500		0	0	0	NR	NR	0
HIST LF	0.500		0	0	0	NR	NR	0
INDIAN ODI	0.500		0	0	0	NR	NR	0
DEBRIS REGION 9	0.500		0	0	0	NR	NR	0
ODI	0.500		0	0	0	NR	NR	0
IHS OPEN DUMPS	0.500		0	0	0	NR	NR	0
Local Lists of Hazardous waste / Contaminated Sites								
US HIST CDL	TP		NR	NR	NR	NR	NR	0
CDL	TP		NR	NR	NR	NR	NR	0
DEL SHWS	1.000		0	0	0	0	NR	0
US CDL	TP		NR	NR	NR	NR	NR	0
Local Land Records								
LIENS 2	TP		NR	NR	NR	NR	NR	0
Records of Emergency Release Reports								
HMIRS	TP		NR	NR	NR	NR	NR	0
SPILLS	TP	16	NR	NR	NR	NR	NR	16
SPILLS 90	TP		NR	NR	NR	NR	NR	0
Other Ascertainable Records								
RCRA NonGen / NLR	0.250		0	2	NR	NR	NR	2
FUDS	1.000		0	0	0	0	NR	0
DOD	1.000	1	0	0	0	0	NR	1
SCRD DRYCLEANERS	0.500		0	0	0	NR	NR	0
US FIN ASSUR	TP		NR	NR	NR	NR	NR	0

MAP FINDINGS SUMMARY

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
EPA WATCH LIST	TP		NR	NR	NR	NR	NR	0
2020 COR ACTION	0.250		0	0	NR	NR	NR	0
TSCA	TP		NR	NR	NR	NR	NR	0
TRIS	TP		NR	NR	NR	NR	NR	0
SSTS	TP		NR	NR	NR	NR	NR	0
ROD	1.000		0	0	0	0	NR	0
RMP	TP		NR	NR	NR	NR	NR	0
RAATS	TP		NR	NR	NR	NR	NR	0
PRP	TP		NR	NR	NR	NR	NR	0
PADS	TP		NR	NR	NR	NR	NR	0
ICIS	TP		NR	NR	NR	NR	NR	0
FTTS	TP		NR	NR	NR	NR	NR	0
MLTS	TP		NR	NR	NR	NR	NR	0
COAL ASH DOE	TP		NR	NR	NR	NR	NR	0
COAL ASH EPA	0.500		0	0	0	NR	NR	0
PCB TRANSFORMER	TP		NR	NR	NR	NR	NR	0
RADINFO	TP		NR	NR	NR	NR	NR	0
HIST FTTS	TP		NR	NR	NR	NR	NR	0
DOT OPS	TP		NR	NR	NR	NR	NR	0
CONSENT	1.000		0	0	0	0	NR	0
INDIAN RESERV	1.000		0	0	0	0	NR	0
FUSRAP	1.000		0	0	0	0	NR	0
UMTRA	0.500		0	0	0	NR	NR	0
LEAD SMELTERS	TP		NR	NR	NR	NR	NR	0
US AIRS	TP		NR	NR	NR	NR	NR	0
US MINES	0.250		0	0	NR	NR	NR	0
ABANDONED MINES	0.250		0	0	NR	NR	NR	0
FINDS	TP	15	NR	NR	NR	NR	NR	15
UXO	1.000		0	0	0	0	NR	0
ECHO	TP	8	NR	NR	NR	NR	NR	8
DOCKET HWC	TP		NR	NR	NR	NR	NR	0
FUELS PROGRAM	0.250		0	0	NR	NR	NR	0
AIRS	TP		NR	NR	NR	NR	NR	0
ASBESTOS	TP		NR	NR	NR	NR	NR	0
COAL ASH	0.500		0	0	0	NR	NR	0
DRYCLEANERS	0.250		0	0	NR	NR	NR	0
Financial Assurance	TP		NR	NR	NR	NR	NR	0
MINES	0.250	12	3	2	NR	NR	NR	17
NPDES	TP	1	NR	NR	NR	NR	NR	1
MO RRC	TP		NR	NR	NR	NR	NR	0
SMARS	0.500		0	0	0	NR	NR	0
UIC	TP	2	NR	NR	NR	NR	NR	2
EDR HIGH RISK HISTORICAL RECORDS								
EDR Exclusive Records								
EDR MGP	1.000		0	0	0	0	NR	0
EDR Hist Auto	0.125	1	0	NR	NR	NR	NR	1
EDR Hist Cleaner	0.125		0	NR	NR	NR	NR	0
EDR RECOVERED GOVERNMENT ARCHIVES								
Exclusive Recovered Govt. Archives								
RGA HWS	TP		NR	NR	NR	NR	NR	0

MAP FINDINGS SUMMARY

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
RGA LF	TP		NR	NR	NR	NR	NR	0
RGA LUST	TP		NR	NR	NR	NR	NR	0
- Totals --		64	6	6	2	0	0	78

NOTES:

TP = Target Property

NR = Not Requested at this Search Distance

Sites may be listed in more than one database

Attachment 2

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IPaC **U.S. Fish & Wildlife Service**

IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

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Location

Cedar, Dade and Polk counties, Missouri

Local office

Missouri Ecological Services Field Office

(573) 234-2132
(573) 234-2181

101 Park Deville Drive
Suite A
Columbia, MO 65203-0057

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population, even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

---

1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information.
2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS

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Gray Bat Myotis grisescens — Endangered
No critical habitat has been designated for this species.
https://ecos.fws.gov/ecp/species/6329

Indiana Bat Myotis sodalis — Endangered
There is **final** critical habitat for this species. Your location is outside the critical habitat.
https://ecos.fws.gov/ecp/species/5949

Northern Long-eared Bat Myotis septentrionalis — Threatened
No critical habitat has been designated for this species.
https://ecos.fws.gov/ecp/species/9045

Fishes

NAME	STATUS
Niangua Darter Etheostoma nianguae There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/7157	Threatened
Ozark Cavefish Amblyopsis rosae No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6490	Threatened

Flowering Plants

NAME	STATUS
Geocarpon minimum No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/7699	Threatened
Mead's Milkweed Asclepias meadii No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/8204	Threatened
Missouri Bladderpod Physaria filiformis No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5361	Threatened

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

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THERE ARE NO CRITICAL HABITATS AT THIS LOCATION.

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

---

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Measures for avoiding and minimizing impacts to birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Nationwide conservation measures for birds http://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON (IF A BREEDING SEASON IS INDICATED FOR A BIRD ON YOUR LIST, THE BIRD MAY BREED IN YOUR PROJECT AREA SOMETIME WITHIN THE TIMEFRAME SPECIFIED,

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WHICH IS A VERY LIBERAL ESTIMATE OF THE DATES INSIDE WHICH THE BIRD BREEDS ACROSS ITS ENTIRE RANGE. "BREEDS ELSEWHERE" INDICATES THAT THE BIRD DOES NOT LIKELY BREED IN YOUR PROJECT AREA.)

Bald Eagle Haliaeetus leucocephalus This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1626	Breeds Sep 1 to Jul 31
Blue-winged Warbler Vermivora pinus This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA	Breeds May 1 to Jun 30
Eastern Whip-poor-will Antrostomus vociferus This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds May 1 to Aug 20
Kentucky Warbler Oporornis formosus This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds Apr 20 to Aug 20
Le Conte's Sparrow Ammodramus leconteii This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA	Breeds elsewhere
Lesser Yellowlegs Tringa flavipes This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9679	Breeds elsewhere
Red-headed Woodpecker Melanerpes erythrocephalus This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds May 10 to Sep 10
Rusty Blackbird Euphagus carolinus This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds elsewhere
Semipalmated Sandpiper Calidris pusilla This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds elsewhere

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Wood Thrush *Hylocichla mustelina* Breeds May 10 to Aug 31

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

Breeding Season (■)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

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Survey Timeframe

Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

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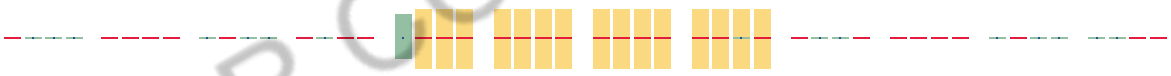
Lesser Yellowlegs
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Red-headed Woodpecker
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Rusty Blackbird
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Semipalmated Sandpiper
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Wood Thrush
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



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Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures and/or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project

intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the AKN Phenology Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets .

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: The Cornell Lab of Ornithology All About Birds Bird Guide, or (if you are unsuccessful in locating the bird of interest there), the Cornell Lab of Ornithology Neotropical Birds guide. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

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Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

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Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGE LANDS AT THIS LOCATION.

Fish hatcheries

THERE ARE NO FISH HATCHERIES AT THIS LOCATION.

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

WETLAND INFORMATION IS NOT AVAILABLE AT THIS TIME

This can happen when the National Wetlands Inventory (NWI) map service is unavailable, or for very large projects that intersect many wetland areas. Try again, or visit the NWI map to view wetlands at this location.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

NOT FOR CONSULTATION

Stockton Lake Reallocation Study

Draft Integrated Water Supply Storage Reallocation Report and Environmental Assessment

Appendix K-User Correspondence

June 2020

US Army Corps of Engineers ®
Kansas City District

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1.0 Introduction

As part of the Stockton Lake Reallocation Study, request letters from the sponsors requesting a reallocation study have been compiled in Attachment 1. Tri-State Water Resources Coalition originally requested a reallocation study in 2007 and then updated their request in 2014 and 2016 as new information was available regarding the estimated future needs for the region. Request letters from Tri-State can be found in Attachment 1. Communication with Tri-State Water Resources has been essential to convey key messages and document the assumption of financial risk that comes along with potential acquisition of water supply storage and Tri-State's responsibility to share in a portion of the annual operation, maintenance, repair, replacement and rehabilitation (OMRR&R) costs. The letters sent to Tri-State to notify them of the Dam Safety Action Classification (DSAC) ranking status, can be found in Attachment 2. Tri-State's response and acknowledgement of their responsibilities are located in Attachment 3.

Attachment 1: Request Letters

Attachment 1 includes the following request letters:

- 2007
- 2014
- 2016

Tri-state
water resource coalition

July 5, 2007

Colonel Michael Rossi, District Engineer
Kansas City District
U. S. Army Corps of Engineers
601 E. 12th Street
Kansas City, MO 64106

Dear Colonel Rossi:

The Tri-State Water Resource Coalition requests an allocation of Fifty Thousand (50,000) acre feet of storage in Stockton Lake. The requested storage is for water supply to serve several water suppliers in the Coalition service area.

The Tri-State Water Resource Coalition is composed of cities, villages, industries, investor-owned water companies, one power company, irrigators and other interested parties. The Coalition was formed as a result of a groundwater study commissioned by the Missouri American Water Company who supplies water to the City of Joplin and some adjacent cities. This study revealed that the Joplin area could suffer a water shortage in 15 years or so during a period of drought. Missouri American held a public meeting to present the study findings. Many in attendance realized their communities faced a similar situation. As a result, the Tri-State Water Resource Coalition was formed. The area included in the Coalition includes southwest Missouri, southeast Kansas and northeast Oklahoma.

The Coalition entered into a contract with the Little Rock District, Corps of Engineers, to conduct an overview of potential sources of additional water to serve the area. One of the potential sources identified was Stockton Lake, hence, this request. The study projects an additional water requirement of some 66 million gallons per day by the year 2050. The request for water in Stockton Lake will not fully meet the requirements. The Coalition will seek additional water from other sources.

We are available to meet with you and/or your staff to discuss this request in further detail. If additional information is desired, please let us know.

Respectfully submitted,

Robert L. Nichols, President

TRI-STATE WATER
Resource Coalition

October 22, 2014

COL Andrew D. Sexton
c/o John Grothaus
U.S. Army Corps of Engineers
601 E. 12th Street, Suite 635
Kansas City, MO 64106

Re: ***Water Storage Reallocation 2007 request –Update***
Stockton and Table Rock Lakes
Tri State Water Resource Coalition

Dear COL Sexton:

Pursuant to the above-referenced request from 2007, and our recent discussions with your staff, this is intended to update and reinforce our request on behalf of the Tri State Water Resource Coalition for a reallocation of water storage to meet the needs for future water supply in Southwest Missouri. The Coalition, formed in 2003, remains viable and determined to establish water supply to meet an estimated deficit need of 125 million gallons per day (mgd) in 2060. This deficit is based on Phase I and Phase II studies performed by CDM, Inc. in cooperation with your offices, Corps of Engineers (COE) Little Rock District Offices, Missouri Department of Natural Resources (MoDNR), and the Coalition.

The Southwest Missouri area covered by the coalition includes a population of well over 800,000. The Coalition has formed a separate and independent Southwest Missouri Water Resource Joint Municipal Utility Commission for the purposes of implementing a water supply project for the region once a source of supply is secured. It is understood a contract would include a cost of storage as well as provisions for sharing in annual operation and maintenance costs of any reservoirs involved. If appropriate, taking and using any reallocated storage could be done in increments as approved by the COE.

On behalf of the citizens of Southwest MO, we want to express appreciation for your continued consideration of this need. We look forward to working with you in the future.

Sincerely,

Roddy Rogers, P.E.
Chair-Technical Committee

c: Executive Director, G. Melgren and Members of the Board of Tri State Water Resource Coalition
Patricia Anslow, U.S. Army COE, LR District
Ryan Mueller, Director, Water Resources, DNR

Tri-State Water Resource Coalition, P.O. Box 3671, Springfield, MO 65808 www.tristatewater.org
Executive Director Gail Melgren (417) 766-9499 gmelgren@tristatewater.org

October 3, 2014

COL Anthony J. Hofmann
c/o John Grothaus
U.S. Army Corps of Engineers
601 E. 12th Street, Suite 635
Kansas City, MO 64106

Re: Water Storage Reallocation 2007 request –Update
Stockton and Table Rock Lakes
Tri State Water Resource Coalition

Dear COL Hofmann:

Pursuant to the above-referenced request from 2007, and our recent discussions with your staff, this is intended to update and reinforce our request on behalf of the Tri State Water Resource Coalition for a reallocation of water storage to meet the needs for future water supply in Southwest Missouri. The Coalition, formed in 2003, remains viable and determined to establish water supply to meet an estimated deficit need of 125 million gallons per day (mgd) in 2060. This deficit is based on Phase I and Phase II studies performed by CDM, Inc. in cooperation with your offices, Corps of Engineers (COE) Little Rock District Offices, Missouri Department of Natural Resources (MoDNR), and the Coalition.

The Southwest Missouri area covered by the coalition includes a population of well over 800,000. The Coalition has formed a separate and independent Southwest Missouri Water Resource Joint Municipal Utility Commission for the purposes of implementing a water supply project for the region once a source of supply is secured. It is understood a contract would include a cost of storage as well as provisions for sharing in annual operation and maintenance costs of any reservoirs involved. If appropriate, taking and using any reallocated storage could be done in increments as approved by the COE.

On behalf of the citizens of Southwest MO, we want to express appreciation for your continued consideration of this need. We look forward to working with you in the future.

Sincerely,

Roddy Rogers, P.E.
Chair-Technical Committee

c: Executive Director, G. Melgren and Members of the Board of Tri State Water Resource Coalition
Patricia Anslow, U.S. Army COE, LR District
Ryan Mueller, Director, Water Resources, DNR

October 3, 2014

COL Courtney W. Paul
c/o Patricia Anslow
U.S. Army Corps of Engineers
P.O. Box 867
Little Rock, AR 72203-0867

Re: Water Storage Reallocation 2007 request –Update
Stockton and Table Rock Lakes
Tri State Water Resource Coalition

Dear COL Paul:

Pursuant to the above-referenced request from 2007, and our recent discussions with your staff, this is intended to update and reinforce our request on behalf of the Tri State Water Resource Coalition for a reallocation of water storage to meet the needs for future water supply in Southwest Missouri. The Coalition, formed in 2003, remains viable and determined to establish water supply to meet an estimated deficit need of 125 million gallons per day (mgd) in 2060. This deficit is based on Phase I and Phase II studies performed by CDM, Inc. in cooperation with your offices, Corps of Engineers (COE) Kansas City District Offices, Missouri Department of Natural Resources (MoDNR),and the Coalition.

The Southwest Missouri area covered by the coalition includes a population of well over 800,000. The Coalition has formed a separate and independent Southwest Missouri Water Resource Joint Municipal Utility Commission for the purposes of implementing a water supply project for the region once a source of supply is secured. It is understood a contract would include a cost of storage as well as provisions for sharing in annual operation and maintenance costs of any reservoirs involved. If appropriate, taking and using any reallocated storage could be done in increments as approved by the COE.

On behalf of the citizens of Southwest MO, we want to express appreciation for your continued consideration of this need. We look forward to working with you in the future.

Sincerely,

Roddy Rogers, P.E.
Chair- Technical Committee

c: Executive Director, G. Melgren and Members of the Board of Tri State Water Resource Coalition
John Grothaus, U.S. Army COE, KC District
Ryan Mueller, Director, Water Resources, DNR

TRI-STATE WATER
Resource Coalition

December 12, 2016

COL Douglas B. Guttormsen
c/o John Grothaus
U.S. Army Corps of Engineers
601 E. 12th Street, Suite 538, PM-PF
Kansas City, MO 64106

Re: ***Water Storage Reallocation 2007 request and 2014 update –Update***
Stockton Lake
Tri State Water Resource Coalition

Dear COL Guttormsen:

Pursuant to the above-referenced request from 2007, the updated request from 2014, and our recent discussions with Kansas City and Little Rock staff, this is intended to update and reinforce our request on behalf of the Tri State Water Resource Coalition for a reallocation of water storage to meet the needs for future water supply in Southwest Missouri. The Coalition, formed in 2003, remains viable and determined to establish water supply to meet an estimated increased demand need of 125 million gallons per day (mgd) in 2060. When currently available sources are considered, the estimated gap or deficit needed to be met by a reallocation is 53 mgd plus an allowable contingency to account for risk and uncertainty. The Coalition is interested in reallocation studies at Stockton, Table Rock and Pomme de Terre lakes to determine if our projected deficit can be met. This future supply gap is an analyzed best estimate of current conditions projected forward and is based on Planning Assistance to States (PAS) Phase I and Phase II (gap) studies performed by CDM Smith, Inc. in cooperation with your offices, Corps of Engineers (COE) Little Rock District Offices, Missouri Department of Natural Resources (MoDNR), and the Coalition. While we stand by our request, we realize it will need to be evaluated and reviewed on an ongoing basis as new data may become available, possible reallocations from other reservoirs are considered, and to insure the future supply gap is adequately met based on updated stakeholder projections.

The Southwest Missouri area covered by the coalition includes a population of well over 800,000. The Coalition has formed a separate and independent Southwest Missouri Joint Municipal Water Utility Commission for the purposes of implementing a water supply project for the region once a source of supply is secured. It is understood a contract would include a cost of storage as well as provisions for sharing in annual operation and maintenance costs of any reservoirs involved. If appropriate, taking and using any reallocated storage could be done in increments as approved by the COE.

On behalf of the citizens of Southwest Missouri, we want to express appreciation for your continued consideration of this need. We look forward to working with you in the future.

Sincerely,

Roddy Rogers, P.E., D.WRE, F.ASCE
Chair-Technical Committee

c: Executive Director, G. Melgren and Members of the Board of Tri State Water Resource Coalition
COL Dixon , U.S. Army COE, SWL District
Andrea Collier, P.E. Director, Water Resources, DNR

Tri-State Water Resource Coalition, P.O. Box 3671, Springfield, MO 65808 www.tristatewater.org
Executive Director Gail Melgren (417) 766-9499 gmelgren@tristatewater.org

Attachment 2: Letters to User

Attachment 2 includes response letters from the following:

- 2017 USACE Letter Concerning Ongoing Reallocation Efforts, Stockton Lake Dam Risk Conditions and Reallocation Agreement Requirements
- 2020 USACE Letter Concerning Increased Risk to Stockton Lake Dam Operations, and Potential Impacts to use of Stockton Dam Under increased Risk Conditions

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E. 12TH STREET
KANSAS CITY, MISSOURI 64106-2824

JUL 28 2017

Planning Branch

Tri-State Water Resources Coalition
Attn: Ms. Gail Melgren, Executive Director
2144 E. Republic Rd.
Suite B103
Springfield, Missouri 65804

Dear Ms. Melgren:

This letter is in response to your request for storage space in Stockton Lake for water-supply uses. Such storage may be available, subject to preparation and approval of a reallocation report and compliance with applicable federal and state laws and regulations. Before proceeding, however, we must inform you of the status of the dam at Stockton Lake and the potential impacts on water-supply storage.

While the United States Army Corps of Engineers (USACE) recognizes the numerous public benefits of providing storage in its reservoirs for water-supply purposes, USACE also recognizes its responsibility to provide storage in a safe, secure, and reliable environment. USACE continually evaluates its dams and determines if remediation may be necessary to meet and maintain current USACE safety standards.

USACE is committed to the safety of our dams. USACE dams are classified through a risk assessment process into five Dam Safety Action Classifications (DSAC) which represent varying levels of urgency of action and incremental flood risk.

The dam at Stockton Lake is classified a DSAC 4 - Low Urgency in that there is low incremental risk; however, it does not meet all USACE safety standards. USACE conducts routine monitoring and evaluation of the dam and completed a risk assessment in 2015. The identified risks at Stockton Lake include the potential for internal erosion of the foundation or embankment material and concentrated leak erosion within the embankment. USACE continuously monitors the dam for any change of conditions. In the event the condition or risk associated with the dam changes, the DSAC assignment may be elevated to a higher level of urgency and USACE may implement interim or long-range measures to remediate the conditions. These measures may impact the storage in the reservoir for water-supply purposes such that the amount of storage available for water supply could be reduced. Upon execution of a water-supply storage agreement, the water user will be required to pay a percentage of the joint-use operations and maintenance expenditures as well as the costs of the project's Interim Risk Reduction Measures (IRRM) in proportion to the storage space that has been provided to the user. All of these responsibilities will be outlined in the water-supply storage agreement. USACE will also notify the water-supply user of any changes to the DSAC rating.

We will continue to work with you in your efforts to meet your present and future water needs. To this end, we continually review our projects for effectiveness, efficiency, and safety. If you have questions about any matters addressed in this letter, or wish to learn more about USACE's commitment to dam safety, please contact Mr. Scott Mensing, Kansas City District Dam Safety Program Manager, at 816-389-2321 or Scott.P.Mensing@usace.army.mil.

Sincerely,

Douglas B. Guttormsen
Colonel, Corps of Engineers
District Commander

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E. 12TH STREET
KANSAS CITY, MISSOURI 64106-2896

Planning Branch

Tri-State Water Resources Coalition
Attn: Ms. Gail Melgren, Executive Director
2144 E. Republic Road
Suite B103
Springfield, MO 65804

Dear Ms. Melgren:

This letter is in response to your request for storage space in Stockton Lake for water-supply uses. Such storage may be available, subject to preparation and approval of a report and compliance with applicable federal and state laws and regulations. Before proceeding, however, we must inform you of the status of the dam at Stockton Lake and the potential impacts on water-supply storage.

While the U.S. Army Corps of Engineers (USACE) recognizes the numerous public benefits of providing storage in its reservoirs for water-supply purposes, USACE also recognizes its responsibility to provide storage in a safe, secure, and reliable environment. USACE continually evaluates its dams and determines if remediation may be necessary to meet and maintain current USACE safety standards.

USACE is committed to the safety of our dams. USACE dams are classified through a risk assessment process into five Dam Safety Action Classifications (DSAC) which represent varying levels of urgency of action and incremental flood risk. A DSAC rating of 5 is for a dam with very low incremental risk (combination of life, economic, or environmental consequences with likelihood of failure). A DSAC rating of 1 is for a dam with very high incremental risk.

Based on a Periodic Risk Assessment performed in 2014, the dam at Stockton Lake was classified as Low Urgency (Dam Safety Action Classification (DSAC)- 4). A Low Urgency Classification indicates that there is low incremental risk. In 2019, an abbreviated risk assessment was conducted as part of the Stockton Lake Reallocation Study. The abbreviated risk assessment was required to incorporate a change in USACE national criteria and new methodologies associated with overtopping risk. As a result of the analysis using the revised national criteria, the DSAC was required to be changed from 4 to a 3 – Moderate Urgency. The total incremental risk at Stockton dam is driven by the potential for overtopping the embankment, internal erosion of the foundation or embankment materials, and concentrated leak erosion within the embankment. Continuous monitoring of the dam has not revealed any significant changes in performance since 2014.

As a result of the re-classification to Moderate Urgency, USACE must consider and evaluate the potential for implementation of Interim Risk Reduction Measures (IRRM) to mitigate the risks posed to the population downstream. These measures are identified through a serious of studies and analysis focused on the primary risk drivers at the project. These measures can range from structural modifications to dam components and/or changes in operations, or downstream warning systems. Depending on their nature, if implemented, some of these IRRMs may result in reducing the volume of reservoir storage available for water supply. Upon execution of a water-supply storage agreement, the water user will be required to pay a percentage of the joint-use operations and maintenance expenditures as well as the costs of any IRRMs that would be implemented, in proportion to the storage space that has been provided to the user. All of these responsibilities will be outlined in the water-supply storage agreement. USACE will also notify the water-supply user of any future changes to the DSAC rating.

It should also be noted that, in the interests of public safety, USACE water supply policy does not allow the conservation pool to be raised at projects where dams are classified as a DSAC 1, 2, or 3. The proposed Tentatively Selected Plan for this reallocation study includes a recommendation to reallocate from the multipurpose pool and flood control pool. The report will outline that implementation of the flood control storage will not be allowed until the DSAC rating has changed to a 4 or a waiver to the current policy has been approved.

We will continue to work with you in your efforts to meet your present and future water needs. To this end, we continually review our projects for effectiveness, efficiency, and safety. If you have questions about any matters addressed in this letter, or wish to learn more about USACE's commitment to dam safety, please contact Mr. Pendo Duku, Kansas City District Dam Safety Program Manager, at 816-389-3831 or Pendo.M.Duku@usace.army.mil.

Sincerely,

Date: 2020.05.12
12:56:39 -05'00'

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

Attachment 3: User Response

Attachment 3 includes the response from Tri-State Water Resources Coalition acknowledging fiscal responsibility and the status of the Stockton Dam and Reservoir project.

- 2020 Response

5/15/2020

Colonel William Hannan, Jr
Corps of Engineers, Kansas City District
601 E. 12th Street
Kansas City, Mo 64106

Dear Col Hannan, Jr.

We received your letter dated May 12, 2020 and previous letter dated July 28, 2017 regarding the Dam Safety Action Classification (DSAC) rating at Stockton Lake. We understand that the DSAC rating changed from a 4 – Low Urgency to a 3- Moderate Urgency as a result of an abbreviated risk assessment that was conducted as part of the Stockton Lake Reallocation Study, in which we have requested a reallocation of water supply storage to meet the growing needs of the Southwest Missouri region, which will outpace the current water supplies that are available.

We also understand that the change in DSAC rating is not attributable to the potential 1.8 foot pool raise that is under evaluation; the PDT has communicated that the change in DSAC rating is due to new criteria and methodologies associated with the overtopping risk. The abbreviated risk assessment concluded that a 1.8 foot pool raise did not incrementally change the risk at Stockton Lake.

We acknowledge and are aware that current USACE Dam Safety guidance does not allow a pool raise at a DSAC 3 project. It is our understanding that the Kansas City District has already taken steps to further the evaluation by conducting a detailed hydrologic and hydraulic study, which will further inform the District about the risks associated with the project. We understand that if a pool raise alternative is approved, it would not be implemented until the DSAC rating has changed to a 4 or a waiver to the current policy is approved.

Lastly, we also acknowledge our financial responsibility if a reallocation of storage would be approved. We agree to pay our potion of the annual joint-use operations and maintenance expenditures as well as the costs associated with any Interim Risk Reduction Measures, rehabilitation, replacements or repairs that may be necessary to ensure the optimal project performance.

Respectfully,

Gail Melgren
Executive Director
Southwest Missouri Water (Tri-State Water Resource Coalition & Southwest Missouri Joint Municipal Water Utility Commission)
2144 E. Republic Rd. B103 Springfield, MO 65804
(417) 766-9499

Stockton Lake Reallocation Study

Draft Integrated Water Supply Storage Reallocation Report and Environmental Assessment

Appendix L-Plan Formulation

June 2020

US Army Corps of Engineers ®
Kansas City District

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Acronyms

AF	acre-feet
AFY	acre-feet per year
Coalition	Tri-State Water Resources Coalition
DYMS	dependable yield mitigation storage
EC	Engineering Circular
EOP	Environmental Operating Principle
ER	Engineering Regulation
FWOP	future without project
FY	fiscal year
gpm	gallons per minute
H&H	hydrologic and hydraulic
KC	Kansas City
M&I	municipal and industrial
MoDNR	Missouri Department of Natural Resources
MG	million gallons
MGD	million gallons per day
amsl	above mean sea level
NEPA	National Environmental Policy Act
NGVD 29	National Geodetic Vertical Datum of 1929
NRHP	National Register of Historic Places
O&M	operation and maintenance
PAS	Planning Assistance to States
SWPA	Southwestern Power Administration
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WSA	Water Supply Act

Section 1
Introduction

This report has been prepared by CDM Smith Federal Programs Corporation under contract Number W912DQ-14-D-1003. This report describes the screening analysis completed to evaluate the feasibility of alternative water supply sources for a 16-county area of southwest Missouri.

Alternative supply sources evaluated in this study include increased conservation measures, water importation, construction of a new reservoir (reservoir storage), groundwater availability, and reallocation options from Stockton Lake, Pomme de Terre Lake, and Table Rock Lake. Screening criteria included 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 sufficient quantity 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 water quality criteria or be cost-effectively treated to meet applicable water quality requirements for municipal and industrial purposes
- Cost of Storage—This reflects the cost to the user to obtain the necessary amount of storage in order 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 in need of water starting as early as 2022. The water supply must be available at the time needed.

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.

The following sections present the background on applicable studies completed to date for southwest Missouri utilized in the evaluation of this screening analysis, a discussion on the evaluation for each potential supply source, and a summary of the findings.

1.1 Background

The southwest Missouri region is comprised of 16 counties, including Barry, Barton, Cedar, Christian, Dade, Greene, Hickory, Jasper, Lawrence, McDonald, Newton, Polk, St. Clair, Stone,

Taney, and Vernon counties. Since 2003, a significant number of studies have been completed by numerous federal, state, and local agencies and organizations to understand the region's future water needs and supply availability. In the early phases of this process, Tri-State Water Resources Coalition (Coalition) completed two regional studies to identify a long-term, sustainable water supply and develop an implementation strategy for the region. Both studies recommended a more detailed analysis of projected water demands to be conducted to evaluate future needs and availability. As a result, the Kansas City District U.S. Army Corps of Engineers (USACE) allocated Planning Assistance to States (PAS) funding to assist in the development of the Southwest Missouri Water Resource Study – Phase I: Forecast for Regional Water Demand (2010–2060) (CDM Smith et al. 2012). This study provided a regional demand forecast for publicly supplied, self-supplied, and agricultural water use sectors through 2060. Phase II (CDM Smith et al. 2014) of this study evaluated current and future supply availability and identified where available surface water and groundwater do not meet future forecasted demands (supply gaps). These studies are discussed further in the following sections.

1.2 Phase I Forecast for Regional Water Demand

The Phase I study is designed to improve the understanding of current and future water use within publicly supplied residential and non-residential, self-supplied residential and non-residential, and agricultural water use sectors for the 16-county region of southwest Missouri.

This analysis is based on different types of data, including water billing and consumptive data, demographic and socioeconomic data, historical agricultural data, and weather data. Additionally, Missouri Department of Natural Resources (MoDNR) provided general demographic data as well as 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 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 the year 2060 in 10-year increments using a computational "driver times rate of use" approach.

Conservation scenarios were also considered during the demands analysis. Under conservation Scenario I, water demands were estimated to decrease by 1 to 3 percent annually based on implementation of moderate conservation activities. Scenario II assumed substantial conservation activities and estimated a water demand decrease by 4 to 7 percent annually.

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 million gallons per day (MGD) in the baseline year of 2010 to an estimated 464 MGD in 2060, an increase of approximately 125 MGD across the sectors evaluated, including publicly supplied residential and non-residential, self-supplied residential and non-residential, and agricultural uses.

1.3 Phase II Regional Supply Availability

The Phase II study is a planning-level evaluation of supply availability based on past studies of the groundwater and surface water resources for the region. Where surface water and groundwater do not meet future forecasted demands identified in Phase I, the term "gap" is used to identify the

deficit. The difference between future demand from current capacity to treat and deliver is referred to as the future "need" in order to supply the available water. The Phase II study was completed to evaluate current and future supply availability through the year 2060 as demanded by primarily municipal and industrial/commercial sectors.

The analysis initially considered both normal and drought conditions by developing four management scenarios. Scenarios evaluated both conditions using U.S. Geological Survey (USGS) groundwater models, with current rate of growth reflecting continual declines or sustainable groundwater management, assuming a fully saturated Ozark Aquifer. To account for Tri-State Water Resource Coalition concerns of high groundwater availability assumptions under Scenario 3 in the Phase II study, Scenario 5 was developed in 2016. Scenario 5 assumes drought condition surface water flows or withdrawals and incorporates regional 2006 drought groundwater withdrawal rates taken from the USGS study, *Groundwater-Flow Model and Effects of Projected Groundwater Use in the Ozark Plateaus Aquifer System in the Vicinity of Greene County, Missouri – 1907–2030* (Richards 2010).

The gap analysis showed there are sufficient available surface water supplies to supplement localized decline in groundwater under normal weather conditions. However, the necessary infrastructure is not in place currently 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 growth, the region can anticipate a gap in supply and demand as early as 2020. This gap particularly applies to the sub-regions, which include Barry, Barton, Christian, Greene, Jasper, Lawrence, McDonald, Newton, Polk, and Stone counties. The original Phase II gap analysis consisting of 4 scenarios indicated a drought gap in supply ranging from 33 to 87 MGD regionally. As mentioned above, the modified drought Scenario 5 was developed and indicates a regional drought gap in supply of 53 MGD by the year 2060. In June 2016, the Project Team (consisting of the Coalition, MoDNR, and USACE Kansas City District) decided to move forward with the assumptions and results calculated under Scenario 5.

1.4 Determination of Regional Reallocation Amount

To translate the results of the Phase I and Phase II studies into a reallocation amount utilized to secure funding for water supply alternatives, 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 supply should include demands of only current Coalition members, with a projected additional 30 percent allocation for future growth. **Table 1-1** shows the 2017 Coalition members with 2060 estimated average day supply gaps[1].

[1] Membership as of April 2017 within the sub-regions expected to participate

Table 1- 1: Estimated 2060 Tri-State 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
	Mo American Joplin	7.47
	Wholesale Mo American Joplin Customers	0.90
	Webb City	2.21
Christian	Nixa	1.40
Greene	Springfield	12.85
Lawrence	Mount Vernon	0.34
	30% Contingency	9.0
Total of all Coalition Members[3]		38.7

As shown in **Table 1-2**, the annual average day municipal Coalition membership gap in supply in 2060 is estimated at approximately 30 MGD, which rises to 39 MGD, with a 30 percent allocation for future growth[2]. In order to determine the projected reallocation amounts for each lake studied for reallocation within this document, yield analysis coefficients from the Phase II study for each lake were applied (CDM Smith et al. 2014). In order to meet the target of 39 MGD, it would require approximately 55,000 acre-feet of storage at Pomme de Terre and 56,000 acre-feet at Table Rock Lake. At Stockton Lake the amount of acre-feet needed ranges from 90,000 acre-feet to 100,000 depending on which pool the reallocation is evaluated from. Table 1-2 describes the various amounts.

Table 1- 2: 2060 Coalition Municipal Projected Gap in Supply and Reallocation Amounts.

	Annual Average Day Demands	30% Contingency	Projected Storage Reallocation (Acre-Feet)		
	MGD	MGD	Pomme de Terre Lake	Stockton Lake	Table Rock Lake
Total of All Coalition Members[3]	29.7	38.7	55,000	90,200 – 100,000	56,000

[2] Future growth contingency is intended to account not only for unanticipated population growth but also participation from additional municipalities.

[3] Includes Coalition membership in sub-regions 1 and 2 as explained in CDM Smith et al. 2014 (as of the date of analysis)

Section 2

Alternative Water Supply Resources Analysis

This section describes the alternatives analyzed as additional water supply sources for southwest Missouri. The purpose of this analysis is to utilize a screening methodology to identify feasible and cost-effective alternatives that are viable sources to meet future water demands for the region. The alternative water supply resources evaluated include increased conservation measures, development of a new groundwater source, surface water storage, and reallocation from Stockton, Pomme de Terre and Table Rock lakes. In general, these alternatives were evaluated based on the criteria identified in Section 1. However, for several of the alternatives, it was determined that a detrimental evaluation criterion existed that ultimately eliminated the source as a viable supply option. Each alternative is discussed further in the following subsections. While each criterion is evaluated as a single source of supply, it is recommended that combinations of alternatives be considered in later phases of this project.

2.1 Federal No Action – Future Without Project

The Federal future without project (FWOP) condition represents that there is no federal action implemented. The National Environmental Policy Act (NEPA) requires this alternative to be considered and evaluated against all other proposed water reallocation alternatives to assess potential effects of proposed actions on the human and natural resources. There would be no water reallocation and the non-Federal No Action FWOP condition would likely result in construction of a new reservoir (Alternative 2) in order to meet future water supply needs.

2.2 New Reservoir Construction

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, performed by Freese and Nichols in 2010, focused on meeting the water needs of some of the smaller demand centers within the Coalition service area. This report evaluated two options for the Joplin, Pittsburg, Lamar, Empire Electric, and rural water districts in the west sub-region that could yield 35 and 36 MGD. The 36 MGD reservoir option located north of Joplin, Missouri is further evaluated within this report as it would be the most viable option to serve the approximate 39 MGD regional supply gap.

2.2.1 Reliability and Availability of Source

Based on analysis of potential reservoir locations in the 2009 Freese and Nichols study, the most viable option would be construction of a 36 MGD reservoir option. Following construction and filling of the reservoir, a new reservoir would serve as a very reliable source of supply for the region.

2.2.2 Operational, Permitting and Stakeholder Considerations

2.2.2.1 Operational Considerations

The primary operational constraints include not only property acquisition and mitigation for the construction of a new reservoir but also the construction of pipelines from the new reservoir to the Coalition water utilities with the greatest demand for water during a drought condition. According to the Southwest Missouri Water Resource Study (CDM Smith et al. 2014), cities requiring the greatest demand for water during a drought condition include Springfield and Joplin, Missouri.

2.2.2.2 Permitting Requirements

Developing a new reservoir or reservoirs that could supply the amount of water needed for southwest Missouri faces considerable political and regulatory challenges. The project will require consistency with all USACE Environmental Operating Principles (EOPs) as well as a 404 permit issued by USACE if construction of the dam results in the discharge of fill material into a stream or wetland, which is highly probable. The Clean Water Act gives authority to each state to issue a 401 Water Quality Certification for any project that needs a 404 permit. As part of the 401 Certification, the MoDNR may require more thorough actions on projects to protect water quality. Another permitting concern is the possible need of interbasin water transfers between the White and Arkansas River basins.

2.2.2.3 Stakeholder Considerations

With the amount of land needed to be purchased, large inundation area, and potential environmental threats, there will be several stakeholder groups; other local, state, and federal agencies; and the general public that will need to be included in the development process. Lack of stakeholder acceptance from these groups could impact project schedule or potentially restrict the use of certain locations to place a new reservoir.

2.2.3 Quality of Water

Overall, Missouri's surface water quality is relatively good, and it is anticipated that the water quality of a new reservoir would be similar to that of existing lakes. Due to rolling topography, thin soils, and poor soil fertility, there are few agricultural practices in the southwest part of the state, which leads to reduced agricultural runoff into open water bodies. It should be noted, however, that many areas in southwest Missouri have several mine sites that could potentially affect water quality in that area and should be reviewed with a site-by-site analysis.

2.2.4 Potential for Environmental Impacts or Impacts to Authorized Purposes

Two categories of environmental issues are typical during reservoir development, those that are common to all reservoirs and those that are specific to the project site. Common issues facing all new reservoirs include change in flow regimes and aquatic life populations within the stream above and below the dam, effects on water quality, and inundation of wildlife habitats. Site-specific examples may include effects on threatened or endangered species, inundation of wetlands, or inundation of significant archeological and historical sites that may lie within the new reservoir. Currently there are 39 endangered species listed in Missouri, most of which can be found in the 16-county study area.

Additionally, a new reservoir could aid in flood control. Reservoirs can also be used to balance flow during different weather conditions such as decreasing the flow by holding water back

during heavy rainfall and releasing more water during droughts to meet 7Q10 standards (the lowest stream flow for 7 consecutive days that would be expected to occur once in 10 years).

2.2.5 Cost

The most economical option from the 2010 supplemental study would be to potentially build a 3,500-acre reservoir approximately 10 miles north of Joplin that could yield 36 MGD to the surrounding area. 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 fiscal year (FY) 2020 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, pre-construction, engineering, and design) for completeness. Since Southwest Missouri Regional Water is seeking a reservoir large enough to supply 39 MGD, to account for the additional yield, an additional 8 percent cost increase was added to the cost estimate. 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. Annualized costs over a 50-year period of analysis (based on the 50-year study period) at the FY2020 federal interest rate of 2.75 percent, including annual operation and maintenance (O&M) costs, are estimated at $11.5 million. **Table 2-1** provides a summary of the estimated costs of new reservoir construction in FY2020 dollars.

Table 2- 1: New Reservoir Cost.

Estimated Yield (MGD)	2020 Cost of Construction	Annualized Construction Cost	Estimated Annual O&M	Total Estimated Annual Cost
39	$296,000,000	$10,960,000	$500,000	$11,460,000

2.2.6 Mileage and Cost of Transmission Lines and Treatment

In addition to considering reservoir costs, the additional cost of transmission, treatment, pump stations, and storage (distribution system storage) must also be taken into consideration. For the purpose of this report, minimum mileage of transmission lines was taken into consideration in order to evaluate and uniformly compare alternatives. For this single reservoir option, an estimated minimum of 150 miles of transmission lines would be required. It is assumed that treatment, pump station, and storage costs will be similar for new reservoir construction and reallocation alternatives.

2.2.7 Timeline for Supply Availability

Traditional reservoirs large enough to supply the needed water would be expected to take roughly 15 to 30 years to develop, including planning, permitting, design, and construction (Freese and Nichols 2009, USACE 2013). As an example, planning for East Locust Reservoir in northern Missouri began in 2002. This 2,352-acre reservoir will produce 7 MGD and scheduled to be completed in 2021. Another northern Missouri reservoir project, Little Otter Creek, has been in the active planning stages since 2000. This reservoir is estimated to supply 1 MGD and have 345 surface acres of water. The project is projected to be completed in 2020. With the planning initiative spanning across decades, this alternative most likely would be infeasible to meet the anticipated drought-dependent gaps within the southwest Missouri region. Reservoir construction currently underway in Texas is expected to take 15 to 20 years to complete. Based

on the CDM Smith Phase II study (CDM Smith et al. 2014), water supply gaps in the Joplin sub-region in drought conditions could exist immediately, depending on the severity of the drought, which would cause significant need prior to completion of a new reservoir.

2.3 Increased Water Conservation

Implementing conservation measures has been proven to provide substantial water savings to help reduce or avoid the demand for water restrictions during periods of drought. Typical conservation practices for the southwest Missouri region include activities under the following three primary categories:

1. Commercial and residential metering with reduction in system losses
2. Community education and information
3. Residential and commercial water use audits

Current regional conservation activities were evaluated and found that some water providers currently implement progressive activities while others are not implementing any. The current conservation methods being used in southwest Missouri are included in the development of the supply gap forecast, estimating a future supply need of 39 MGD by 2060. To recognize any additional savings from conservation measures, water providers not currently implementing any conservation practices would need to start this practice.

2.3.1 Reliability and Availability of Source

The Southwest Missouri Water Resource Study – Phase I (CDM Smith et al. 2012) evaluated two conservation scenarios to estimate the effects of implementing moderate to substantial conservation measures in southwest Missouri. Within the Phase I report, Scenario I assumes a moderate expansion of existing conservation practices, including metering for a majority of water providers in each county, system loss reduction, and educational school programs and bill inserts. Scenario II assumes a substantial but achievable expansion of conservation practices, including metering for all water providers in each county; greater system loss reduction; water conservation educational school programs, bill inserts, and conservation tip website; and implementation of residential and non-residential water audits. These scenarios were evaluated through 2060 on a low, medium, and high population and employment growth scale. The total MGD savings per year, assuming medium population and employment growth for both scenarios, is presented in **Table 2-2**.

Table 2- 2: Medium-Growth Annual Conservation Savings.

Potential Conservation Savings	Medium-Growth Savings			
	Scenario I		Scenario II	
	2030	2060	2030	2060
TOTAL MGD[1]	6.6	10.0	16.9	26.6
Savings from anticipated participating counties (MGD)[2]	3.3	5.3	6.5	10.6

[1] million gallons per day
[2] Counties with anticipated participation (from **Table 1-1**) include Barry, Barton, Jasper, Christian, Greene, and Lawrence counties

It is important to note that the conservation scenarios evaluate potential savings for the entire southwest Missouri 16-county region. As **Table 2-2** shows, further analysis of only counties expected to participate in acquisition, funding, and development of the alternative source (see Section 1.4) indicate substantially lower savings. In either scenario, conservation on its own is not a viable solution as the calculated savings of up to 26.6 MGD do not meet the Coalition's estimated 2060 annual need of approximately 39 MGD. Furthermore, if only anticipated participating counties implement conservation measures, estimated savings in 2060 are only 10.6 MGD.

Conservation as a supplemental source is not entirely reliable, given the supply is dependent on water providers implementing these activities and the public changing their water use behaviors. Although conservation will be encouraged to all water providers, it cannot be assumed that all providers will initiate these practices. Nonetheless, water conservation is recognized as an important tool in managing water resources. In addition to providing decreased cost to water providers and reductions in customer water bills, the water saved through conservation programs has been shown to help reduce or avoid the demand for water restrictions during periods of drought.

2.3.2 Cost

One economic measure of a water conservation program is to calculate the unit cost of the water saved. Thus, water conservation program costs are often evaluated in terms of dollars per volume of water saved such as dollars per thousand gallons or dollars per AF. This requires calculation of the water savings from a conservation program over the life of the conservation action as well as all related program costs and benefits. The cost of water conservation programs varies widely. The cost of a conservation program from the utility perspective is mostly related to the implementation design of the program. These may include variables such as staff labor, rebates, and incentives. There may also be costs to the utility, such as lost revenue from decreased sales, and benefits such as reduced pumping and treatment costs. However, the cost of a conservation program from a customer's perspective is mostly related to the cost of participating in the conservation program. This may include the purchase of hardware, plumbing costs, or contractor costs. There may be long-term benefits, such as reduced water bills and lower water heating bills, that should also be considered when calculating program costs from the participant's perspective (Davis 2004).

Costs for Coalition providers are dependent on a number of factors, including current implementation of measures, population served, and treatment and distribution costs. Broadly implemented programs, such as education programs, have been estimated in past research at an implementation cost of $123 per AF ($377 per million gallons [MG]) of water saved. Residential and non-residential indoor audits are estimated at $169 ($518 per MG) and $209 per AF ($641 per MG),

respectively, of water saved (Davis 2004). Costs for individual providers need to be assessed on a case by case basis.

2.3.3 Operational, Permitting and Stakeholder Considerations

In addition to costs of implementation, a successful conservation program requires adequate staffing to educate customers, install metering systems, and perform audits.

2.4 Development of a New Groundwater Source

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 due to the lack of recharge within the aquifer. The aquifers underlying southwest Missouri include the Springfield Plateau aquifer and the Ozark aquifer. As seen in **Figure 2-1**, the confined Ozark aquifer is underlying the Springfield aquifer.

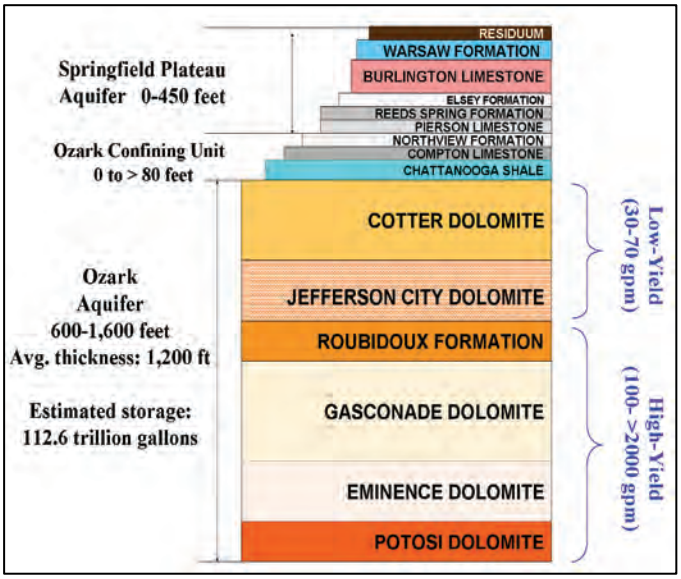

Figure 2- 1: Springfield Plateau and Ozark Aquifer. Source: MoDNR Water Resources Center.

2.4.1 Reliability and Availability of Source

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 due to the release of solvents such as trichloroethylene, into the environment (MoDNR Water Resources Center). Since this region is comprised of karst features, a network of pathways is created for contaminants to travel, causing widespread contamination within the aquifer. Therefore, the majority of wells drilled in this region are drilled into the deeper, confined Ozark aquifer. MoDNR has created a contamination impact area and casing depth map for Newton and Jasper counties, which shows the general extent of contamination near Joplin, Missouri, as shown in **Figure 2-2**. Due to the extent and depth of contamination, costly installation procedures, such as additional casing, will be required to drill new wells in this portion of the region.

In response to contamination, many water providers and industries access the Ozark aquifer to fulfill water needs. Due to the lack of recharge in the Ozark aquifer, the addition of wells has led to the increased drawdown. Excessive drawdown of water levels within the aquifer can lead to wells drying up, reducing the water level in streams and lakes, increasing pumping costs, causing land subsidence, and deteriorating water quality.

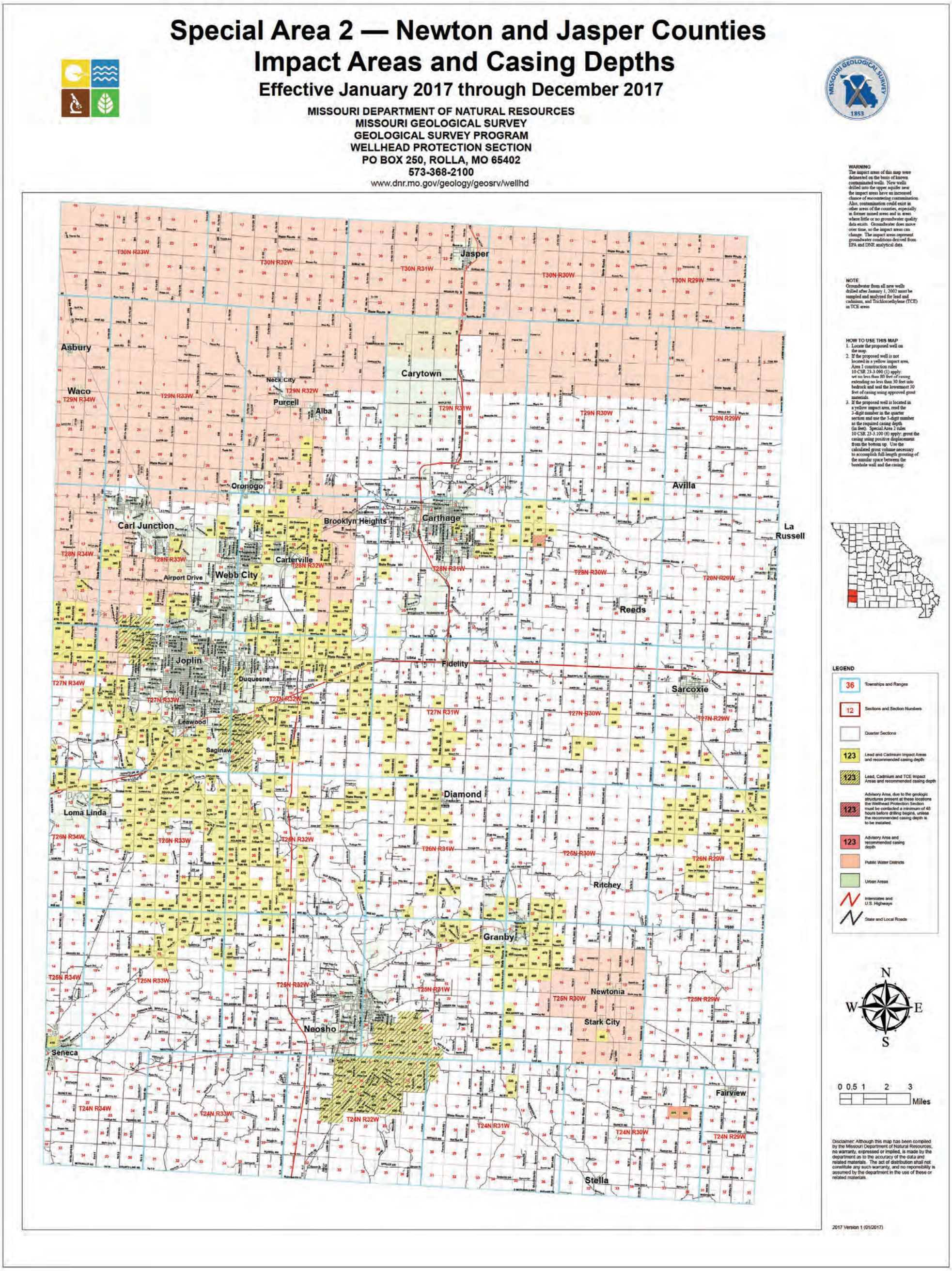

Figure 2- 3: Newton and Jasper County Impact Areas. Source: MoDNR.

Drawdown within southwestern Missouri was documented in the Phase II Final Southwest Missouri Water Resource report. This report discusses the decline of water levels from pre-development to 2007, taking note that the water levels are reflective of the 2005 and 2006 drought (CDM Smith et al. 2014). Regional supply gap modeling completed under Phase II of this study (CDM Smith et al. 2014) indicates an immediate need for additional supply in portions of these counties under a drought situation. For this screening alternative, it is important to note that during drought conditions, recharge of the aquifer is limited due to the lack of precipitation, which causes increased drawdown; therefore, groundwater well fields may not be a reliable source to meet water demands during a future drought condition.

2.4.2. Cost

To estimate the number of wells needed to create a well field, several key assumptions for demand and well yield were determined. Assuming a need of 39 MGD by the year 2060 and that each well will yield 800 to 600 gallons per minute (gpm) or approximately 1.15 to 0.86 MGD, between 34 and 45 wells, respectively, would be required in order to create a well field to meet the gap in demand. Costs to consider when developing a well field include well installation, pump cost, electrical components and wellhead finish, piping for conveyance of water to the water treatment plant, and operation and maintenance costs. However, due to the present issues with water quality and the extent of drawdown present within the southwestern Missouri region, reliability on groundwater to fill the gap in demands in the region is not likely to be a viable option; therefore, costs for development and additional evaluation of screening criteria of a new well field to serve the region were not pursued as part of this analysis.

2.5 Reallocation from the Multipurpose Pool at Stockton Lake

Stockton Lake is located in southeastern Cedar County, northeastern Dade County, and southwestern Polk County, Missouri. It is located on the Sac River in southwest Missouri and lies approximately 40 miles northwest of Springfield, Missouri and 50 miles northeast of Joplin, Missouri. The lake is “V” shaped and covers 39 square miles, with 298 miles of shoreline. The construction was authorized by the Flood Control Act approved in 1954 as a multipurpose project with storage allocation for flood control, hydroelectric power, sediment reserve, recreation, and fish and wildlife management. Construction of Stockton Dam began in 1963, with closure of the structure occurring on September 23, 1968. The lake first filled to the top of the multipurpose zone (867.0 feet mean sea level) on December 18, 1971. In 1993, 50,000 AF of storage was reallocated for water supply purpose to City Utilities of Springfield, Missouri.

2.5.1 Reliability and Availability of Source

Based solely on lake size, Stockton Lake has the ability to supply the desired storage amount of 60,697 AF by the year 2060 during a drought condition. Currently, Stockton Lake has storage reallocated for water supply in the multipurpose pool for City Utilities of Springfield. Since water supply would only be withdrawn during a drought-based scenario, noticeable impacts to water levels would be most likely to occur only during a drought condition.

2.5.2 Operational, Permitting and Stakeholder Considerations

2.5.2.1 Operational Considerations

The primary operational constraint is the construction of pipelines from Stockton Lake to the Coalition water utilities with the greatest demand for water during a drought condition. According to the Southwest Missouri Water Resource Study (CDM Smith et al. 2014), cities requiring the greatest demand for water during a drought condition include Springfield and Joplin, Missouri. The current infrastructure from Stockton Lake to Springfield would need to be either supplemented or replaced with a new pipeline to handle the increase of 39 MGD.

The length of the pipe needed to connect Stockton Lake to Springfield is approximately 30 miles. City Utilities of Springfield currently owns the easement from Stockton to Lake Springfield, making permitting constraints and costs for easements less than that on Pomme de Terre Lake and Table Rock Lake. The total pipeline length from Stockton Lake to Joplin is approximately 140 miles. Construction of the majority of the pipeline between Springfield and Joplin follows I-44 and Highway 96; therefore, few permits for easement should be required.

2.5.2.2 Permitting Requirements

Reallocation of water from storage to water supply will require consistency with all USACE EOPs as well as a 404 permit issued by USACE if intake construction activities result in the discharge of fill material into a stream or wetland. The Clean Water Act gives authority to each state to issue a 401 Water Quality Certification for any project that needs a 404 permit. As part of the 401 Certification, the MoDNR may require more thorough actions on projects to protect water quality. For reallocated municipal and industrial (M&I) water supply storage under the Water Supply Act of 1958 (1958 WSA) authority, the water supply user must be advised that the reallocation study itself will not specifically address the Section 408 considerations, but that Section 408 considerations will be taken into account in the drafting of a water storage agreement and associated real estate instruments. Any requirements for water supply user's facilities (e.g., intake structures) will be included in the agreement and associated real estate instruments (USACE 2015).

2.5.2.3 Stakeholder Considerations

Local business owners and members of the Stockton Lake Association have voiced their concerns about any proposal to reallocate water in the lake. They stated that the community of Stockton depends on the lake and expressed concern about future lake levels due to water levels in the lake having fallen in the past during periods of drought (Kennedy 2012). These concerns will have to be addressed in future stakeholder meetings regarding any reallocation for water supply out of Stockton Lake.

2.5.3 Quality of Water

In 2015, water quality at Stockton Lake was beneficial to the operating purposes of flood control, hydroelectric power, recreation, fish and wildlife, and water supply and did not exceed MoDNR water quality standards for designated uses. The Sac River from Stockton Lake Dam downstream for 40 miles is classified for whole body contact, boating and canoeing, and irrigation. The Sac River from Stockton Lake upstream for 32.5 miles is also classified for these uses. However, Turnback Creek, which flows into the Sac River arm of Stockton Lake, has been on the MoDNR impaired waters list since 2010 due to E. coli bacteria impacts to swimming and wading.

2.5.4 Potential for Environmental Impacts or Impacts to Authorized Purposes

2.5.4.1 Potential Environmental Impacts

There are 11 different endangered and threatened species that reside in Cedar, Dade, and Polk counties around Stockton Lake. 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 Arkansas darter and the Niangua darter — inhabit the rivers and streams around Stockton Lake. To thrive, these species prefer cool, clear, shallow water with slow currents and plenty of herbaceous aquatic vegetation present. The pink mucket and spectaclecase are mussel species and need free flowing rivers and streams to survive. Dams, water flow, and the zebra mussel are the most detrimental aspects to the survival of these mussels. Geocarpon, Mead's milkweed, Missouri bladderpod, and running buffalo clover are endangered or threatened plant species. These plant species all have different habitat requirements but are primarily upland species (U.S. Fish and Wildlife Service [USFWS] 2016).

The Aldrich Refuge is a 750-acre portion of the Stockton Lake Management Lands located on the Little Sac Arm of Stockton Lake. 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.

Additional environmental impacts considered during this evaluation include impacts to cultural and historic sites. There are 549 recorded archeological sites on fee land at Stockton Lake. Of these, 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 a list of 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.

2.5.4.2 Potential Impacts to Authorized Purposes

2.5.4.2.1 Potential Impacts to Dam Safety

Since this alternative is not proposing a change to the multipurpose elevation; there are no dam safety concerns.

2.5.4.2.2 Potential Impacts to Hydropower

Southwestern Power Administration (SWPA) currently uses the multipurpose pool to meet power generation contracts held within their region. Reallocating storage solely from the multipurpose pool would have a greater impact than reallocating from the flood control pool (or a pool raise) because water levels impact the efficiency and ability to generate power.

2.5.4.2.3 Potential Impacts to Recreation and Recreational Facilities

Stockton Lake offers numerous 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, while Stockton State Park is operated by MoDNR. Marinas offering a full range of services and supplies are located at Stockton State Park, Mutton Creek, and Orleans Trail. Small changes in lake levels are not anticipated to impact recreation and recreational activities; however, significant drawdown of lake levels especially during periods of drought would be most likely to negatively impact facilities such as swim beaches and marinas. These changes also could impact boating, hiking, and camping aesthetics as they could cause a bathtub ring[4] effect along the shoreline of the lake and extend the distance from campsites to water. Significant drawdown could impact access to the lake via roadways and boat ramps. Similarly, significant increase in lake levels due to changes in pool could negatively impact marinas, campsites, swim beaches, and lake access.

2.5.5 Cost

The Engineer Regulation 1105-2-100, the Planning Guidance Notebook, provides the overall direction by which USACE Civil Works projects are formulated, evaluated, and selected and defines how to calculate the cost of storage. The cost of reallocated storage includes reimbursement for reservoir capital and O&M costs (USACE 2000). The cost of reallocated water is based on the greatest (1) updated cost of storage, (2) benefits forgone, (3) revenues foregone, or (4) replacement costs. The value of usable storage at Stockton Lake is estimated at $328.16 per AF, or $29,600,000 for the 90,200 total AF of water. Annualized costs, including operation and maintenance (O&M), are shown in **Table 2-3**.

[4] The exposure of shoreline due to declining water levels

Table 2- 3: Stockton Lake Cost of Storage – Multipurpose Pool.

Water Supply Storage (AFY)	Estimated Yield (MGD)	Cost of Storage	Average Annual Cost of Storage	Estimated Annual O&M	Total Estimated Annual Cost
90,200	39	$34,100,000	$1,260,000	$180,000	$1,440,000

AFY – acre-feet per year

FY20 price level, annualized at the FY20 Fed discount rate of 2.75% based on a 50-year period of analysis.

2.5.6 Mileage and Cost of Transmission and Treatment

In addition to considering reservoir costs, the additional costs of transmission, treatment, pump station, and storage (distribution system storage) must also be taken into consideration. For the purpose of this report, minimum mileage of transmission lines was taken into consideration in order to evaluate and uniformly compare alternatives. For this Stockton Lake reallocation option, an estimated minimum of 170 miles of transmission lines would be required to connect the new Stockton Lake intake to the entire area of analysis. It is assumed that treatment, pump station, and storage costs will be similar for new reservoir construction and each of the reallocation alternatives. These costs would be further evaluated in later phases of the project.

2.5.7 Timeline for Supply Availability

The expected time frame for a water supply reallocation contract from Stockton Lake to be signed is 2021, with an additional 5 to 7 years being needed for installation of transmission facilities.

2.6 Flood Control Pool Reallocation from Stockton Lake

If the reallocation is made from the flood control pool (a pool raise), the storage in the multipurpose pool is increased by reallocation from the flood control pool and the yield/storage relationship changes. This occurs because a flood control pool reallocation requires raising the multipurpose pool elevation into the current flood control pool. To determine the yield as the storage is increased it is necessary to reference the yield/storage curve for Stockton Lake. Preliminary hydrologic and hydraulic (H&H) modeling indicates that in order to achieve a yield of 39 MGD the multipurpose pool would have to be raised approximately four 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 their expected yield. This additional storage is called “dependable yield mitigation storage” or DYMS. As stated in Engineering Circular (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 their storage remaining constant and their 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 cost of the DYMS is the responsibility of the water supply requestor, as stated in EC 1105-2-216, "All costs associated with the additional storage that is 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)."

2.6.1 Reliability and Availability of Source

Based solely on lake size, Stockton Lake has the ability to supply the desired storage amount of 60,697 AF by the year 2060 during a drought condition. Currently, Stockton Lake has storage reallocated for water supply in the multipurpose pool for City Utilities of Springfield. Since water supply would only be withdrawn during a drought-based scenario, noticeable impacts to water levels would be most likely to occur only during a drought condition.

2.6.2 Operational, Permitting and Stakeholder Considerations

2.6.2.1 Operational Considerations

The primary operational constraint is the construction of pipelines from Stockton Lake to the Coalition water utilities with the greatest demand for water during a drought condition. According to the Southwest Missouri Water Resource Study (CDM Smith et al. 2014), cities requiring the greatest demand for water during a drought condition include Springfield and Joplin, Missouri. The current infrastructure from Stockton Lake to Springfield would need to be either supplemented or replaced with a new pipeline to handle the increase of 39 MGD.

The length of the pipe needed to connect Stockton Lake to Springfield is approximately 30 miles. City Utilities of Springfield currently owns the easement from Stockton to Lake Springfield, making permitting constraints and costs for easements less than that on Pomme de Terre Lake and Table Rock Lake. The total pipeline length from Stockton Lake to Joplin is approximately 140 miles. Construction of the majority of the pipeline between Springfield and Joplin follows I-44 and Highway 96; therefore, few permits for easement should be required.

2.6.2.2 Permitting Requirements

Reallocation of water from storage to water supply will require consistency with all USACE EOPs as well as a 404 permit issued by USACE if intake construction activities result in the discharge of fill material into a stream or wetland. The Clean Water Act gives authority to each state to issue a 401 Water Quality Certification for any project that needs a 404 permit. As part of the 401 Certification, the MoDNR may require more thorough actions on projects to protect water quality. For reallocated M&I water supply storage under the 1958 WSA authority, the water supply user must be advised that the reallocation study itself will not specifically address the Section 408 considerations, but that Section 408 considerations will be taken into account in the drafting of a water storage agreement and associated real estate instruments. Any requirements for water supply user's facilities (e.g., intake structures) will be included in the agreement and associated real estate instruments (USACE 2015).

2.6.2.3 Stakeholder Considerations

Local business owners and members of the Stockton Lake Association have voiced their concerns about any proposal to reallocate water in the lake. They stated that the community of Stockton depends on the lake and expressed concern about future lake levels due to water levels in the lake having fallen in the past during periods of drought (Kennedy 2012). These concerns will have to be addressed in future stakeholder meetings regarding any reallocation for water supply out of Stockton Lake.

2.6.3 Quality of Water

In 2015, water quality at Stockton Lake was beneficial to the operating purposes of flood control, hydroelectric power, recreation, fish and wildlife, and water supply and did not exceed MoDNR water quality standards for designated uses. The Sac River from Stockton Lake Dam downstream for 40 miles is classified for whole body contact, boating and canoeing, and irrigation. The Sac River from Stockton Lake upstream for 32.5 miles is also classified for these uses. However, Turnback Creek, which flows into the Sac River arm of Stockton Lake, has been on the MoDNR impaired waters list since 2010 due to E. coli bacteria impacts to swimming and wading.

2.6.4 Potential for Environmental Impacts or Impacts to Authorized Purposes

2.6.4.1 Potential Environmental Impacts

There are 11 different endangered and threatened species that reside in Cedar, Dade, and Polk counties around Stockton Lake. 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 Arkansas darter and the Niangua darter — inhabit the rivers and streams around Stockton Lake. To thrive, these species prefer cool, clear, shallow water with slow currents and plenty of herbaceous aquatic vegetation present. The pink mucket and spectaclecase are mussel species and need free flowing rivers and streams to survive. Dams, water flow, and the zebra mussel are the most detrimental aspects to the survival of these mussels. Geocarpon, Mead's milkweed, Missouri bladderpod, and running buffalo clover are endangered or threatened plant species. These plant species all have different habitat requirements but are primarily upland species (USFWS 2016).

The Aldrich Refuge is a 750-acre portion of the Stockton Lake Management Lands located on the Little Sac Arm of Stockton Lake. When Stockton Lake is at its normal water level, more than 500 acres of the refuge are covered in water less than 2 feet deep.

Additional environmental impacts considered during this evaluation included impacts to cultural and historic sites. A 1993 survey of 1,372 acres on government lands around Stockton Lake resulted in the investigation of 90 cultural properties and 24 isolated prehistoric artifacts (Klinger et al. 1993). Of these 90 sites, two lie below the multiuse pool elevation of 867 feet NGVD 29, 19 are between 867 and 889 feet NGVD 29, 14 are between 890 and 899 feet NGVD 29, and 55 are above 900 feet NGVD 29 in elevation. Negligible changes in pool elevations are not expected to impact additional cultural or historic resources at Stockton Lake; however, mitigation of cultural sites within the approximate four-foot band would be required.

More environmental impacts are anticipated from an approximate four-foot pool raise as compared with the no action condition.

2.6.4.2 Potential Impacts to Authorized Purposes

2.6.4.2.1 Potential Impacts to Dam Safety

In order to obtain the necessary storage to meet a yield of 39 MGD, an approximate four-foot pool raise would be necessary, which will most likely have negative impacts on dam safety and flood risk management.

2.6.4.2.2 Potential Impacts to Hydropower

SWPA currently uses the multipurpose pool to meet power generation contracts held within their region. Reallocating storage solely from the flood control pool would have lesser impacts than reallocating from the multipurpose pool because SWPA would have more head and be able to generate power more efficiently.

2.6.4.2.3 Potential Impacts to Recreation and Recreational Facilities

Stockton Lake offers numerous 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, while Stockton State Park is operated by MoDNR. Marinas offering a full range of services and supplies are located at Stockton State Park, Mutton Creek, and Orleans Trail. Small changes in lake levels are not anticipated to impact recreation and recreational activities; however, significant drawdown of lake levels especially during periods of drought would be most likely to negatively impact facilities such as swim beaches and marinas. These changes also could impact boating, hiking, and camping aesthetics as they could cause a bathtub ring[5] effect along the shoreline of the lake and extend the distance from campsites to water. Similarly, significant increase in lake levels due to changes in pool could negatively impact marinas, campsites, swim beaches, and lake access.

2.6.5 Cost

The Engineer Regulation (ER) 1105-2-100, the Planning Guidance Notebook, provides the overall direction by which USACE Civil Works projects are formulated, evaluated, and selected and defines how to calculate the cost of storage. The cost of reallocated storage includes reimbursement for reservoir capital and O&M costs (USACE 2000). The cost of reallocated water is based on the greatest of (1) updated cost of storage, (2) benefits forgone, (3) revenues foregone, or (4) replacement costs. The value of usable storage at Stockton Lake is estimated at $328.00 per AF, or $32,800,000 for the 100,000 total AF of water. Annualized costs, including O&M, are shown in **Table 2-4**.

Table 2- 4: Stockton Lake Cost of Storage – Flood Control Pool.

Water Supply Storage (AFY)	Estimated Yield (MGD)	Cost of Storage	Average Annual Cost of Storage	Estimated Annual O&M	Total Estimated Annual Cost
100,000	39	$37,800,000	$1,400,000	$200,000	$1,600,000

FY20 price level, annualized at the FY20 Fed discount rate of 2.75% based on a 50-year period of analysis.

2.6.6 Mileage and Cost of Transmission and Treatment

In addition to considering reservoir costs, the additional costs of transmission, treatment, pump station, and storage (distribution system storage) must also be taken into consideration. For the purpose of this report, minimum mileage of transmission lines was taken into consideration in order to evaluate and uniformly compare alternatives. For this Stockton Lake reallocation option, an estimated minimum of 170 miles of transmission lines would be required to connect the new Stockton Lake intake to the entire area of analysis. It is assumed that treatment, pump station, and storage costs will be similar for new reservoir construction and each of the reallocation alternatives. These costs would be further evaluated in later phases of the project.

[5] The exposure of shoreline due to declining water levels

2.6.7 Timeline for Supply Availability

The expected time frame for a water supply reallocation contract from Stockton Lake to be signed is 2021, with an additional 5 to 7 years being needed for installation of transmission facilities.

2.7 Combination of Multipurpose Pool and Flood Control Pool Reallocation at Stockton Lake

A reallocation from both pools would have some of the same effects as a reallocation singularly from either pool but it is the USACE's professional judgement that reallocation from the combination of pools would potentially have lesser impacts on the authorized purposes at the lake. This alternative would raise the multipurpose pool by 1.8 feet to 868.8 feet NGVD 29 and this in theory would help lessen the impacts of full reallocation from the multipurpose pool –the intensities of the effects are netted 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.

2.7.1 Reliability and Availability of Source

Based solely on lake size, Stockton Lake has the ability to supply the desired storage amount of 45,750 AF from the multipurpose pool and 49,000 AF from the flood control pool by the year 2060 during a drought condition. Currently, Stockton Lake has storage reallocated for water supply in the multipurpose pool for City Utilities of Springfield. Since water supply would primarily be withdrawn during a drought-based scenario, noticeable impacts to water levels would be most likely to occur during a drought condition.

2.7.2 Operational, Permitting and Stakeholder Considerations

2.7.2.1 Operational Considerations

The primary operational constraint is the construction of pipelines from Stockton Lake to the Coalition water utilities with the greatest demand for water during a drought condition. According to the Southwest Missouri Water Resource Study (CDM Smith et al. 2014), cities requiring the greatest demand for water during a drought condition include Springfield and Joplin, Missouri. The current infrastructure from Stockton Lake to Springfield would need to be either supplemented or replaced with a new pipeline to handle the increase of 39 MGD.

The length of the pipe needed to connect Stockton Lake to Springfield is approximately 30 miles. City Utilities of Springfield currently owns the easement from Stockton to Lake Springfield, making permitting constraints and costs for easements less than that on Pomme de Terre Lake and Table Rock Lake. The total pipeline length from Stockton Lake to Joplin is approximately 140 miles. Construction of the majority of the pipeline between Springfield and Joplin follows I-44 and Highway 96; therefore, few permits for easement should be required.

2.7.2.2 Permitting Requirements

Reallocation of water from storage to water supply will require consistency with all USACE EOPs as well as a 404 permit issued by USACE if intake construction activities result in the discharge of fill material into a stream or wetland. The Clean Water Act gives authority to each state to issue a 401 Water Quality Certification for any project that needs a 404 permit. As part of the 401 Certification, the MoDNR may require more thorough actions on projects to protect water quality.

For reallocated M&I water supply storage under 1958 WSA authority, the water supply user must be advised that the reallocation study itself will not specifically address the Section 408 considerations, but that Section 408 considerations will be taken into account in the drafting of a water storage agreement and associated real estate instruments. Any requirements for water supply user's facilities (e.g., intake structures) will be included in the agreement and associated real estate instruments (USACE 2015).

2.7.2.3 Stakeholder Considerations

Local business owners and members of the Stockton Lake Association have voiced their concerns about any proposal to reallocate water in the lake. They stated that the community of Stockton depends on the lake and expressed concern about future lake levels due to water levels in the lake having fallen in the past during periods of drought (Kennedy 2012). These concerns will have to be addressed in future stakeholder meetings regarding any reallocation for water supply out of Stockton Lake.

2.7.3 Quality of Water

In 2015, water quality at Stockton Lake was beneficial to the operating purposes of flood control, hydroelectric power, recreation, fish and wildlife, and water supply and did not exceed MoDNR water quality standards for designated uses. The Sac River from Stockton Lake Dam downstream for 40 miles is classified for whole body contact, boating and canoeing, and irrigation. The Sac River from Stockton Lake upstream for 32.5 miles is also classified for these uses. However, Turnback Creek, which flows into the Sac River arm of Stockton Lake, has been on the MoDNR impaired waters list since 2010 due to E. coli bacteria impacts to swimming and wading.

2.7.4 Potential for Environmental Impacts or Impacts to Authorized Purposes

2.7.4.1 Potential Environmental Impacts

There are 11 different endangered and threatened species that reside in Cedar, Dade, and Polk counties around Stockton Lake. 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 Arkansas darter and the Niangua darter — inhabit the rivers and streams around Stockton Lake. To thrive, these species prefer cool, clear, shallow water with slow currents and plenty of herbaceous aquatic vegetation present. The pink mucket and spectaclecase are mussel species and need free flowing rivers and streams to survive. Dams, water flow, and the zebra mussel are the most detrimental aspects to the survival of these mussels. Geocarpon, Mead's milkweed, Missouri bladderpod, and running buffalo clover are endangered or threatened plant species. These plant species all have different habitat requirements but are primarily upland species (USFWS 2016).

The Aldrich Refuge is a 750-acre portion of the Stockton Lake Management Lands located on the Little Sac Arm of Stockton Lake. When Stockton Lake is at its normal water level, more than 500 acres of the refuge are covered in water less than 2 feet deep.

Additional environmental impacts considered during this evaluation included impacts to cultural and historic sites. A 1993 survey of 1,372 acres on government lands around Stockton Lake resulted in the investigation of 90 cultural properties and 24 isolated prehistoric artifacts (Klinger et al. 1993). Of these 90 sites, two lie below the multiuse pool elevation of 867 feet NGVD

29, 19 are between 867 and 889 feet NGVD 29, 14 are between 890 and 899 feet NGVD 29, and 55 are above 900 feet NGVD 29 in elevation. Negligible changes in pool elevations are not expected to impact additional cultural or historic resources at Stockton Lake; however, mitigation of cultural sites within the approximate 1.8-foot band of elevation increase would be required.

2.7.4.2 Potential Impacts to Authorized Purposes

2.7.4.2.1 Potential Impacts to Dam Safety

In order to obtain the necessary storage to meet a yield of 39 MGD, a pool raise would be necessary, which will most likely have negative impacts on dam safety and flood risk management, but not as large of impacts as full reallocation from the flood control pool.

2.7.4.2.2 Potential Impacts to Hydropower

SWPA currently uses the multipurpose pool to meet power generation contracts held within their region. Reallocating some of the storage from the flood control pool would have lesser impacts than reallocating wholly from the multipurpose pool because SWPA would have more head and be able to generate power more efficiently.

2.7.4.2.3 Potential Impacts to Recreation and Recreational Facilities

Stockton Lake offers numerous 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, while Stockton State Park is operated by MoDNR. Marinas offering a full range of services and supplies are located at Stockton State Park, Mutton Creek, and Orleans Trail. Small changes in lake levels are not anticipated to impact recreation and recreational activities; however, significant drawdown of lake levels especially during periods of drought would be most likely to negatively impact facilities such as swim beaches and marinas. These changes also could impact boating, hiking, and camping aesthetics as they could cause a bathtub ring[6] effect along the shoreline of the lake and extend the distance from campsites to water. Significant increase in lake levels due to changes in pool could negatively impact marinas, campsites, swim beaches, and lake access.

2.7.5 Cost

The ER 1105-2-100, the Planning Guidance Notebook, provides the overall direction by which USACE Civil Works projects are formulated, evaluated, and selected and defines how to calculate the cost of storage. The cost of reallocated storage includes reimbursement for reservoir capital and O&M costs (USACE 2000). The cost of reallocated water is based on the greatest of (1) updated cost of storage, (2) benefits forgone, (3) revenues foregone, or (4) replacement costs. The value of usable storage at Stockton Lake is estimated at $328.23 per AF, or $31,100,000 for the 94,750 total AF of water. Annualized costs, including O&M, are shown in **Table 2-5**.

Table 2- 5: Stockton Lake Cost of Storage – Combination Multipurpose and Flood Control Pool.

Water Supply Storage (AFY)	Estimated Yield (MGD)	Cost of Storage	Average Annual Cost of Storage	Estimated Annual O&M	Total Estimated Annual Cost
94,750	39	$35,800,000	$1,330,000	$190,000	$1,520,000

FY20 price level, annualized at the FY20 Fed discount rate of 2.75% based on a 50-year period of analysis.

[6] The exposure of shoreline due to declining water levels

2.7.6 Mileage and Cost of Transmission and Treatment

In addition to considering reservoir costs, the additional costs of transmission, treatment, pump station, and storage (distribution system storage) must also be taken into consideration. For the purpose of this report, minimum mileage of transmission lines was taken into consideration in order to evaluate and uniformly compare alternatives. For this Stockton Lake reallocation option, an estimated minimum of 170 miles of transmission lines would be required to connect the new Stockton Lake intake to the entire area of analysis. It is assumed that treatment, pump station, and storage costs will be similar for new reservoir construction and each of the reallocation alternatives. These costs would be further evaluated in later phases of the project.

2.7.7 Timeline for Supply Availability

The expected time frame for a water supply reallocation contract from Stockton Lake to be signed is 2021, with an additional 5 to 7 years being needed for installation of transmission facilities.

2.8 Inactive Pool Reallocation from Stockton Lake

Reallocation from the inactive pool would essentially increase the size of the multipurpose pool by lowering the bottom of the multipurpose pool into the inactive pool. The inactive pool at Stockton Lake contains storage for the following purposes: hydropower head, recreation, fish habitat, water quality, and sediment storage space. The hydropower units are unable to generate power below elevation 845 NGVD 29 due to a skimming weir that was constructed shortly after the dam was built.

2.8.1 Reliability and Availability of Source

Based solely on lake size, Stockton Lake has the ability to supply the desired storage amount by the year 2060 during a drought condition. Currently, Stockton Lake has storage reallocated for water supply in the multipurpose pool for City Utilities of Springfield. Since water supply would primarily be withdrawn during a drought-based scenario, noticeable impacts to water levels would be most likely to occur during a drought condition. Since this storage is towards the bottom of the lake, sedimentation could be an issue.

2.8.2 Operational, Permitting and Stakeholder Considerations

2.8.2.1 Operational Considerations

The primary operational constraint is the construction of pipelines from Stockton Lake to the Coalition water utilities with the greatest demand for water during a drought condition. According to the Southwest Missouri Water Resource Study (CDM Smith et al. 2014), cities requiring the greatest demand for water during a drought condition include Springfield and Joplin, Missouri. The current infrastructure from Stockton Lake to Springfield would need to be either supplemented or replaced with a new pipeline to handle the increase of 39 MGD.

The length of the pipe needed to connect Stockton Lake to Springfield is approximately 30 miles. City Utilities of Springfield currently owns the easement from Stockton to Lake Springfield, making permitting constraints and costs for easements less than that on Pomme de Terre Lake and Table Rock Lake. The total pipeline length from Stockton Lake to Joplin is approximately 140 miles. Construction of the majority of the pipeline between Springfield and Joplin follows I-44 and Highway 96; therefore, few permits for easement should be required.

2.8.2.2 Permitting Requirements

Reallocation of water from storage to water supply will require consistency with all USACE EOPs as well as a 404 permit issued by USACE if intake construction activities result in the discharge of fill material into a stream or wetland. The Clean Water Act gives authority to each state to issue a 401 Water Quality Certification for any project that needs a 404 permit. As part of the 401 Certification, the MoDNR may require more thorough actions on projects to protect water quality. For reallocated M&I water supply storage under 1958 WSA authority, the water supply user must be advised that the reallocation study itself will not specifically address the Section 408 considerations, but that Section 408 considerations will be taken into account in the drafting of a water storage agreement and associated real estate instruments. Any requirements for water supply user's facilities (e.g., intake structures) will be included in the agreement and associated real estate instruments (USACE 2015).

2.8.2.3 Stakeholder Considerations

Local business owners and members of the Stockton Lake Association have voiced their concerns about any proposal to reallocate water in the lake. They stated that the community of Stockton depends on the lake and expressed concern about future lake levels due to water levels in the lake having fallen in the past during periods of drought (Kennedy 2012). These concerns will have to be addressed in future stakeholder meetings regarding any reallocation for water supply out of Stockton Lake.

2.8.3 Quality of Water

In 2015, water quality at Stockton Lake was beneficial to the operating purposes of flood control, hydroelectric power, recreation, fish and wildlife, and water supply and did not exceed MoDNR water quality standards for designated uses. The Sac River from Stockton Lake Dam downstream for 40 miles is classified for whole body contact, boating and canoeing, and irrigation. The Sac River from Stockton Lake upstream for 32.5 miles is also classified for these uses. However, Turnback Creek, which flows into the Sac River arm of Stockton Lake, has been on the MoDNR impaired waters list since 2010 due to E. coli bacteria impacts to swimming and wading.

2.8.4 Potential for Environmental Impacts or Impacts to Authorized Purposes

2.8.4.1 Potential Environmental Impacts

There are 11 different endangered and threatened species that reside in Cedar, Dade, and Polk counties around Stockton Lake. 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 Arkansas darter and the Niangua darter — inhabit the rivers and streams around Stockton Lake. To thrive, these species prefer cool, clear, shallow water with slow currents and plenty of herbaceous aquatic vegetation present. The pink mucket and spectaclecase are mussel species and need free flowing rivers and streams to survive. Dams, water flow, and the zebra mussel are the most detrimental aspects to the survival of these mussels. Geocarpon, Mead's milkweed, Missouri bladderpod, and running buffalo clover are endangered or threatened plant species. These plant species all have different habitat requirements but are primarily upland species (USFWS 2016).

The Aldrich Refuge is a 750-acre portion of the Stockton Lake Management Lands located on the Little Sac Arm of Stockton Lake. When Stockton Lake is at its normal water level, more than 500 acres of the refuge are covered in water less than 2 feet deep.

Additional environmental impacts considered during this evaluation included impacts to cultural and historic sites. A 1993 survey of 1,372 acres on government lands around Stockton Lake resulted in the investigation of 90 cultural properties and 24 isolated prehistoric artifacts (Klinger et al. 1993). Of these 90 sites, two lie below the multiuse pool elevation of 867 feet NGVD29, 19 are between 867 and 889 feet NGVD 29, 14 are between 890 and 899 feet NGVD 29, and 55 are above 900 feet NGVD 29 in elevation. Negligible changes in pool elevations are not expected to impact additional cultural or historic resources at Stockton Lake; however, mitigation of cultural sites within the approximate 1.8-foot band of elevation increase would be required.

2.8.4.2 Potential Impacts to Authorized Purposes

2.8.4.2.1 Potential Impacts to Dam Safety

Since this alternative is not proposing a change to the multipurpose elevation; there are no dam safety concerns.

2.8.4.2.2 Potential Impacts to Hydropower

SWPA currently uses the multipurpose pool to meet power generation contracts held within their region. Reallocating storage solely from the inactive pool would have more impacts than reallocating from the multipurpose pool because SWPA be would have less head and need more water to be able to generate power more efficiently.

2.8.4.2.3 Potential Impacts to Recreation and Recreational Facilities

Stockton Lake offers numerous 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, while Stockton State Park is operated by MoDNR. Marinas offering a full range of services and supplies are located at Stockton State Park, Mutton Creek, and Orleans Trail. Small changes in lake levels are not anticipated to impact recreation and recreational activities; however, significant drawdown of lake levels especially during periods of drought would be most likely to negatively impact facilities such as swim beaches and marinas. These changes also could impact boating, hiking, and camping aesthetics as they could cause a bathtub ring[7] effect along the shoreline of the lake and extend the distance from campsites to water. Significant increase in lake levels due to changes in pool could negatively impact marinas, campsites, swim beaches, and lake access.

2.8.5 Cost

The ER 1105-2-100, the Planning Guidance Notebook, provides the overall direction by which USACE Civil Works projects are formulated, evaluated, and selected and defines how to calculate the cost of storage. The cost of reallocated storage includes reimbursement for reservoir capital and O&M costs (USACE 2000). The cost of reallocated water is based on the greatest of (1) updated cost of storage, (2) benefits forgone, (3) revenues foregone, or (4) replacement costs. Costs are expected to be about the same as the combination pool alternative.

[7] The exposure of shoreline due to declining water levels

2.8.6 Mileage and Cost of Transmission and Treatment

In addition to considering reservoir costs, the additional costs of transmission, treatment, pump station, and storage (distribution system storage) must also be taken into consideration. For the purpose of this report, minimum mileage of transmission lines was taken into consideration in order to evaluate and uniformly compare alternatives. For this Stockton Lake reallocation option, an estimated minimum of 170 miles of transmission lines would be required to connect the new Stockton Lake intake to the entire area of analysis. It is assumed that treatment, pump station, and storage costs will be similar for new reservoir construction and each of the reallocation alternatives. These costs would be further evaluated in later phases of the project.

2.8.7 Timeline for Supply Availability

The expected time frame for a water supply reallocation contract from Stockton Lake to be signed is 2021, with an additional 5 to 7 years being needed for installation of transmission facilities.

2.9 Water Importation

Water importation was evaluated to determine if purchasing water within southwest Missouri or through inter-state water purchases would be a viable option to meet the projected regional supply gap of 39 MGD. The primary challenge for importing water within the State of Missouri or from inter-state water purchases is finding a water supply and obtaining water rights due to some states limiting or prohibiting the transfer of water supplies outside state boundaries.

2.9.1 Reliability and Availability of Source

Purchasing water from several wholesale water providers was evaluated within the southwest Missouri 16-county region. Data requests were completed in 2016 by Joplin/Mo American, the City of Lamar, the City of Springfield, the City of Branson, the City of Carthage, and the City of Monett to determine future water availability from potential wholesalers in the region. Based on these results, it was determined that there are no planned improvements regionally that will allow additional wholesale supply to meet the identified need. Therefore, in-state water importation would not be a viable option.

Inter-state water purchases from Arkansas, Kansas, and Oklahoma were investigated and would only be feasible if large volumes of yield are realized over a long period of time. Arkansas has projected that by 2050 they will have an annual average groundwater supply gap of 8.2 million AF throughout the state. Additionally, Arkansas' three major river basins have projected water supply gaps by the year 2050, accounting for both groundwater and surface water supplies. Due to the projected water supply gap, water importation was not considered from Arkansas (Arkansas Natural Resources Commission 2014). Additionally, purchasing water from Oklahoma's Grand Lake was examined, and it was determined that due to a lengthy moratorium prohibiting transferring water out of Oklahoma, it was not a viable option. This moratorium (2016 Oklahoma Statutes Title 82) resulted in the conclusion that this water is not likely to be available to Coalition members (CDM Smith et al. 2012). Water importation from Kansas was also investigated, but there would be difficulty implementing these transfers within a reasonable timeframe due to the logistics of obtaining water rights and legal agreements for out-of-basin transfers. Conveyance and treatment costs also would be substantial due to the geographical location of Kansas's water sources to the cities in critical need of water supply in southwestern Missouri.

Wholesale water purchases from within southwest Missouri or water importation from outside the region do not appear to be feasible options to meet the anticipated water supply gap due to the lack of excess water supply availability and legal obstructions. Therefore, remaining screening criteria were not evaluated as part of this effort.

2.10 Local River or Stream Withdrawal

Local surface water availability from rivers and streams was assessed to determine if withdrawals would provide sufficient supply into the future.

2.10.1 Reliability and Availability of Source

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.

2.11 Pomme de Terre Lake Reallocation

Pomme de Terre Lake is located 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. As a multipurpose pool, Pomme de Terre Lake covers 7,820 acres and can increase to 16,100 acres for flood control purposes. This lake has a pool elevation of 839 feet above mean sea level (amsl) and has approximately 113 miles of shoreline (Fuller 2013). The primary authorized purposes for Pomme de Terre Lake include flood control, recreation, water quality, and fish and wildlife management. Water supply need for reallocation within Pomme de Terre Lake has been evaluated to be 54,194 AF by the year 2060. The greatest issues present when considering reallocation within Pomme de Terre Lake include the geographical distance to cities requiring water supply in drought conditions and the complexity of acquiring easement for construction of the pipeline to a water treatment facility.

2.11.1 Reliability and Availability of Source

Based solely on lake size, Pomme de Terre Lake has the ability to supply the desired storage amount of 54,194 AF by the year 2060 during a drought condition. Currently, Pomme de Terre Lake does not have any storage reallocated for water supply in either the multipurpose or flood control pools. Since water supply would primarily be withdrawn during a drought-based scenario, noticeable impacts to water levels would be expected to occur during a drought condition. Impacts caused by reduction of lake levels may depend on whether the water storage is reallocated out of the multipurpose pool or the flood control pool. Since Pomme de Terre Lake is the smallest lake compared to Stockton and Table Rock, the impacts due to drawdown of comparable lake levels may be more pronounced at Pomme de Terre Lake.

2.11.2 Potential for Environmental Impacts or Impacts to Authorized Purposes

2.11.2.1 Potential for Environmental Impacts

Based on records from USFWS, there are six endangered or threatened species that reside in Hickory and Polk counties. Three are bat species — Grey bat, Indiana bat, and Northern Long-Eared bat — that dwell mostly in caves for hibernation and roost in forested areas during the remainder of the year; however, the grey bat dwells in the caves year-round. Niangua darter is found in clear creeks and small rivers, draining hilly areas and shallow pools. Geocarpon prefers moist, eroded areas on exposed sandstone glades. Mead's Milkweed prefers upland tall grass prairie or glade/barren habitat (USFWS 2017). Based on the habitat requirements for each of these species, it is not anticipated that there would be any adverse impacts to the threatened or endangered species by reducing the water level within Pomme de Terre Lake.

Drawdown from normal lake levels may decrease the amount of suitable habitat for aquatic life that live along the shoreline, potentially decreasing spawning locations for certain fish species and increasing stress levels in fish due to increased lake temperatures. Additionally, marine habitats along the shoreline may be negatively impacted by reducing water levels. The Missouri Department of Conservation intentionally drew down Pomme de Terre Lake levels in 2010 to conduct major renovation on the stilling basin below the dam and create habitat structures. Reductions of water levels in Pomme de Terre Lake due to reallocation withdrawals may expose these habitat structures along the shoreline and may increase vulnerability to damage from unsuspecting boats. **Figure 2-3** shows the locations of the habitat structures along the shoreline.

Figure 2- 4: Location of Shallow Water Wood Pallet Habitat Sites. Source: Fuller 2013.

Additional environmental impacts considered during this evaluation included impacts to cultural and historic sites. USACE has professionally surveyed 4,702 acres of their 18,335 acres for archeological sites since 1979 (USACE Kansas City District 2016). The land was surveyed between the elevation of 838 and 851 feet above msl. From the survey, 326 cultural resource sites have been recorded but not listed on the National Register of Historic Places (NRHP), and 27 sites were determined to be eligible for the NRHP. Another 102 sites have not been determined as eligible for the NRHP.

2.11.2.2 Potential for Impacts to Authorized Purposes

2.11.2.2.1 Potential Impacts to Dam Safety

Since this alternative is not proposing a change to the multipurpose elevation; there are no dam safety concerns.

2.11.2.2.2 Potential Impacts to Hydropower

SWPA is not authorized to generate from Pomme de Terre; however, outflows from Pomme de Terre become inflows into Harry S. Truman Reservoir, which is authorized for hydropower generation. Less outflow from Pomme de Terre could negatively impact SWPA power generation at Harry S. Truman Reservoir.

2.11.2.2.3 Potential Impacts to Recreation and Recreational Facilities

The reduction of normal water levels within Pomme de Terre Lake can have both short- and long-term effects on recreation and recreational facilities. The recreation activities at Pomme de Terre Lake include boating, canoeing, swimming, fishing, bicycling, camping, hiking, hunting, and picnicking. MoDNR manages Pomme de Terre State Park, which is located on the Hermitage and Pittsburg sides of Pomme de Terre Lake. Pomme de Terre State Park features a marina, swim beaches, campgrounds, amphitheaters, and hiking trails. There are 13 public boat ramps, 4 public fishing docks, and 569 private boat docks around Pomme de Terre Lake according to the 2016 Pomme de Terre Lake Master Plan (USACE-KC 2016). The reduction of water levels may result in

the long-term effect of closures to boat ramps and docks as well as the closure of fishing docks. There are two swim beaches on the Pittsburg and Hermitage side of the lake that may be negatively impacted by the drawdown of lake levels.

2.11.3. Operational, Permitting, and Stakeholder Considerations

2.11.3.1 Operational Considerations

The primary operational constraint is the construction of pipelines to water treatment facilities due to the geographical location of Pomme de Terre Lake to the Coalition water utilities with the greatest demand for water during a drought condition. According to the Southwest Missouri Water Resource Study (CDM Smith et al. 2014), cities requiring the greatest demand for water during a drought condition include Springfield and Joplin, Missouri. Pomme de Terre Lake does not have an existing intake structure or pipeline to convey water to a water treatment facility. Therefore, an intake structure would need to be built and pipelines installed to water treatment facilities in and around Springfield and Joplin.

Based on preliminary hydraulic analysis, a pump station would be installed on the southwest side of the lake and connect to the Springfield Pipeline Easement. While City Utilities of Springfield currently owns the easement from Stockton Lake to Springfield, there is no linear route along a roadway to connect Pomme de Terre Lake to the Springfield Pipeline Easement; therefore, a greater amount of permits and costs for easements or acquisition of private property will be required to complete the construction of the pipeline. The increased number of permits required to install the pipeline may increase the complexity and timeline for completion of the project as well as the overall cost of construction.

The length of the pipe needed to connect Pomme de Terre Lake to Springfield is approximately 40 miles. The total pipeline length from Pomme de Terre Lake to Joplin is approximately 150 miles. Construction of the majority of the pipeline between Springfield and Joplin follows I-44 and Highway 96; therefore, few permits for easement will be required. However, the challenges presented to connect the pipeline from Pomme de Terre Lake to the Springfield Pipeline Easement would still be encountered.

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 of 39 MGD.

2.11.3.2 Permitting Requirements

Reallocation of water from storage to water supply will require consistency with all USACE EOPs as well as a 404 permit issued by USACE if construction of the dam results in the discharge of fill material into a stream or wetland, which is highly probable. The Clean Water Act gives authority to each state to issue a 401 Water Quality Certification for any project that needs a 404 permit. As part of the 401 Certification, MoDNR may require more thorough actions on projects to protect water quality. For reallocated M&I water supply storage under 1958 WSA authority, the water supply user must be advised that the reallocation study itself will not specifically address the Section 408 considerations but that Section 408 considerations will be taken into account in the drafting of a water storage agreement and associated real estate instruments. Any requirements for water supply user's facilities (e.g., intake structures) will be included in the agreement and associated real estate instruments (USACE 2015).

2.11.3.3 Stakeholder Considerations

The community acceptance for reallocating a portion of Pomme de Terre Lake's multipurpose pool for water supply to be used during a drought condition may be a concern due to the large number of private boat docks located on the lake. Dock owners and real estate companies would be expected to be involved in this process as changes in lake elevations could directly impact boat dock use and property values.

2.11.4 Quality of Water

Water quality at Pomme de Terre Lake is beneficial to operating purposes (i.e., flood control, recreation, and fish and wildlife) and does not exceed Missouri state water quality standards for its designated uses (USACE- KC 2016). Natural treatment processes occur as water flows through Pomme de Terre Lake by settling, diluting, and biologically processing nutrients, herbicides, and sediments prior to discharging at the dam. The reduction of water levels may have an impact on water quality parameters such as temperature of the lake or turbidity from exposed shoreline.

2.11.5 Cost

Based on a desired total storage of 55,000 AF in the year 2060, annual cost of storage was estimated by USACE to be approximately $660,000. **Table 2-6** provides a summary of costs. Pomme de Terre Lake is approximately 20 miles farther from the cities that will require the greatest demand for water during a drought condition when compared to Stockton Lake.

Table 2- 6: Pomme de Terre Lake Cost of Storage.

Water Supply Storage (AFY)	Estimated Yield (MGD)	Cost of Storage	Average Annual Cost of Storage	Estimated Annual O&M	Total Estimated Annual Cost
55,000	39	$14,900,000	$552,000	$156,000	$710,000

FY20 price level, annualized at the FY20 Fed discount rate of 2.75% based on a 50-year period of analysis.

2.11.6 Mileage and Cost of Transmission Lines and Treatment

In addition to considering reservoir costs, cost of transmission, treatment, pump station, and storage (distribution system storage) must be taken into consideration. For the purpose of this report, minimum mileage of transmission lines was taken into consideration in order to evaluate and uniformly compare alternatives. For this Pomme de Terre Lake reallocation option, an estimated minimum of 190 miles of transmission lines would be required to connect the new Pomme de Terre Lake intake to the entire area of analysis. It is assumed that treatment, pump station, and storage costs will be similar for new reservoir construction and reallocation alternatives. These costs would be further evaluated in later phases of the project.

2.11.7 Timeline for Supply Availability

The expected time frame for a water supply reallocation contract from Pomme de Terre Lake to be signed is 2022, with an additional 5 to 7 years being needed for installation of transmission facilities.

2.12 Table Rock Lake Reallocation

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 nominal top of the multipurpose pool for Table Rock

Lake is 915 feet above msl and covers an area of 42,644 acres, which can be increased to 931 feet amsl and cover 51,291 acres for flood control purposes. During an extreme drought condition, the maximum drawdown of the lake is 846 feet amsl in order to still meet the long-range hydroelectric power commitments (USACE 2014). The primary authorized purposes for Table Rock Lake include flood control, generation of hydroelectric power, recreation, and fish and wildlife habitat.

Water supply availability for reallocation within Table Rock Lake has been evaluated to be 56,000 AF by the year 2060. The greatest issues present when considering reallocation within Table Rock Lake include the geographical distance to cities requiring water supply in drought conditions and the community's acceptance for reallocating water storage within Table Rock Lake for water supply.

2.12.1 Reliability and Availability of Source

Based solely on lake size, Table Rock Lake has the ability to supply the desired storage amount of 56,000 AF by the year 2060 during a drought condition. Currently, Table Rock Lake does not have any storage reallocated for water supply in either the multipurpose or flood control pools. Since water supply would primarily be withdrawn during a drought-based scenario, impacts to water levels would occur during a drought condition. Impacts caused by reduction of lake levels may depend on whether the water storage is reallocated out of the multipurpose pool or the flood control pool.

2.12.2 Potential for Environmental Impacts or Impacts to Authorized Purposes

2.12.2.1 Potential for Environmental Impacts

Based on records from the USFWS in Arkansas (2015) and Missouri (2017), there are 11 different endangered or threatened species that reside in Barry, Stone, Taney, Carrol, or Boone counties that are discussed in this section. Of the endangered or threatened species, the four bat species — grey bat, Indiana bat, northern long-eared bat, and Ozark big-eared bat — dwell mostly in caves for hibernation and roost in forested areas during the remainder of the year. However, the gray bat and Ozark big-eared bat dwell in the caves year-round. Neosho mucket, rabbitsfoot, and snuffbox are freshwater mussels found anchoring themselves in rivers and streams. The Arkansas darter lives in rivers and streams, whereas the Ozark cavefish and tumbling creek cavesnail have adapted to cave environments. Running buffalo clover is found in periodically disturbed rich soils between open forest and prairie. Additionally, even though bald eagles are not endangered or threatened, they are still protected in Carroll and Boone counties. Based on the habitat requirements for each of these species and the minimal impacts to water levels anticipated from the reallocation, it is not anticipated that there would not be any adverse impacts to the threatened or endangered species by reducing the water level within Table Rock Lake. Also, no adverse impacts to aquatic life that is non-endangered or threatened are anticipated due to the relatively minimal amount of drawdown necessary.

Additional environmental impacts considered during this evaluation included impacts to cultural and historic sites. Previous investigations in locations surrounding Table Rock Lake have found historical sites with local and regional significance but no sites with national significance. The surrounding areas of Table Rock Lake include 1,076 archeological sites made up of open camp sites, shelter and cave sites, rock cairns, and earthen mound sites (USACE 2014).

2.12.2.2 Potential for Impacts to Authorized Purposes

2.12.2.2.1 Potential Impacts to Dam Safety

Since this alternative does not entail a change to the multipurpose elevation there are no dam safety concerns. However, in a formal water supply storage reallocation, dam safety would be further evaluated if the reallocation is taken from the flood control pool and/or requires a change in pool elevation.

2.12.2.2.2 Potential Impacts to Hydropower

Potential impacts to hydropower would be assessed based on possible changes to the pool elevation and the amount of storage reallocated.

2.12.2.2.3 Potential Impacts to Recreation and Recreational Facilities

Millions of visitors come to Table Rock Lake to enjoy the recreational activities, including swimming, SCUBA diving, boating, water skiing, fishing, picnicking, camping, hiking, and biking. In 2016, there were more than 13,000 private and public boat slips and other accesses from resorts and marinas around Table Rock Lake (Barmeier 2016). As seen in **Figure 2-4** from the informational website Lakes Online, the water levels at Table Rock Lake experienced seasonal variability of drawdown from 2012 to 2016. In 2012, 2014, and 2016, lake levels decreased steadily 5 to 10 feet throughout the year and increased to normal lake levels in mid-April (Lakes Online 2017). These seasonal impacts are shown to occur during the beginning of the summer months and extend into the fall and may have an effect on recreational activities and facilities at Table Rock Lake.

In a drought condition, an additional decrease in water level due to reallocation withdrawals may occur. Negative impacts seen from this amount of drawdown most likely are minimal but may include limited access to private and public boat slips, access locations at resorts, or access from the marina, depending on the water elevations in certain locations. Recreational facilities and activities located away from the shoreline (i.e., campgrounds, trails, playgrounds, picnicking areas, shower houses) would be minimally impacted due to the lowering of lake water levels that may occur during a drought scenario.

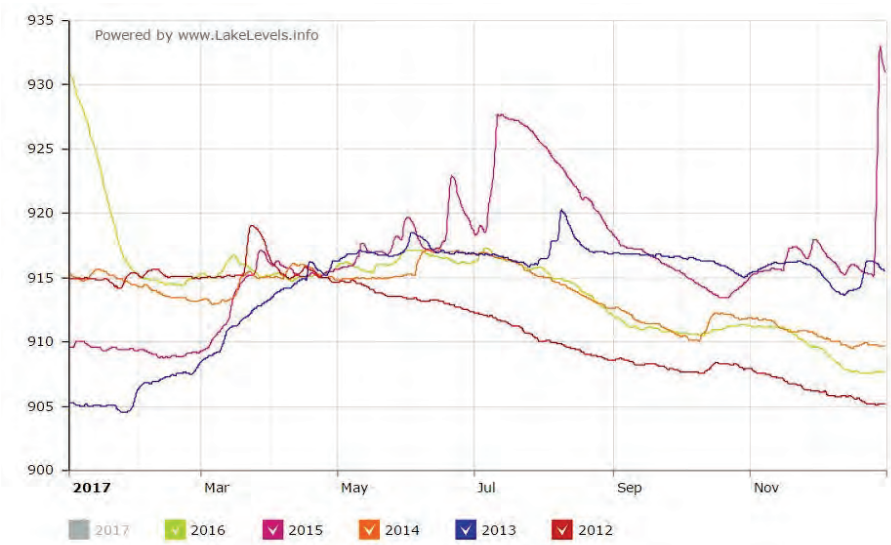

Figure 2- 5: Table Rock Lake Levels from 2012 through 2016. Source: Lakes Online 2017.

2.12.3 Operational, Permitting, and Stakeholder Considerations

2.12.3.1 Operational Considerations

The primary operational constraint is the construction of pipelines to water treatment facilities due to the geographical location of Table Rock Lake to the water utilities that will require the greatest demand for water during a drought condition. According to the Southwest Missouri Water Resource Study (CDM Smith et al. 2014), cities requiring the greatest demand for water during a drought condition include Springfield and Joplin, Missouri. Table Rock Lake does not have an existing intake structure or pipeline to convey water to a water treatment facility. Therefore, an intake structure would need to be built and pipelines installed to water treatment facilities in and surrounding Springfield and Joplin.

2.12.3.2 Permitting Requirements

Reallocation of water from storage to water supply will require consistency with all USACE EOPs as well as a 404 permit issued by USACE if construction of the dam results in the discharge of fill material into a stream or wetland, which is highly probable. The Clean Water Act gives authority to each state to issue a 401 Water Quality Certification for any project that needs a 404 permit. As part of the 401 Certification, the MoDNR may require more thorough actions on projects to protect water quality. For reallocated M&I water supply storage under 1958 WSA authority, the water supply user must be advised that the reallocation study itself will not specifically address the Section 408 considerations but that Section 408 considerations will be taken into account in the drafting of a water storage agreement and associated real estate instruments. Any requirements for water supply user's facilities (e.g., intake structures) will be included in the agreement and associated real estate instruments (USACE 2015).

2.12.3.3 Stakeholder Considerations

The community acceptance for reallocating a portion of Table Rock Lake's multipurpose pool for water supply to be used during a drought condition may be a concern due to the community's desire to limit development around Table Rock Lake. The community is able to voice their concerns about real estate development around Table Rock Lake through the Tri-Lakes Board of Realtors. The Tri-Lakes Board of Realtors has recently petitioned against the USACE's un-submitted Shoreline Management Plan, which has led to including new regulations for development of the plan in the 2016 Water Resources and Development Act.

2.12.4 Quality of Water

Historically, Table Rock Lake has seen higher nutrient levels, specifically nitrogen and phosphorus, from wastewater treatment plant discharge, residential onsite treatment systems (i.e., failing septic systems), and runoff of wastes from livestock and poultry operations into the lake (Table Rock Lake Water Quality, Inc. 2007). Table Rock Lake, James River, Kings River, and Long Creek arms of the lake are currently on the 2016 Missouri Section 303(d) list for nutrient and eutrophication biological indicators (MoDNR 2016). By reducing the water levels in Table Rock Lake, there will be less water to dilute the nutrient concentrations. Therefore, lowering water levels most likely will not have a positive impact on nutrient concentrations. In order to use water supplies from Table Rock Lake for drinking water purposes, additional treatment may be required to reduce nutrient concentrations at the water treatment plant, which may increase treatment costs.

2.12.5 Cost

Based on a desired total storage of 56,000 AF in the year 2060, annual cost of storage was estimated by USACE to be approximately $360,000. A summary of estimated costs of storage is provided in **Table 2-7**.

Table 2- 7: Table Rock Lake Cost of Storage.

Water Supply Storage (AFY)	Estimated Yield (MGD)	Cost of Storage	Average Annual Cost of Storage	Estimated Annual O&M	Total Estimated Annual Cost
56,000	39	$8,300,000	$367,000	$32,000	$400,000

FY20 price level, annualized at the FY20 Fed discount rate of 2.75% based on a 50-year period of analysis.

2.12.6 Mileage and Cost of Transmission Lines and Treatment

In addition to considering reservoir costs, cost of transmission, treatment, pump station, and storage (distribution system storage) must also be taken into consideration. For the purpose of this report, minimum mileage of transmission lines was taken into consideration in order to evaluate and uniformly compare alternatives. The cost to build an inlet and convey water from Table Rock Lake to the cities that will require the greatest demand for water during a drought condition would be extensive. Table Rock Lake is approximately 20 miles farther from the cities that will require the greatest demand for water during a drought condition when compared to Stockton Lake. For this Table Rock Lake reallocation option, an estimated minimum of 190 miles of transmission lines would be required to connect the new Table Rock Lake intake to the entire area of analysis. It is assumed that treatment, pump station, and storage costs will be similar for new reservoir construction and reallocation alternatives. These costs would be further evaluated in later phases of the project.

2.12.7 Timeline for Supply Availability

The expected time frame for a water supply reallocation study is pending and dependent upon completion of a White River Basin study. If a reallocation is authorized in the future, an additional 5 to 7 years would be needed for installation of transmission facilities.

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Section 3

Summary and Conclusions

This report evaluated the feasibility of alternative water supply sources for southwest Missouri to meet the forecasted regional water demand in 2060. The alternatives evaluated include increased conservation measures; creating groundwater well fields; importing water; utilizing local river or stream withdrawals; constructing surface water storage; and water reallocation from Stockton Lake, Pomme de Terre Lake, and Table Rock Lake.

The results of the screening analysis are summarized in **Table 3-1**. 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 is not ideal for implementation due to constraints of that criteria category. "Low" indicates the alternative is feasible for implementation with limited to no impact on that criterion. "N/A" indicates the criterion was not evaluated due to a previously analyzed criterion that was determined to be detrimental to the progression of the alternative. The alternative was therefore not further evaluated.

Table 3- 1: 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**

Table 3-1 Notes:

Alternative 1, the Future Without Project Alternative, but is used as a comparison with Future With Project 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.

The evaluation of increased conservation measures concluded that the alternative may be implementable; however, the alternative is not viable as a sole source of future supply because the maximum amount of water conserved by the year 2060 would not be enough to meet water supply demands. Additionally, some providers with future gaps in supply are currently implementing all conservation measures discussed within this analysis. Groundwater well fields were also determined to not be a viable option due to the present issues with water quality and the extent of drawdown in the regional aquifers. As for Pomme de Terre Lake Reallocation and Table Rock Lake Reallocation, these alternatives likely would be able to supply the amount of water required to meet future regional demands; however, these alternatives have significant operational constraints due to the distance from the lakes to the cities requiring water supply. Additionally, construction of one or multiple new reservoirs would adequately meet the supply gap of the region; however, this would be the most expensive cost option and have an extended timeline. Gaps in supply may be experienced prior to new reservoir completion. Environmental and stakeholder limitations also may hinder new reservoir construction.

Stockton Lake reallocation has been determined to be the most feasible and sustainable option to meet the future water supply need. Assuming 5 to 7 years for construction of necessary transmission facilities to deliver reallocated water and having a contract in place by 2022, based on the forecasted drought scenario, the additional water supply from Stockton Lake would be available prior to when the gap becomes a concern. Additionally, the location of Stockton Lake and the existing infrastructure and easements in place make the operational constraints for delivery of the reallocated water more feasible and economical than Pomme de Terre and Table Rock lakes. Further analysis will be conducted to evaluate the impacts to the authorized purposes based upon the future supply gap of 39 MGD for the region.

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Section 4

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STOCKTON LAKE REALLOCATION STUDY

Draft Integrated Water Supply Storage Reallocation Report and Environmental Assessment

Draft Appendix M-Programmatic Agreement

June 2020

US Army Corps of Engineers ®
Kansas City District

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DRAFT PROGRAMMATIC AGREEMENT

AMONG THE U.S. ARMY CORPS OF ENGINEERS, KANSAS CITY DISTRICT; SOUTHWEST MISSOURI REGIONAL WATER COMMISSION; OSAGE NATION; (OTHER TRIBES); THE MISSOURI STATE HISTORIC PRESERVATION OFFICER; AND THE ADVISORY COUNCIL ON HISTORIC PRESERVATION REGARDING THE STOCKTON LAKE WATER SUPPLY STORAGE REALLOCATION FEASIBILITY STUDY

WHEREAS, the U.S. Army Corps of Engineers, Kansas City District (Corps) is developing a water supply storage reallocation study at Stockton Lake, Missouri in response to a request made by the Tri-State Water Resources Coalition (also known as the Southwest Missouri Regional Water Commission) for the purpose of obtaining enough water supply storage to meet a projected gap of 39 million gallons per day in the 16-county southwest Missouri region by 2070; and

WHEREAS, the general Area of Potential Effects for the reallocation study includes the proposed pool raise on Corps-owned lands along the shoreline of Stockton Lake from the normal pool operating elevation of 867 feet NGVD 29 to the proposed lake raise of 868.8 NGVD 29 (Appendix A); and

WHEREAS, the Corps is the lead federal agency for purposes of the National Environmental Policy Act of 1969 (NEPA) and the National Historic Preservation Act (NHPA) (54 U.S.C. §§ 300101 et seq.) and in accordance with 36 C.F.R. §§ 800.2(a)(2) and 800.8; and

WHEREAS, the Corps has determined that the proposed reallocation of water supply storage resulting from the reallocation study constitutes a Federal Undertaking that may have adverse effects on historic properties and has consulted with the Missouri State Historic Preservation Officer (SHPO) pursuant to 36 CFR Part 800, the regulations implementing Section 106 of the NHPA; and

WHEREAS, in accordance with 36 C.F.R. §§ 800.4(b)(2) and 800.5(a)(3), the Corps has elected to use a phased process to conduct identification and evaluation of properties included on, or eligible for inclusion on, the National Register of Historic Places (hereafter called historic properties) and for application of the criteria of adverse effect, respectively, because the scope of the undertaking makes it unreasonable to identify historic properties or determine the effects at this time; and

WHEREAS, 36 C.F.R. § 800.14, allows the Corps to negotiate a programmatic agreement (PA) to govern the implementation of a particular program or the resolution of adverse effects from complex project situations or multiple undertakings; and,

WHEREAS, in this PA, “Signatories” is defined in 36 C.F.R. § 800.6(c)(1) and “Invited Signatories” is defined in 36 C.F.R. § 800.6(c)(2); and

WHEREAS, in accordance with 36 C.F.R. § 800.6(a)(1)(i)(C), the Advisory Council on Historic Preservation (ACHP) has been provided the required documentation and invited to participate in this PA, and has accepted in a letter dated May 22, 2020 in accordance with 36 C.F.R. § 800.6(a)(1)(iv); and

WHEREAS, the Corps and Southwest Missouri Regional Water Commission as the proponents of the Undertaking, are Signatories to this PA; and

WHEREAS, letters describing the Project and its objectives and inviting participation were sent to eight (8) Federally-recognized Indian Tribes (listed in Appendix B); and

WHEREAS, of those Federally-recognized Indian Tribes invited to participate the Osage Nation has chosen to participate in Section 106 consultation and to be Invited Signatories to this PA, in accordance with 36 C.F.R. 800.2 and 800.6; and

WHEREAS, the Missouri Alliance for Historic Preservation was invited to participate, but declined; and

NOW THEREFORE, the Corps, Southwest Missouri Regional Water Commission, Osage Nation, and Missouri SHPO agree that the Projects under Stockton Lake Water Supply Storage Reallocation Feasibility Study shall be implemented in accordance with the following stipulations in order to take into account the effect of the individual undertakings on historic properties.

STIPULATIONS

The Corps shall ensure that the following measures are carried out:

I. STANDARDS

A. All cultural resource investigations including site identification, National Register of Historic Places (NRHP) eligibility evaluations and, as appropriate, mitigation measures for adverse effects to historic properties required under the terms of this PA will be carried out by or under the direct in the field supervision of appropriate professional(s) or by contractors who meet, at a minimum, the *Secretary of the Interior's Historic Preservation Professional Qualification Standards* (48 FR 44716, September 29, 1983).

B. In developing scopes of work for identification, evaluation studies, treatment measures, and stewardship activities required under the terms of this PA, the Corps and Southwest Missouri Regional Water Commission will take into account the following guidance:

1. ACHP's guidance on conducting archaeology under Section 106 (2007);
2. ACHP's *Policy Statement Regarding the Treatment of Burial Sites, Human Remains and Funerary Objects* (February 23, 2007);
3. Guidance from the Osage Nation *National Historic Preservation Act Section 106 Protocol and Standards, Archaeological Survey Standards, Archaeological Resources Protection Act Violation Procedures, and Procedures for Handling Human Remains during Authorized Intentional Excavations or during Inadvertent Discoveries of Human Remains* (Appendix C);
4. Guidance from the Missouri SHPO (Appendix D);
5. Secretary of the Interior's *Standards and Guidelines for Archaeology and Historic Preservation* (48 FR 44716-42, September 29, 1983); and
6. "*Treatment of Archaeological Properties*" (ACHP 1983).

II. CONFIDENTIALITY

The Corps will safeguard information about historic properties of religious and cultural significance to Federally-recognized Indian Tribes, including location information, or non-public information provided by Federally-recognized Indian Tribes to assist in the identification of such properties, to the extent allowed by Section 304 of NHPA (54 U.S.C. § 307103), and other applicable laws.

III. POINTS OF CONTACT

A. The Signatories and Invited Signatories will each designate a primary and secondary point of contact. The primary contact is the contact to which all initial and formal correspondence is sent. If the individual designated as the primary point of contact is not available, communications shall be directed to the secondary contact.

B. Each Signatory and Invited Signatory of this PA shall provide all parties to the PA with the phone numbers, email addresses, and mailing addresses for the primary and secondary contacts (see Appendix E). Similarly, when a point of contact changes, all Signatories and Invited Signatories shall be notified in writing (hardcopy or email) within thirty (30) business days of the change. Such changes shall not require an amendment to this PA.

IV. CONSULTATION STANDARDS

A. Consultation among all Signatories and Invited Signatories to this PA will continue throughout the implementation of this PA. Consultation is mutual, meaningful dialogue regarding the fulfillment of this PA, the process of Section 106 compliance, and the treatment of historic properties that may be affected by Corps undertakings.

B. The Corps will consult with any Federally-recognized Indian Tribe whether a signatory to this PA or not on a government-to-government basis in recognition of their sovereign status, throughout any activity or undertaking that might affect historic properties, particularly Tribal cultural sites.

C. The Corps will notify/consult with the SHPO, Federally-recognized Indian Tribes, and other consulting parties. Consultations may include face-to-face meetings, as well as communications by mail, electronic mail, facsimile, and/or telephone. Times and places of meetings, as well as an agenda for meetings, will be developed with mutual acceptance and done in a timely manner.

V. HISTORIC PROPERTY IDENTIFICATION

A. In consultation with SHPO, the Osage Nation, and other consulting parties, the Corps will determine the Area of Potential Effects (APE). The APE will be defined as all areas to be impacted by the increase in normal pool elevation from 867.0 NGVD 29 to 868.8 NGVD 29 resulting from the approval and implementation of a pool raise from the Stockton Lake Water Supply Storage Reallocation Feasibility Study. The APE will include any areas of anticipated erosion through inundation, erosion, exposure, and other factors.

B. In consultation with the SHPO, the Osage Nation, and other consulting parties the Corps will complete the identification and evaluation of historic properties within the APE in accordance with 36 C.F.R. § 800.4(a), (b) and (c).

C. The Corps will also take appropriate measures necessary to identify historic properties within the APE including but not limited to archaeological sites; historic structures; human burials, cemeteries, or other sites likely to contain human skeletal remains and funerary objects; sacred sites; and Traditional Cultural Properties, which are cultural resource sites that are eligible for inclusion in the NRHP based on associations with the cultural practices, traditions, beliefs, lifeways, arts, crafts, or social institutions of a living community. The Corps will provide the appropriate documentation for these identification efforts to the SHPO, the Osage Nation, and other consulting parties.

D. The Corps and Southwest Missouri Regional Water Commission will conduct cultural resource surveys on approval of the proposed water reallocation plan to identify historic properties in the APE in accordance with Section 106 of the NHPA and in consultation with no objection from SHPO, the Osage Nation, and other consulting parties.

1. Cultural resource identification (survey) methods must be adequate to identify cultural resource sites, if present as determined in consultation and with no objection from SHPO, Osage Nation, and other consulting parties. As appropriate, methods may include but are not limited to pedestrian survey, shovel testing, coring, mechanical trenching, geomorphic evaluations, and remote sensing, historic structure surveys, and traditional cultural property surveys.

2. In consultation and with no objection from the Osage Nation and other consulting parties, survey methods may appropriately exclude land unlikely to contain cultural resource sites such as steep slopes without the potential for rock shelters or areas shown to be disturbed to an extent that it is unlikely that cultural resources would be present in the area. Documentation for excluding such land will be provided to the Osage Nation and other consulting parties in advance of the cultural resource survey.

3. The Corps will ensure that all surveys and field studies are conducted in a manner consistent with the Secretary of the Interior's *Standards and Guidelines for Identification and Evaluation* (https://www.nps.gov/history/local-law/arch_stnds_0.htm); the National Park Service publication *The Archaeological Survey: Methods and Uses* (National Park Service 1978); and appropriate state and tribal guidelines (see above Stipulation I.(B).

4. All cultural resource surveys will be implemented on a schedule established to accommodate all archaeological field investigations in consideration of adequate pool level and appropriate Signatory and Invited Signatory review.

5. The results of all existing surveys including cultural resource report, maps, and pertinent documents will be subject to a review and comment period no less than thirty (30) business days by the appropriate Signatories and Invited Signatories prior to the initiation of archaeological fieldwork. Submissions will conform to the requirements of each respective Signatory and Invited Signatory in accordance with Stipulation I.(B).

E. Once SHPO, the Osage Nation, and other consulting parties have received the newly completed survey report and supporting documentation, they shall have forty-five (45) business days from the receipt of all documentation by the Point of Contacts in which to review and provide comments to Corps.

VI. HISTORIC PROPERTY EVALUATION

A. In consultation with SHPO, the Osage Nation, and other consulting parties, the Corps will evaluate cultural resource sites that are entirely within the APE of the proposed pool raise, as defined in Stipulation V. (C). above for sites listed on or eligible for listing on historic properties that are eligible to be listed pursuant to NRHP criteria (36 C.F.R. Part 60.4).

1. For those cultural resources that SHPO, the Osage Nation, and other consulting parties agree are not eligible for inclusion in the NRHP, the Corps will reach a determination of no historic properties affected and no further consultation is required.

2. If the survey results in the identification of historic properties that SHPO, the Osage Nation, and other consulting parties agree are historic properties, the Corps shall treat such properties in accordance with Stipulation VII below.

3. If, after consulting, SHPO, the Osage Nation, and other consulting parties do not agree on NRHP eligibility the Corps will request a formal determination of eligibility from the Keeper of the NRHP, whose determination shall be final.

VII. TREATMENT OF HISTORIC PROPERTIES

A. Historic properties determined to be eligible or potentially eligible for listing in the NRHP, absent a formal determination of eligibility from the Keeper of the NRHP, will be treated by the Corps in the following manner:

1. The Corps will first attempt to resolve adverse effects or potential adverse effects to the historic property by determining if avoidance is feasible through protective measures for a finding of no adverse effect.

2. If the Corps determines that avoidance is impracticable or not feasible, the Corps will reach a determination of adverse effect and develop an appropriate plan, in consultation and with no objection from SHPO, Osage Nation, and other consulting parties, to minimize and treat the impacts.

    a) If data recovery is the agreed upon treatment, then the stipulations in Stipulation VIII will be followed.
    b) If other mitigation measures including alternative measures are agreed upon as appropriate:

        i. The Corps shall submit the treatment plan to SHPO, the Osage Nation, and other consulting parties, for a thirty (30) business day review and comment period to determine whether the measures are sufficient to reduce, mitigate, or treat adverse effects to the historic property. The Corps will take into account the comments and shall ensure that appropriate plans are implemented. Any disagreement among the Corps, Signatories, and Invited Signatories will be resolved, in accordance with Stipulation XI of this PA.
        ii. The Corps will ensure that the treatment plan is carried out by qualified personnel including archaeologist(s), architectural historian(s) and/or other appropriate cultural resource specialist that meets, at a minimum, the Secretary of Interior's Professional Qualifications Standards (48 FR 44738-9), and the guidelines mentioned in Stipulation I.(B).

3. As appropriate and if feasible, protective measures may be developed in consultation with SHPO, Indian Tribes and other consulting parties, on a case by case basis to avoid or minimize adverse effects.

VIII. DATA RECOVERY AS TREATMENT OF HISTORIC PROPERTIES

A. If data recovery is the agreed upon treatment for archaeological sites, the data recovery plan will address substantive research questions developed in consultation and with no objection from the Signatories and Invited Signatories.

B. The data recovery plan shall be consistent with the Secretary of the Interior's *Standards and Guidelines for Identification and Evaluation* (https://www.nps.gov/history/local-law/arch_stnds_0.htm), and take into account the Council's publication *Treatment of Archaeological Properties* (ACHP 1980). It shall specify, at a minimum, the following:

1. The property, properties, or portions of properties where the data recovery plan is to be carried out;

2. The research questions to be addressed, with an explanation of research relevance and importance;

3. The methods to be used, with an explanation of methodological relevance to the research questions;

4. Proposed methods of disseminating results of the work to the interested public; and

5. A discussion of the property's significance within the appropriate historic context.

C. The Corps shall submit the treatment plan to the SHPO, the Osage Nation, and other consulting parties, for a thirty (30) business day review and comment period to determine whether the measures are sufficient to reduce, mitigate, or treat adverse effects to the historic property. The Corps will take into account the comments and shall ensure that appropriate plans are implemented. Any disagreement among the SHPO, Osage Nation, and/or other consulting parties will be resolved in accordance with Stipulation XI of this PA.

D. The Corps will ensure that the treatment plan is carried out by an archaeologist(s), architectural historian(s), and/or other appropriate cultural resource specialist that meets, at a minimum, the Secretary of Interior's *Professional Qualifications Standards* (48 FR 44738-9), and the guidelines mentioned in Stipulation I.(B).

E. The Corps will ensure that adequate provisions, including personnel, time, and laboratory space, are available for the analysis of recovered archaeological material.

F. The Corps will ensure that artifacts from federal lands are curated in a facility meeting federal standards for curation of artifacts as required per 36 C.F.R. § 79.

G. The Corps will develop and implement an adequate program in consultation with and no objection from with the Osage Nation, SHPO, and other consulting parties to secure historic properties from vandalism during data recovery.

IX. TREATMENT OF HUMAN REMAINS AND ITEMS OF RELIGIOUS AND CULTURAL IMPORTANCE

A. If human remains, funerary objects, sacred objects, or objects of cultural patrimony are encountered during project field investigations or laboratory work for the Stockton Lake Water Supply Storage Reallocation Feasibility Study the Corps will comply with all provisions outlined below. The procedures are intended to ensure that the undertaking is in compliance with all applicable Federal and State laws and their implementing regulations, including NAGPRA; Archeological Resources Protection Act of 1979 (ARPA) (16 U.S.C. § 470aa-mm); and Section 106 of the NHPA. The Corps will use the following procedures:

1. In the case of the inadvertent discovery of human remains, funerary objects, sacred objects or objects of cultural patrimony, the Corps will follow the procedures outlined by NAGPRA regulations (43 C.F.R. Part 10, Subpart B), and ARPA (43 C.F.R. Part 7). If the human remains are not American Indian, the Corps will comply with the appropriate state unmarked burial laws as cited in Stipulation IX. (B).

2. Any Corps employee or contractor who knows or has reason to know that he or she has inadvertently discovered human remains, funerary objects, sacred objects, or objects of cultural patrimony or human remains or funerary objects must provide immediate telephone notification of the inadvertent discovery, with written confirmation, to the Corps cultural resources point of contact.

3. The Corps will immediately notify local law enforcement by telephone of the discovery of unmarked human remains and accompany local law enforcement personnel during all field investigations.

4. The Corps will implement measures to protect the discovery from looting and vandalism. Any human remains or other items in the immediate vicinity of the discovery must not be removed or otherwise disturbed. Human remains must be covered with canvas or other natural material.

5. If local law enforcement determines that the remains are not involved in a legal investigation and where the remains are determined to be American Indian or of undetermined ancestry, the protocol of implementing NAGPRA procedures will be applied.

6. The Corps will notify SHPO, the Osage Nation, and other consulting parties by telephone and email within twenty-four (24) hours of the discovery of human remains, funerary objects, sacred objects, items of cultural patrimony, or burial furniture and inform them of the steps already taken to address the discovery. This step is not intended to substitute the requirements of 43 C.F.R. 10.4(d)(iii).

7. The Corps will take immediate steps, if necessary, to further secure and protect inadvertently discovered human remains, funerary objects, sacred objects, or items of cultural patrimony, including, as appropriate, stabilization, or covering the find location.

8. The Corps in consultation with the Indian Tribes, whether they are Signatories to this PA or not, and other interested parties such as living descendants, may consult with a qualified physical anthropologist, forensic scientist, or other experts as may be needed to examine and assess the inadvertent discovery. Unless the remains were inadvertently removed, the evaluation will be conducted at the site of discovery. Other than for crime scene investigation, no excavation, examination, photographs, or analysis of American Indian human remains or remains suspected of being American Indian will be conducted or allowed by the Corps archaeologists or any other professional without first consulting with and securing permission from the appropriate Indian Tribes, whether they are Signatories to this PA or not. The consulting expert will be allowed to draw and measure the exposed remains and associated funerary objects. Drawings and other records will be shared with appropriate Indian Tribes and curated at a State-approved curation facility in the state of discovery. Drawings cannot be published in any form or shown as part of scholarly presentations without the written permission of the claimant Indian Tribe/s or nearest living descendant.

9. The Corps in consultation with SHPO, claimant Indian Tribes, and other consulting parties will have seven (7) business days to determine if the skeletal remains are human, the degree to which they were disturbed, and, if possible using reasonable measures to, assess their potential age, cultural affiliation, and identity, if possible, without any further disturbance. Upon making their determination or at the end of the seven (7) business days, whichever comes first, the Corps will notify the claimant Indian Tribes, whether they are Signatories to this PA or not, of its findings. This notification must include pertinent information as to kinds of human remains, funerary objects, sacred objects, or items of cultural patrimony discovered, their condition, and the circumstances of their inadvertent discovery. The Corps will also inform the claimant Indian Tribes of any involvement the SHPO plans to have in the process.

10. The claimant Indian Tribes, whether they are Signatories to this PA or not, will have seventy-two (72) hours to respond verbally followed by written response via U.S. mail and electronic mail.

The response should specify the intent of the claimant Indian Tribes to conduct or decline further consultation.

11. The Corps will consult with the claimant Indian Tribes, whether they are Signatories to this PA or not, or identified lineal descendant regarding additional measures to avoid and protect or mitigate the adverse effect of the project on the human remains and grave site. These measures may include:

    a. formally evaluate the archaeological site for NRHP-eligibility;
    b. visits to the site by SHPO, claimant Indian Tribes, and other consulting parties;
    c. explore potential alternatives to avoid or protect the human remains or grave;
    d. develop a mitigation plan by the Corps in consultation and with no objection from SHPO, claimant Indian Tribes, and other consulting parties, including procedures for disinterment and re-interment; and
    e. Implementation of the mitigation plan.

12. A report of findings describing the background history leading to and immediately following the reporting and resolution of an inadvertent discovery will be prepared within thirty (30) business days of the resolution of each inadvertent discovery. A copy will be transmitted to all consulting Tribes within thirty (30) days of publication. This report must meet the Secretary of the Interior's *Standards and Guidelines for Archeology and Historic Preservation* (49 FR 44716) and guidelines in Stipulation I.(B).

B. For human remains determined to be not American Indian, the Corps will ensure applicable Missouri State laws will be followed human remains in accordance with the Missouri Unmarked Human Burial Sites Act (Mo. Rev. Stat. §§ 194.400-410).

1) The contractor shall immediately stop all work within a three hundred (300) foot radius of the remains and notify the Corps. The construction contractor shall implement interim measures to protect the discovery from vandalism and looting but must not remove or otherwise disturb any human remains or other items in the immediate vicinity of the discovery. Work shall not resume without specific authorization from either the SHPO or the local law enforcement officer, whichever party has jurisdiction over and responsibility for such remains.
2) Upon notification from the contractor the Corps shall notify the local law enforcement (to ensure that it is not a crime scene) and the SHPO as per RSMo 194 or to notify SHPO what has occurred and that it is covered by Missouri's Cemeteries Law, §§ 214. RSMo.
3) The Corps shall then ensure that construction activities have halted within a three hundred (300) foot radius and that protection measures have been implemented.
4) If local law enforcement determines that it is not a crime scene and that SHPO has jurisdiction, the Corps shall contact an SOI-qualified archaeologist to conduct a preliminary examination to determine possible cultural affiliation and if necessary biological characteristics. The human remains should not be removed at any point in this process.
5) If the remains cannot be avoided and must be removed then a SOI-qualified archaeologist shall remove the human remains and any associated grave goods. The Corps will then transfer control to the SHPO office.
6) The Corps recognizes that SHPO assumes responsibility for any human remains and associated funerary objects, sacred objects, or objects of cultural patrimony (other than from a crime scene or covered under Missouri's Cemeteries Law, §§ 214. RSMo) that may be discovered or excavated during an undertaking's activities and are located on state land, and are to be handled pursuant to the Missouri Unmarked Human Burial Sites Act, §§ 194.400 – 194.410, RSMo, and

subject to any provisions of NAGPRA applicable to such remains and artifacts found on non-federal lands.

C. If items of religious and cultural importance to Indian Tribes are encountered or collected, the Corps will comply with all provisions outlined in the appropriate federal acts, statues, guidance, provisions, etc. and any decisions regarding the treatment of items of religious and cultural importance will be made in consultation with Indian Tribes including the Osage Nation Human Remains Handling Procedures (Appendix F).

X. REPORTS

A. The Corps will ensure that all reports and other documents resulting from the actions pursuant to this PA will be provided in a format acceptable to SHPO, the Osage Nation, and other consulting parties. The Corps will ensure that all such reports (e.g., identification surveys, evaluation reports, treatment plans, and data recovery reports) meet or exceed the Department of the Interior's *Format Standards for Final Reports of Data Recovery* (42 FR 5377-79) and the standards identified in Stipulation I.(B).

B. The Corps will comply with Section 304 of the NHPA (54 U.S.C. § 307103) and restrict disclosure of sensitive information on locational data of all cultural resource sites including but not limited to archeological sites, traditional cultural properties or sacred sites, cultural landscapes, rock art, objects, and confidential information provided by SHPO, the Osage Nation, or other Consulting parties.

C. The Corps will make available for publication and public dissemination the reports and associated data, minus locational information and sensitive information as mentioned in Stipulation X.(B).

XI. DISPUTE RESOLUTION

A. Should any Signatory or Invited Signatory to this PA object at any time to any actions proposed or the manner in which the terms of this PA are implemented, the Corps shall consult with such party to resolve the objection. If Corps determines that such objection cannot be resolved, the Corps will forward all documentation relevant to the dispute, including the Corps' proposed resolution, to the ACHP. The ACHP shall provide Corps with its advice on the resolution of the objection within thirty (30) days of receiving adequate documentation. Prior to reaching a final decision on the dispute, the Corps shall prepare a written response that takes into account any timely advice or comments regarding the dispute from the ACHP, Signatories, and Invited Signatories, and provide them with a copy of this written response. The Corps will then proceed according to its final decision.

B. If the ACHP does not provide its advice regarding the dispute within the thirty (30) day time period, the Corps may make a final decision on the dispute and proceed accordingly. Prior to reaching such a final decision, Corps shall prepare a written response that takes into account any timely comments regarding the dispute from the Signatories and Invited Signatories to the PA, and provide them and the ACHP with a copy of such written response.

C. The Corps' responsibility to carry out all other actions subject to the terms of this PA that are not the subject of the dispute remain unchanged.

XII. TERMINATION

Any Signatory or Invited Signatory to this PA may request a reconsideration of its terms or revoke the relevant portions of this PA upon written notification to the other Signatories or Invited Signatories, by providing a notice of thirty (30) business days to the other Signatories or Invited Signatories, provided that Signatories or Invited Signatories consult during the period prior to termination to seek agreement on amendments or other actions that would avoid termination. Once the PA is terminated, and prior to work

continuing on Undertakings cover by the PA, the Corps must either (a) execute a new PA pursuant to 36 CFR § 800.14 or comply with 36 CFR part 800.4 through part 800.6 for all Undertakings that would otherwise be reviewed under this PA. The Corps shall notify the Signatories and Invited Signatories as to the course of action it will pursue

XIII. AMENDMENTS

This PA may be amended when such an amendment is agreed to in writing by all Signatories and Invited Signatories. The amendment will be effective on the date a copy signed by all Signatories and Invited Signatories is filed with the ACHP.

XIV. PERIODIC REVIEW

A. The Corps will provide the SHPO, Osage Nation, and other consulting parties evidence of compliance with this PA in site-specific annual reports pursuant to NEPA and Section 106 of the NHPA. This documentation shall contain the name of the project, historic properties identified, determinations of effect, avoidance procedures, and level of investigation and/or mitigation conducted with titles of all project reports related to such investigation and/or mitigation which have been completed.

B. The PA shall expire ten (10) years from the date of the last signature. One (1) year prior to the expiration of the PA, the Corps, SHPO, the Osage Nation, and other consulting parties shall review the PA in order to determine whether it should be reissued or allowed to expire. If the PA requires reissue, the Corps shall consult with the Signatories and Invited Signatories, as well as amend the PA in order to ensure compliance with the most current version of the Federal regulations implementing the NHPA.

XV. ANTI-DEFICIENCY ACT

The Corps' obligations under this PA are subject to the availability of appropriated funds and the stipulations of this PA are subject to the provisions of the Anti-Deficiency Act. The Corps shall make reasonable and good faith efforts to secure the necessary funds to implement this PA in its entirety. If compliance with the Anti-Deficiency Act alters or impairs the Corps' ability to implement the stipulations of this PA, the Corps shall consult in accordance with the amendment procedures found at Stipulation XI and termination procedures found at Stipulation XII.

XVI. COMMUNICATION

The Corps will provide the SHPO, the Osage Nation, and consulting parties with public meeting announcements, special releases, and notifications of the availability of report(s); comments received by the Corps will be taken into account for water storage reallocation changes.

XVII. EXECUTION AND IMPLEMENTATION

A. Nothing in this PA is intended to prevent the Corps from consulting more frequently with the Signatories and Invited Signatories concerning any questions that may arise or on the progress of any actions falling under or executed by this PA.

B. Execution of this PA by the Signatories and Invited Signatories and implementation of its terms evidence that the Corps has taken into account the effects of this Undertaking on historic properties and afforded the ACHP an opportunity to comment.

C. The Corps will file a copy of the executed PA with the ACHP.

D. This PA may be executed in counterparts.

SIGNATORIES

U.S. ARMY CORPS OF ENGINEERS, KANSAS CITY DISTRICT

BY:_____Date:_____

William C. Hannan
Colonel, Corps of Engineers
District Commander

SOUTHWEST MISSOURI REGIONAL WATER COMMISSON

BY:_____Date:_____

Designated Signatory, Southwest Missouri Regional Water Commission

MISSOURI STATE HISTORIC PRESERVATION OFFICER

BY:_____Date:_____

Dr. Toni M. Prawl, Ph.D., Director and Deputy State Historic Preservation Officer

INVITED SIGNATORIES

IOWA TRIBE OF KANSAS AND NEBRASKA

BY:_____Date:_____

Lance Foster
Vice Chairman

KAW NATION

BY:_____Date:_____

Ms. Lynn Williams
Chair

OSAGE NATION

BY:_____Date:_____

Geoffrey M. Standing Bear
Principal Chief

PONCA TRIBE OF NEBRASKA

BY:_____Date:_____

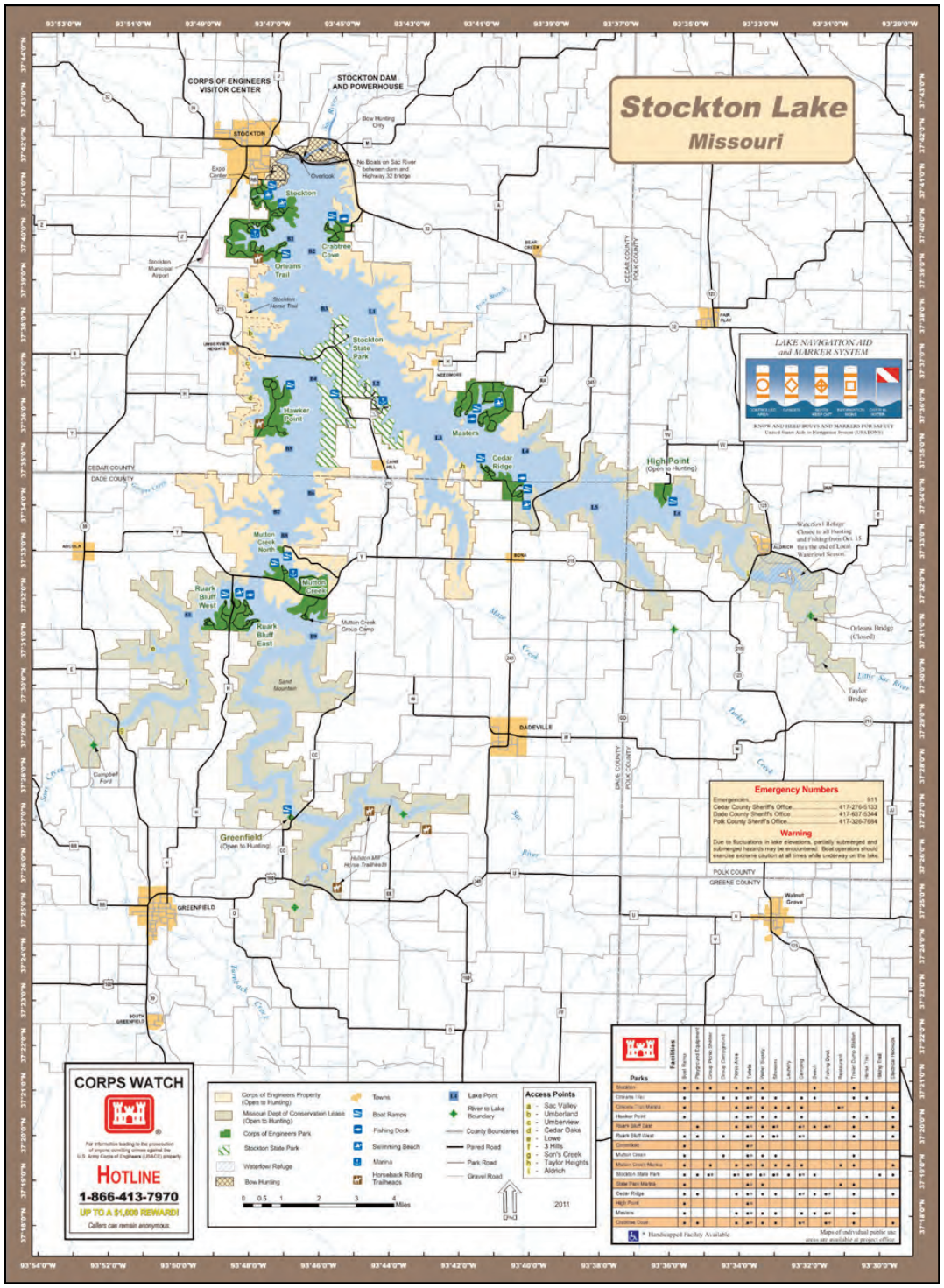
Larry Wright Jr.
Chairperson

PONCA TRIBE OF OKLAHOMA

BY:_____Date:_____

Douglas Rhodd
Chairman

APPENDIX A
STOCKTON LAKE, MISSOURI REALLOCATION FEASIBILITY STUDY AREA



APPENDIX B
NATIVE AMERICAN TRIBES CONTACTED BY CORPS

Chairwoman Tamara Francis-Fourkiller
Caddo Nation
P.O. Box 487
Binger, Oklahoma 73009-0487

Chairperson Tim Rhodd
Iowa Tribe of Kansas and Nebraska
3345 B Thrasher Road
White Cloud, Kansas 66094

Chairperson Lynn Williams
Kaw Nation
Drawer 50
Kaw City, Oklahoma 74641

Chairperson Vernon Miller
Omaha Tribe
P.O. Box 368
Macy, Nebraska 68039

Principal Chief Geoffrey M. Standing Bear
Osage Nation
627 Grandview
Pawhuska, Oklahoma 74056

Chairperson Larry Wright Jr.
Ponca Tribe of Nebraska
P.O. Box 288
Niobrara, Nebraska 6786

Chairman Douglas Rhodd
Ponca Tribe of Oklahoma
20 White Eagle Drive
Ponca City, Oklahoma 74601

APPENDIX C
GUIDANCE FROM THE OSAGE NATION

OSAGE NATION

Historic Preservation Office

National Historic Preservation Act Section 106 Protocol and Standards

The Osage Nation Historic Preservation Office (ONHPO) has developed the following procedures for Section 106 consultation required by the Historic Preservation Act, (NHPA) [54 U.S.C. § 300101 et seq.] 1966.

Please submit all of the following information for all NHPA Section 106 consultation requests (additional formatting and information requested in standards for cultural resource survey reports below):

A. To initiate consultation with the Osage Nation Historic Preservation Office submit a 1-page cover letter with the following included:
   - Federal agency name, district, or department
   - Point of contact information: individual's name, address, phone, fax, and email
   - Project name and number, or other designation (if for tracking)
   - Project location information: USPLSS (quadrangle, quarter section, section, township, and range) and UTM (WGS84) coordinates are required
   - Projects will not be reviewed until both USPLSS and UTM coordinates are submitted
   - Total area surveyed in acres

B. Professional cultural resource survey report. At a minimum, **all field surveyors** must possess a **BA or BS in anthropology** with an emphasis in archaeology (exception- see page 4). At a minimum, the **supervisor who is in the field and supervises the field survey**, interprets the results of the field survey, determines the cultural resource recommendation, and produces the cultural survey report **must possess an MA or MS in anthropology** with an emphasis in archaeology. **Supervisors must accompany and oversee all field surveyors during the fieldwork**. With the first cultural resource survey report, include curriculum vitaes for all project archaeologists and identify work performed. See page 3 for an outline of the documentation required in a standard cultural resource survey report.

C. USGS topographic and/or aerial maps locating project area within the: 1) state, 2) county, 3) quadrangle, and 4) section.

D. USGS topographic and/or aerial maps specifically locating: 1) project APE, 2) project staging areas outside of APE, 3) access road, and 4) location of all archaeological and historic sites in and in close vicinity of the project APE. Please do not submit hand drawn or hand annotated maps.

E. GLO maps for project area, please include both late 19th century and early 20th century maps and identify project APE on maps.

F. Project site plan map indicating location of screened shovel tests (please label shovel tests with identification number on maps). Please do not submit hand drawn or hand annotated maps. **Shovel test minimum width is 30 cm. Shovel test minimum depth is 20 cm beyond sterile soil. If terminated before sterile soil is reached, please provide an explanation either in the**

text or in the shovel test log. Excavated shovel tests must be screened using a 0.25 in mesh screen, dug in stratigraphic or 10 cm levels, and measurements must be recorded in centimeters. Please refer to the Archaeological Survey Standards for density of shovel testing.

G. Table listing shovel test locations, width (cm), actual depth (cm) of each level, soils of each level, and results.
H. Shovel test map with all shovel test locations labeled by their field identification number.
I. Site photographs in color, specifically images depicting exact location of 1) project marked by stakes or flagging (if possible), 2) access roads, 3) utility easement (if applicable), 4) staging areas, and 5) identified archaeological/historic sites.
J. Copy of the review letter from the State Historic Preservation Office. For projects in Oklahoma, letters from both SHPO components, the Oklahoma Archaeological Survey and the Oklahoma Historical Society are required.

Please do not email documentation; it will be deleted without being opened. Mail one printed color copy of all documentation accompanied with a CD version.

Please use only the following contact and address information:

Dr. Andrea A. Hunter, THPO
Osage Nation Historic Preservation Office
627 Grandview
Pawhuska, OK 74056

Phone: 918-287-5328
Fax: 918-287-5376

Standards for Cultural Resource Survey Reports

The following outlines the documentation required in a cultural resource survey report that will enable the Osage Nation Tribal Historic Preservation Office to efficiently evaluate the information gathered for a proposed project in a coherent, standardized format. Please include in all reports:

1. Abstract

   Executive summary of project, survey results, and recommendations

2. Introduction

   Introduce project and project design

3. Environmental Setting

   Specific location, legal description, composition of project site

   General location, geomorphology, landform, soils, vegetation, hydrology

4. Cultural History

   Brief overview of cultural occupation represented in locale

5. File Search and Previous Research

   Results of file search in state database for previously recorded archaeological sites and review of previous archaeological investigations, NRHP listings, GLO records and maps, late 19th and early/mid-20th century maps, and mid-20th and current aerial photographs. For projects in Osage County, OK include: Osage tribal allotment records and maps, late 19th and early/mid-20th century maps such as the Oklahoma State Highway Department's General Highway and Transportation Map of Osage County, and mid-20th and current aerial photographs such as those at the Oklahoma Petroleum Research Library in Norman, Oklahoma.

6. Field Methods and Analytical Techniques

   How field survey and analysis were conducted

7. Results of Archaeological Field Investigations

   Review findings and identification of National Register of Historic Places

8. Recommendations

   Summarize archaeological sites identified, NRHP determinations, and project recommendations

9. References Cited

Minimum Qualifications for Archaeology Personnel*

The minimum professional qualifications for archaeology field survey assistants are:

- BA or BS in anthropology with an emphasis in archaeology

Or with prior approval from the ONHPO by providing the following documentation:

- BA or BS in Applied Indigenous Studies, Native American Studies, Geology, Geography, History, Architectural History, Historic Preservation plus:
- at least one year of full-time professional archaeology experience or equivalent specialized training in archaeological research, administration, or management;
- at least four months of supervised field experience in general North American archaeology; and
- demonstrated ability to carry fieldwork to completion.

The minimum professional qualifications for personnel who supervises and conducts the archaeological field survey, interprets the results of the field survey, determines the cultural resource recommendation, and produces the cultural survey report are:

- Graduate degree in archaeology or anthropology with an emphasis in
- archaeology; and
- One year of full-time professional experience at a supervisory level in the
- study of archaeological resources of the prehistoric period.

* With the first cultural survey report, please submit the curriculum vitae for the field survey personnel and for the archaeological supervisor. When personnel change, please submit their curriculum vitae.

OSAGE NATION

HISTORIC PRESERVATION OFFICE

ARCHAEOLOGICAL SURVEY STANDARDS

The following archaeological survey standards are the minimum amount of work acceptable for archaeological surveys conducted on the Osage Nation Reservation/Osage County and throughout Osage Nation ancestral territory as determined by the Osage Nation Historic Preservation Office (ONHPO). Additional archaeological work (i.e. more shovel tests or transects) or methods (backhoe trenches) can always be incorporated into the research design to help locate and identify archaeological sites depending on the area or potential for encountering significant cultural resources. Alternative, project-specific, standards may be developed in conjunction with the ONHPO for projects with unique or unusual circumstances as appropriate.

Professional Qualifications:

Archaeological investigations must be conducted by an archaeologist who meets the U.S. Secretary of the Interior's *Professional Qualification Standards for Archeology* (36 CFR Part 61; 48 FR 44716). At a minimum, all field surveyors must possess a BA or BS in anthropology with an emphasis in archaeology. At a minimum, the supervisor who is in the field and supervises the field survey, interprets the results of the field survey, determines the cultural resource recommendation, and produces the cultural survey report must possess an MA or MS in anthropology with an emphasis in archaeology. Supervisors must accompany and oversee all field surveyors during the fieldwork. With the first cultural resource survey report, include curriculum vitae for all project archaeologists and identify work performed.

Background Research:

Archaeologists must conduct a background literature search prior to field investigations. At a minimum this shall include searches of the SHPO's databases for previously recorded archaeological sites and historic properties, and previous archaeological work in the vicinity. For projects in Osage County, OK, the archaeologists would also include searches of the Osage Allotment Maps, Oklahoma Geological Survey Archives (Norman, Oklahoma) for early USGS

7.5 and 15-minute topographic maps and aerial photographs, plus the GLO map archive available online (www.glorecords.blm.gov).

Deeply Buried Cultural Deposits:

Archaeologists must assess the potential for deeply buried cultural deposits within the block area prior to starting field investigations. At a minimum, this shall include a review of the USDA soil surveys and geologic maps. If there is a potential for deeply buried cultural deposits within the block survey area, deeper subsurface investigations (to be determined in consultation with the ONHPO) will be required.

Survey Report:

Archaeologists must submit the results of their investigation in a report to the ONHPO that follows the Secretary of the Interior's *Standards for Archeological Documentation*. The ONHPO will complete its review within 30 days of receipt of the archaeology survey report and the SHPO review letters. For Oklahoma this would include review letters by the Oklahoma Archaeological Survey and the Oklahoma Historical Society.

Fieldwork:

Unless otherwise determined in conjunction with the ONHPO, all areas of a project's Area of Potential Effects (APE) should be subjected to subsurface investigations via systematic shovel testing. No area of the project's APE should be omitted from shovel testing due to surface visibility. The omission of areas from subsurface testing in an archaeological survey due to ground visibility is neither effective nor ethical. While the presence of artifacts on the surface of the ground can be an indication for the presence of a site, the absence of artifacts on the surface of the ground, even in conditions of 100 percent surface visibility, is not a confirmation for the absence of an archaeological site which may be buried beneath the ground's surface. Additionally, it should not be assumed that previously disturbed areas contain no significant archaeological sites or buried human remains. Those areas known to be, or thought to be, previously disturbed should also be subjected to survey in order to identify archaeological sites and to evaluate the level of disturbance which may or may not have impacted buried archaeological sites.

A. Shovel Testing

The entire APE must be subject to systematic shovel testing. Shovel tests must be conducted in intervals no greater than 30 meters in transects no wider than 30 meters. A smaller or reduced shovel test interval may be appropriate in areas with particularly high probability or potential for significant, intact archaeological deposits. Additionally, the ONHPO may require shovel test intervals be reduced to 15 meters in areas known to have a higher probability for archaeological sites or areas of significance to the Osage Nation. Shovel tests must be a minimum of 30 cm in diameter and must be dug to 20 cm beyond sterile subsoil. If portions of the APE are believed to contain subsoil at the surface of the ground, then shovel tests are to be dug to 20 cm below the surface to confirm that it is subsoil and to determine that the subsoil is sterile of artifacts and/or features. Shovel tests should be dug in stratigraphic or 10 cm levels with sediments screened through ¼-inch mesh unless high clay or water content requires that they be troweled through.

If sterile subsoil is too deep to reach via shovel testing, then selective coring/auguring should commence to determine the need for more appropriate methods to survey for deeply buried archaeological deposits. In seasonally inundated areas where the soil is very poorly drained, shovel testing should be conducted to verify soil conditions (i.e. hygroscopic soils), but shovel test intervals may be extended to a maximum of 50 meters in those areas.

Unless previously determined in conjunction with the ONHPO, the only areas within the APE in which shovel testing may be omitted are areas of a 20 percent or greater slope. Areas known to be, or believed to be previously disturbed, including but not limited to previously developed lands, agricultural fields, and buried utilities, are not to be omitted from subsurface testing. Systematic shovel testing in the manner stated above is required in those areas to establish the presence of archaeological sites, to determine the level of ground disturbance, and to evaluate the impact of previous ground disturbance on any archaeological sites located in the area.

Notes should be kept on each shovel test documenting the shovel test location (including GPS coordinates), soil stratigraphy referencing USDA soil descriptions and actual soils encountered, soil color description (Munsell color codes if possible), depth, and the presence or absence of artifacts. A

representative sample of shovel tests should be documented with photographs and profile drawings all of which should be incorporated into the survey report. The survey report will also include a shovel test log and a shovel test map that clearly depicts each labeled shovel test location.

B. Pedestrian Survey

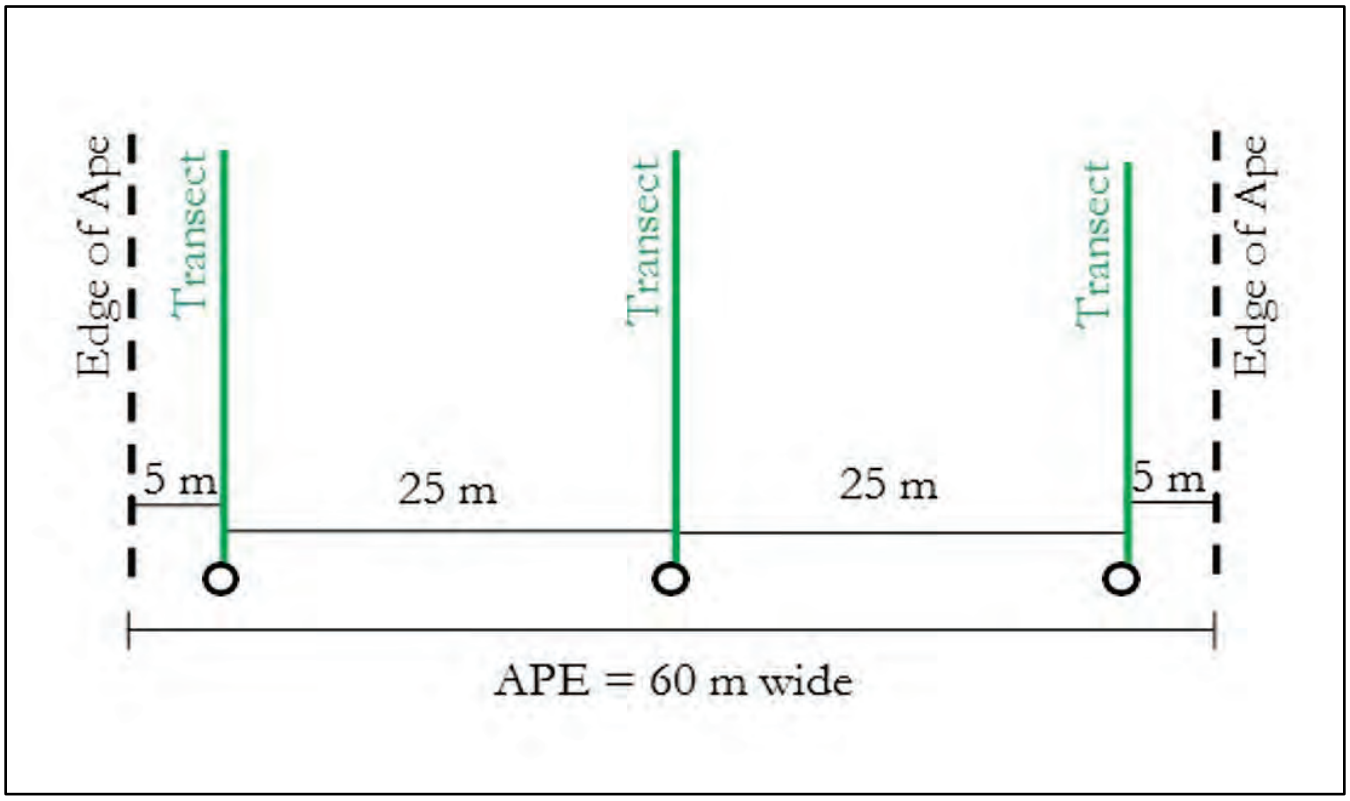
While pedestrian survey may be used in addition to systematic shovel testing, it may not be used in lieu of shovel testing in any area, except for those areas consisting of a slope 20 degrees of greater. Sloped areas exceeding 20 degrees should be investigated via pedestrian survey at intervals no wider than 10 meters.

C. Linear Projects

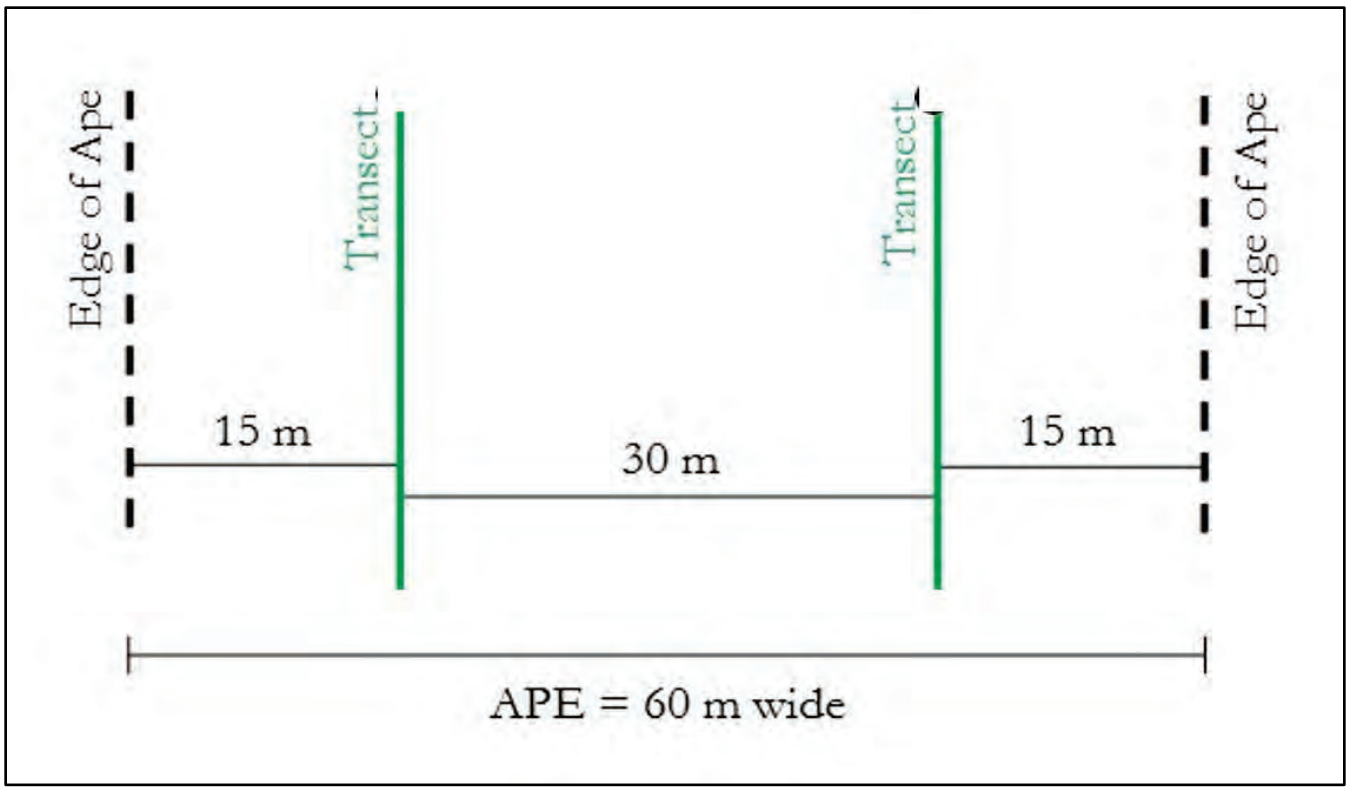
For linear projects exceeding 1 mile, such as power line corridors, shovel test intervals may be extended to a maximum of 100 meters. A linear project is defined as an undertaking with an APE width no greater than 30 m. Additional judgmental shovel tests, as appropriate, should be placed in areas with particularly high probability or potential for significant, intact archaeological deposits.

If shovel test transects parallel the edge of the APE, the transect nearest the edge of the APE should be no further than half a standard shovel test interval as defined for the project from the edge of the APE. For example, if the shovel test interval being used for a particular project is 25 m, the transects nearest the edges of the APE should be no further than 12.5 m from the edge of the APE. If the APE is 60 m wide and shovel tests are being excavated at 25 m intervals, there should be three shovel test transects, and the transects nearest the edges of the APE would be 5 m from the edge of the APE. If shovel tests were excavated on only two transects, the distance from the transects to the edge of the APE would be 17.5 m, which is greater than half of a standard shovel test interval as defined for the project, and not deemed adequate coverage for a high probability area.

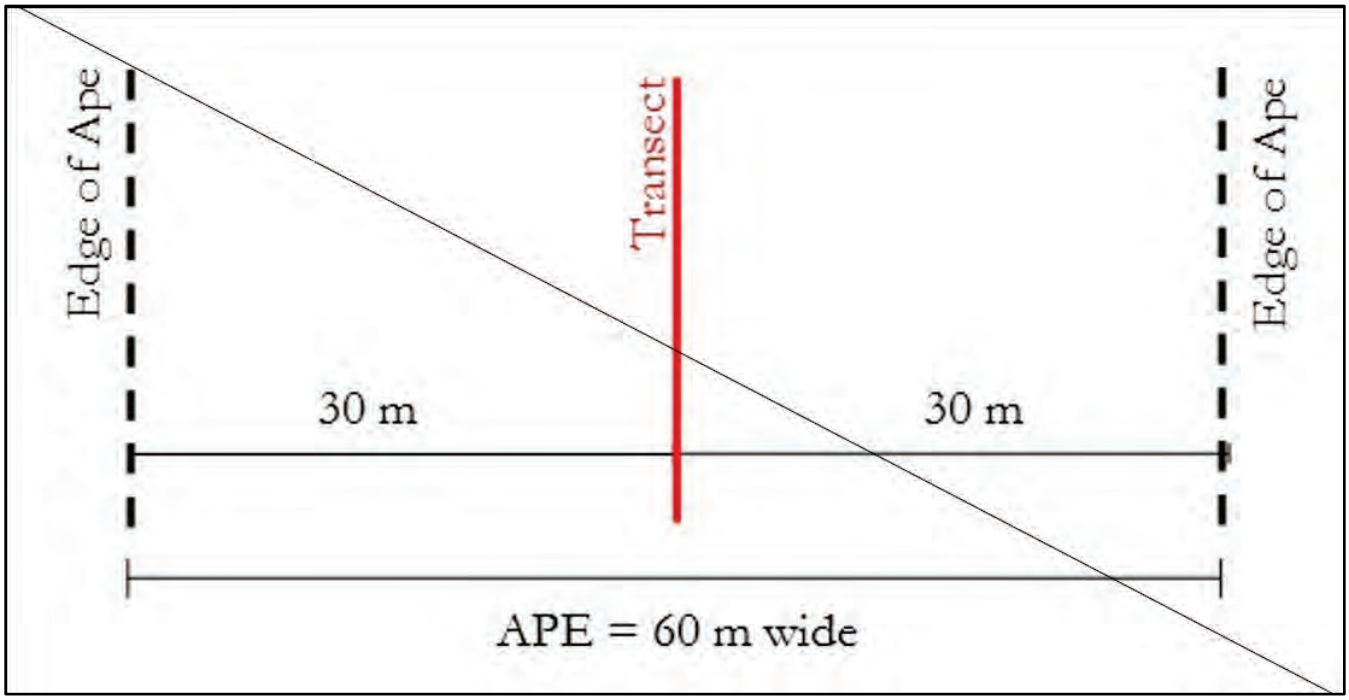
Examples of Shovel Test Transect Placements (Across 60-Meter Wide Survey Corridor)



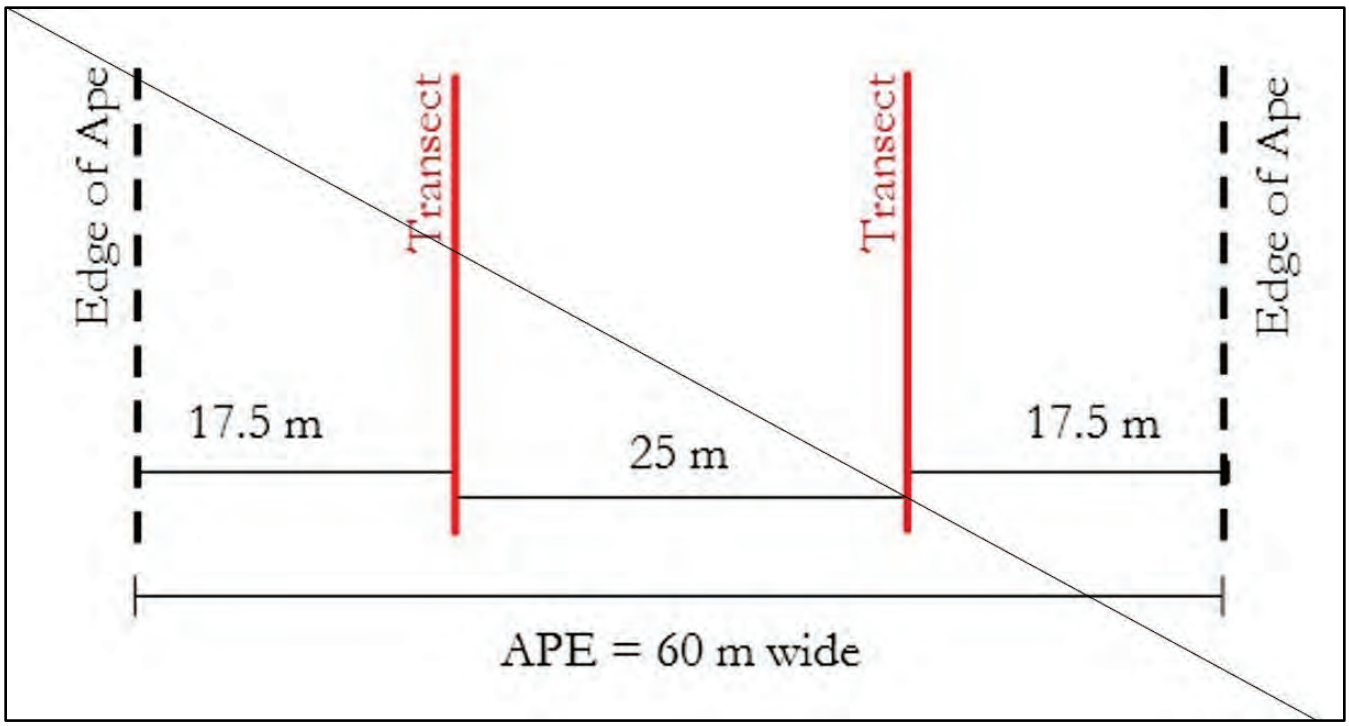
Adequate Coverage (high probability) *Three Shovel Test Transects Spaced 25 m Apart on 60-m Wide Corridor, with Shovel Tests Excavated at 25-m Intervals.*



Adequate Coverage (minimum) *Two Shovel Test Transects Spaced 30 m Apart on 60-m Wide Corridor, with Shovel Tests Excavated at 30-m Intervals.*



Insufficient Coverage *One Shovel Test Transect on 60-m Wide Corridor, Regardless of Shovel Test Interval on Transect.*



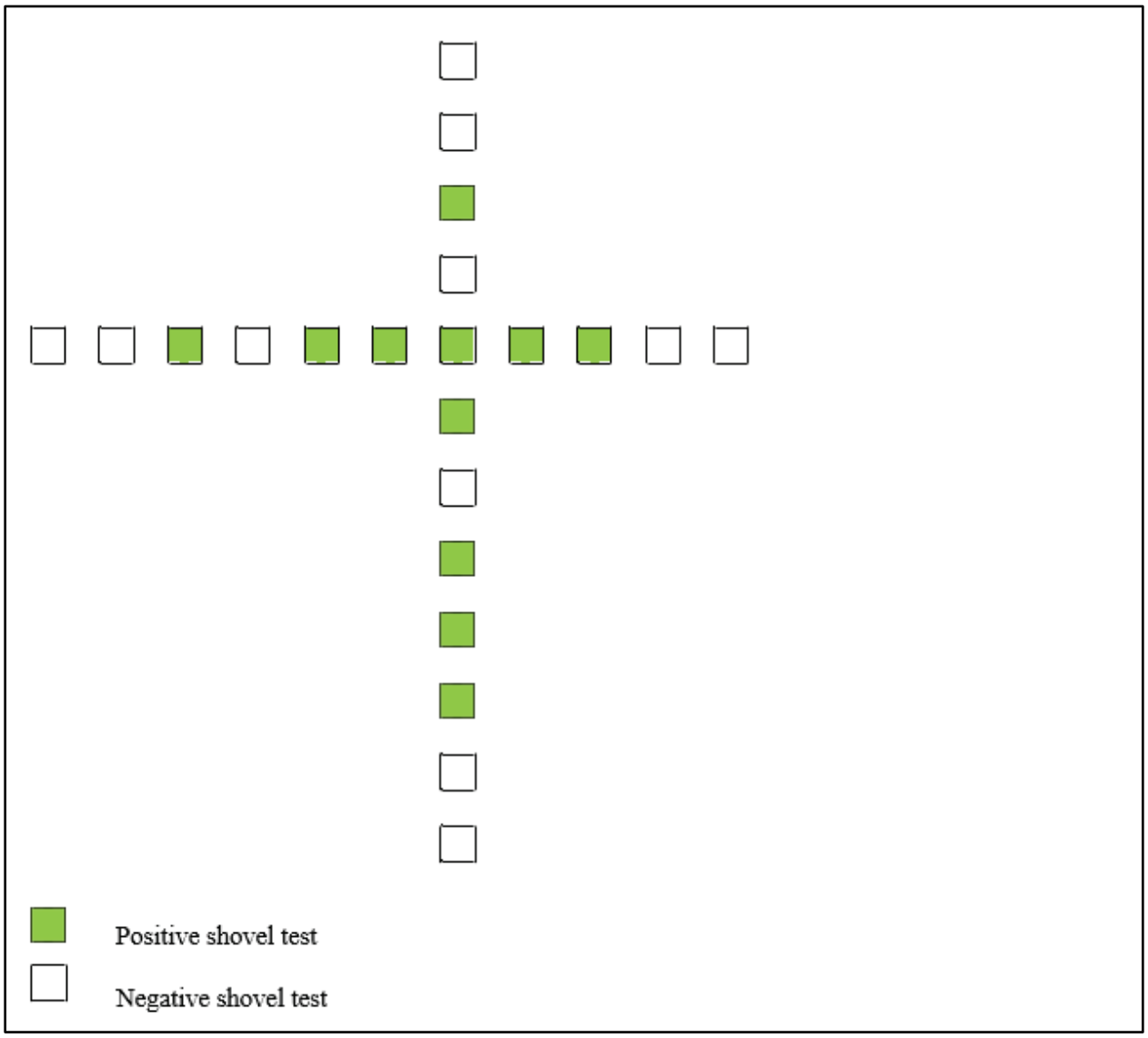
Insufficient Coverage *Two Shovel Test Transects Spaced 25 m Apart on 60-m Wide Corridor, with Shovel Tests Excavated at 25-m Intervals.*

Determining Site Boundary:

Shovel testing is required to determine site boundaries.

A minimum of nine (9) shovel tests must be placed in a + pattern that is perpendicular extending from the center of the artifact discovery location.

A shovel test must be placed every five (5) meters until two (2) negative shovel tests are sequentially excavated in each direction. All surface finds and positive shovel tests must be bounded by radial shovel tests in this manner.



Osage Nation Historic Preservation Office

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Archaeological Resources Protection Act Violation Procedures

Federal agencies must conduct consultation and cooperation with Federally-recognized Tribes (Tribes) regarding Federal Acts and Orders including, but not limited to the Archaeological Resources Protection Act of 1979 (ARPA), as amended (16. U.S.C. §470aa-470mm), the Native American Graves Protection and Repatriation Act (NAGPRA, 25 U.S.C. §3001 et seq.), Presidential Executive Order 13007 ("Indian Sacred Sites"), Presidential Executive Order 13175 ("Consultation and Coordination with Indian Tribal Governments"), and the American Indian Religious Freedom Act, 42 U.S.C. § 1996 (AIRFA). Further, Federal agencies are required to use staff who meet the Secretary of Interior's *Professional Qualifications Standards* for archaeology (48 FR 44738k-9).

The Osage Nation has a deep concern for the identification, treatment, and protection of its properties of cultural, historic, and religious significance throughout its Ancestral Territory. Of particular concern to the Osage Nation are its sacred sites. Federal agencies with land- management responsibilities have a responsibility to accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners and to avoid adversely affecting the physical integrity of sacred sites (Executive Order 13007). Sacred sites may be further endangered during ARPA investigations particularly when sites are assessed for damages and also by public outreach activities conducted by law enforcement personnel. Although the Osage Nation understands the lands owned by the Federal government are managed for the benefit of the American people, places of significance to the Osage people belong to the Osage people. The treatment of sacred sites is of grave concern to the Osage Nation, particularly when they have been desecrated and are subject to investigations pursuant to ARPA. Federal agencies are encouraged to coordinate with the Osage Nation in developing specific protocols in response to violations of ARPA (looting, vandalism, etc.) as well as providing support in the investigation, trying, and, if a conviction is obtained, sentencing of parties responsible for these abhorrent acts. Federal agencies do not know what is culturally sensitive and must consult with Tribes so that they may interpret these places while respecting its concerns. Federal agencies must work with the Osage Nation as partners in increasing their capacity for, and compliance with, Section 10(c) of ARPA, as codified at 16 U.S.C. 470ii(c); Section 14 of ARPA, as codified at 16 U.S.C.

470mm; and Section 14(c) of ARPA, as codified at 16 U.S.C. 470mm(c). It is, perhaps, not possible to prevent such crimes entirely, but the Osage Nation contends that, through coordination, we can mitigate the risk of and appropriately address such crimes when they do occur. The Osage Nation considers these places to be invaluable and irreplaceable; no assessment of the damage will appropriately reflect the true damage that has been done. The Osage Nation anticipates consulting with each of its Federal partners on this matter.

It is the responsibility of each Federal agency to identify and maintain persistent relationships with Tribes that have an interest in the lands they manage and communicate with those Tribes through their identified representatives. The Osage Nation and each Federal Agency shall designate a primary and secondary point of contact for ARPA-related matters. Each party shall provide the other parties with the phone numbers, email addresses, and mailing addresses for the primary and secondary point of contact. Each party shall notify the other parties in writing when the primary point of contact changes. All inquiries and correspondence shall be directed to the primary point of contact. If the individual designated as the primary point of contact is not available, communications should be directed to the secondary point of contact. Please note, in light of the confidential nature of criminal investigations,

representatives of the Osage Nation are subject to Tribal confidentiality law, specific Non-Disclosure Agreements entered into as a condition of their employment, Federal confidentiality laws, professional ethical codes governing their behavior, and their own personally held beliefs, morals, and convictions concerning the dissemination of information that may endanger places of sacred and historical significance to the people of the Osage Nation.

The Archeological Resource Protection Act (ARPA), as well as other laws, protect and provide for consultation procedures on Federal lands. The respectful treatment of these sites is of paramount concern to the Osage Nation. The purpose of these procedures is to ensure the respectful treatment of these sites and to ensure that views of affiliated Tribes are fully considered in the decision-making process. The treatment of human remains, graves, and funerary objects shall be conducted according to the provisions of NAGPRA and previously executed agreements between the Osage Nation and Federal agencies. In the event of a violation of ARPA, Federal agencies shall do the following:

1) Upon the discovery that a violation of ARPA has occurred, Federal agency (Agency) personnel will immediately notify the Agency Archaeologist and appropriate Law Enforcement official of the discovery. This will initiate a criminal investigation under the management of the Agency.
2) The responding Agency official will implement interim measures to protect the site from additional looting and vandalism as well as inadvertent disturbance to the crime scene.
3) Following notification of the discovery, the Agency Archaeologist will immediately, within twenty-four (24) hours inspect the site and ensure that no further disturbance will occur.
4) If deemed necessary, immediate surveillance measures, including persistent physical presence by Agency Law Enforcement personnel, will be taken.
5) Treatment of the crime scene and evidence will proceed as stipulated by the Agency's ARPA plan, as approved and established in consultation with the Osage Nation.
6) Prior to dissemination of information regarding the violation and the location of the violation, the Osage Nation must be afforded the opportunity to provide input on the content of that information.
7) Artifacts that have been removed from their primary context and where that context may be in question may be retained in a secure location, pending further decisions on treatment and disposition. Artifacts held as evidence in an ARPA or other legal cases will remain in the chain of custody until released by the Agency Law Enforcement official to the Agency Archaeologist.
8) If the Agency Archaeologist determines that the site is affiliated or potentially affiliated with the Osage Nation or the Osage Nation has elected to take responsibility for earlier period cultures, the Agency Official will notify the Osage Nation within twenty-four (24) hours. The notification shall include law enforcement findings, if applicable and permissible, along with general location information, and other details or written descriptions of the artifacts. The Osage Nation will respond verbally within seventy-two (72) hours, followed by response via U.S. mail or electronic mail. The response will specify the Tribe's intention to conduct or decline further consultation and coordination.
9) Once an initial consultation meeting is established, a mutually-agreed upon agenda will be provided to all anticipated participants. Through consultation between the Agency and the Osage Nation, a determination of cultural affiliation of the site should be made, if possible, and a draft treatment plan developed. The Osage Nation shall be able to visit the site with the Agency Archeologist.
10) At the completion of consultation, a draft treatment plan shall be completed to clearly designate the decisions that have been agreed upon by each party. The treatment plan will outline procedures, restrictions, and timelines. Said plan will be submitted by the Agency to the Osage Nation for comment and shall be approved by the Osage Nation prior to implementation. The final treatment plan will be signed by the Osage Nation and the Agency.

11) Treatment plan elements may include but are not limited to:

    a) Future monitoring of the site(s);
    b) Periodic access to the site by the Osage Nation;
    c) Restrictions including, but not limited to, proposed changes from current land use in the area, maintenance activities, restrictions regarding marking the site, and public access;
    d) Additional, long-term security measures including signage and electronic surveillance;
    e) Long-term coordination with the Osage Nation;
    f) A confidentiality agreement stipulating that the location and Tribal significance of the site not be disclosed to the public or to Agency personnel without a demonstrated need to know;
    g) Travel and Per Diem for Agency personnel and Tribal representatives;
    h) Public outreach, as appropriate; and
    i) The opportunity to conduct religious ceremonies with regard to the site itself.

12) Additional considerations made in the development of the Treatment Plan may include but are not limited to:

    a) A map of the area;
    b) A description of the site area including topography, soil type, flora, fauna, and distance to roads and public areas;
    c) Known historic properties and other cultural resources in the general vicinity of the site;
    d) Need for field investigations;
    e) Accounts of any Tribal consultation or coordination regarding the violations that may have already occurred;
    f) Flood susceptibility and location above the flood pool level;
    g) Current restrictions on public access;
    h) Current land use;
    i) Anticipated future land use;
    j) Access potential;
    k) Viewshed;
    l) Photographs and/or other media, as appropriate; and
    m) Proximity to areas with a history of ARPA violations.

13) The Agency shall maintain a current list of monitoring attempts, reports on observations made during those monitoring attempts, and additional consultation between the Osage Nation and the Agency. As this list is updated, it will be forwarded to the Osage Nation. This information will be housed with the Agency Archaeologist in a secure location protected from public access. The list and its contents shall be disclosed only to authorized Osage Nation representatives and, upon prior notification to the Osage Nation, to other Federally recognized Tribes and Agency personnel who have a need to know the information.

14) No photography of human remains will be permitted except in cases in which criminal activity is involved and photographic documentation is essential for investigative and prosecutorial needs. Associated photographs, drawings, and other records will be held at the Agency and made available only to those involved with the case, including Special Agents, Law Enforcement Specialists, Law Enforcement Rangers, Assistant United States Attorney, and Archaeologists assigned to this case, and as necessary by direction of the court to the defense and jury. Photographs and drawings cannot be published in any form or shown as part of scholarly presentations without the written permission of the Osage Nation. Subsequent to the closure of a case, any photographs taken in the course of the investigation will be destroyed if the human remains are unrelated to a crime and they can be identified as Native American or potentially Native American. It is understood that some photographs will become part of a permanent record as they pertain to the case and retained by the courts and Agency as documentation of the case. Archaeological Damage Assessment reports that include images of human remains or other

culturally sensitive objects will contain a page identifying the sensitive nature of the images with any stipulations necessary to protect and preserve their integrity.

15) Additional requests and comments may be provided through subsequent consultation between the Osage Nation and Federal agencies including but not limited to:

   a) Damage assessment;
   b) Forensic testimony; and
   c) Letters of support for submission to the court.

APPENDIX D
GUIDANCE FROM THE MISSOURI STATE HISTORIC PRESERVATION OFFICER

MISSOURI GUIDELINES FOR PHASE I ARCHAEOLOGICAL SURVEYS AND REPORTS

INTRODUCTION

Please note that the following "Guidelines for Phase I Archaeological Surveys / Reports in Missouri" are just that, guidelines. They are designed to provide baseline procedures for field methodology and budgeting so that adequate information can be provided to the Missouri Department of Natural Resources, State Historic Preservation Office (SHPO) staff for their review and comment on a project.

We fully expect that "field decisions" will need to be made to allow for individual situations. We will accept reports that vary from the following guidelines so long as an adequate justification is provided as to why the variations in methodology were made. For example a project corridor crosses several small drainages with a high likelihood for archaeological sites and then crosses into a large area of uplands with less likelihood for archaeological sites, it would be appropriate to widen out the shovel probe interval in the upland areas. Or, areas with slopes, wetlands, or other aspects that would make previous habitation unlikely were not surveyed and are described in the report as such. Use professional judgment when considering methodology variations and expect to provide the justification in the report.

To avoid having requests for clarification or additional information, keep in mind that this is likely the only information on the project the SHPO reviewer has and they were not involved during the fieldwork, analysis and write-up of the project. We recommend that prior to submission, if possible, you pass the report by a cold reader (a person familiar with the following procedure, who was not involved in the fieldwork, analysis and write-up).

In addition, please bear in mind that these are guidelines for *archaeological* surveys. Do not confuse the project footprint and the Area of Potential Effect (APE) for an archaeological project with the footprint and the APE for a project that also includes an architectural component (i.e. cell tower) when reading and dealing with the standing structures and photographs section.

Thank you,

Missouri Department of Natural Resources
State Historic Preservation Office
Archaeological Review Staff

Survey Procedures

D. Pedestrian survey of previously plowed / disturbed and high surface visibility areas:

Pedestrian survey of project areas is the most archaeologically thorough and cost effective technique presently available. Pedestrian survey can be employed in areas with good surface visibility. Visibility must equal 25 percent or greater of the ground surface area to use pedestrian survey techniques. The appropriate transect interval is 5 meters.

The exception to this is areas that have never been plowed or otherwise disturbed in the past because it is unlikely that artifacts would be found on the surface regardless of surface visibility (see Systematic shovel testing).

E. Systematic shovel testing of low surface visibility and previously undisturbed / unplowed areas:

In areas that have not been previously plowed, or areas with less than 25 percent surface visibility, systematic shovel testing should be employed. The appropriate transect interval is 15 meters. Such shovel testing involves the excavation of holes at least 25cm in diameter down to archaeologically sterile soil (usually the B-horizon) if possible. If it is not possible to get to archaeological sterile soil using the standard method being employed then every third test hole should be augured to a sufficient depth. The excavated material from each shovel probe should be screened through a minimum of ½ inch mesh.

Where cultural materials are encountered the grid interval should close to 5 meters to more accurately delineate the actual site boundaries (i.e. do not "Swiss cheese" the entire site, just locate an accurate boundary).

F. Deep testing:

When dealing with areas that potentially contain deeply buried cultural remains it will be necessary to utilize techniques that can investigate deep strata. Usually such techniques include hand or mechanical systematic deep coring, or deep trenches using heavy equipment (typically a backhoe). Examples of geomorphic features requiring such testing are floodplains, alluvial fans, and occasionally some uplands and terraces where post-Pleistocene loess deposition has occurred.

G. Photographic Requirements for Structures:

Photographs must be provided for all structures located within the project area and the Area of Potential Effect (APE). This includes all structures regardless of the condition. For example, a 40-acre subdivision development project that contains 3 former farmsteads on the property will require photographs of all structures.

Be sure to provide a statement regarding eligibility and effect in the "Recommendations" portion of the report for each structure or district (see example – Section C Recommendations below).

H. Collection Strategy and Curation:

At a minimum, samples of artifacts observed during Phase I survey should be collected and curated. If artifact collection is not feasible due to lack of landowner permission, then field photographs of diagnostic artifacts (scale included) and a sample of non-diagnostic artifacts should be included in the report along with a signed statement from the landowner indicating the desire to retain the artifacts.

Until the development of a state curation facility is completed, artifacts should be curated either with the consulting firm or with the Museum Support Center at the University of Missouri.

Survey Report

At the completion of the field survey a report of the archaeological findings and recommendations must be sent to the SHPO for evaluation. Please keep in mind, that when submitting reports to the SHPO for review, all project reports submitted will be considered final and therefore should be thorough and complete. Draft reports will be reviewed only if agreed upon during consultation prior to project initiation.

For most projects we recommend that the Section 106 Survey Memo be completed for the report. When determining if the Survey Memo or a full text report is appropriate, bear in mind that other researchers (including yourselves) will be using the report in future and it will need to convey the information regarding the survey and sites located clearly.

If you are submitting a full text report, a Section 106 Survey Memo must be completed and included. Staff uses the Section 106 Survey Memo to compile a bibliographic index of archaeological investigations throughout the state. And in this situation it should be noted that maps and attachments will not be required (as they are already in the report) and many of the fields on the form, such as "Cultural Material Recovered" will be completed as "please see the following report".

To assist in this evaluation and to avoid delays in processing, the full text reports should contain, at a minimum, a discussion of the following topics:

A. Background Information:

1. Full, detailed description of project for which the survey was conducted. This must include the name of the applicable federal agency.
2. Previous archaeological research within a minimum of one mile from the maximum extent of the archaeological Area of Potential Effects (which includes areas such as construction limits and access roads) for the project area. This must be based on examination of published and unpublished literature at the Cultural Resource Inventory in Jefferson City, Missouri and other regional and local repositories as appropriate

   This must include, but not be limited to the following: the site files, CRM reports, Determinations of Eligibility, historic architectural surveys, etc. A thorough examination of historical documents to ascertain presence and extent of historical occupation/land use of project area should also be included. At a minimum, copies of relevant plat maps and atlases that document historic habitation with a discussion of length of occupation and use must be included. These topics need to be addressed in the report of investigations in addition to the ASM site file check.
3. Delineation of important regional research questions based on cultural history and past investigations. This should include, but not be limited to, referencing The Master Plan for Archaeological Resource Protection in Missouri (1987).
4. Thorough discussion and description of present and past environment and the implications for interpreting the local archaeological record should be included. Such topics as topography, soils, and discussion of relevant periods of prehistory should also be included. Discuss only the periods of prehistory and history that are relevant to the current project based on the background research.

B. Survey Information:

1. Complete description of project area including acreage, ground cover, topography, and any other factors that are important to interpreting the survey results.
2. Relevant portion of the 7.5 minute topographic map delineating the project area.

3. Survey techniques thoroughly described and documentation of consultation for alternative procedures.
4. Sketch maps should be included with each report. While maps do not have to be to scale and can be hand drawn, they must be legible and include the following information:
   - Land use / ground cover (including percentage surface visibility).
   - Survey limitations (a description and justification for any areas that could not be surveyed. For example: 0.2 acres of pasture could not be surveyed because landowner could not be contacted to turn off electric fence and remove livestock.) These areas should be clearly labeled on Figure 2, the sketch map.
   - Survey techniques employed in relation to individual areas of land use / ground cover (i.e. pedestrian survey or shovel probes).
   - Location of testing procedures (i.e. backhoe trenches, test units, etc.) and site limits (if applicable).
5. Any additional photographs, maps, or other relevant materials that would contribute to the understanding of the project.

C. Recommendations:

This section must include the consultant's recommendations determined by consulting the appropriate National Register Bulletin(s) available from the National Park Service. At a minimum, National Register Bulletin 15 - "How to Apply the National Register Criteria for Evaluation" must be employed to make determinations of eligibility and recommendations.

Other bulletins are available for specific topics and should be consulted and used appropriately for topics such as:

Cemeteries*
Shipwrecks*
Historic archaeological sites
Historic landscapes
Rural historic landscapes
Traditional cultural properties

* Missouri state laws also protect these resources. Refer to http://www.moga.mo.gov/statutesearch/ for the revised Missouri Statutes concerning protection of these resources.

Recommendations in the report must include one of the following statements with regard to the project as a whole *in addition to determinations of eligibility for the individual sites / structures*:

a) **No Historic Properties Located.**
For projects that failed to locate historic properties
b) **No National Register Eligible Historic Properties Located.**
Historic properties were located; however they do not meet the eligibility standards for listing on the National Register of Historic Places.
c) **National Register Eligible Historic Properties Located.**
Historic properties were located which meet the eligibility standards for listing on the National Register of Historic Places.
d) **Historic Properties May Meet Requirements For National Register Listing; Phase II Testing Is Recommended**
Historic properties were located which may meet the eligibility standards for listing on the National Register of Historic Places. However, not enough information was collected during the Phase I. Phase II Testing is therefore needed to make the eligibility determination.

For example: *Survey located twelve archaeological sites, 23XX001 through 23XX012. Sites 23XX001, 23XX002, and 23XX003 are small, low-density prehistoric scatters that do not appear to meet requirements for National Register Eligibility (see site form for details). Sites 23XX004 – 23XX011 are small historic period scatters which do not appear to meet requirements for National Register eligibility. One site, 23XX012 appears to be eligible. Mid-range dates for the ceramics collected suggest a mid-1800s occupation, but the site* terminus post quem *and* terminus ante quem *are 1874 and 1895 respectively, as based on an indicated structure in historic atlases. It therefore appears that the ceramics may have been curated. The site may meet requirements for National Register Eligibility, and avoidance or Phase II testing is recommended for this resource.*

In addition, the survey located 4 buildings over 50 years old. Buildings A, B, and C (see photograph log) have had several recent additions and had vinyl siding added and do not appear to be eligible for listing in the National Register of Historic Places. Building D (see photograph log), is a Greek Revival I - house that appears to be eligible under Criterion C for Architecture. As planned, the proposed project will have no adverse effect on this historic property because it will have no direct impact to the physical structure of the building.

"Potentially Eligible" ***This term is not acceptable.*** Resources will be considered eligible until proven otherwise. Recommendations of eligibility should clearly state that the site/structure "is eligible for listing on the National Register of Historic Places" or the site/structure "is not eligible for listing on the National Register of Historic Places".

D. Site Information (if present):

1. A full description of the site location, material recovered (including curation facility), and a preliminary interpretation of its place in the local culture history must be included.
2. A completed site form with topographic map and sketch map must be submitted to the SHPO for each site. **Site forms should be included only in the SHPO copy of the reports.** These site forms are not to be included in any reports that may be disseminated to the general public. Reports must include the citation *Section 304 of the National Historic Preservation Act of 1966* on the confidentiality of site location information.
3. Recommendations for each site are required. These will consist of either: "the site is not eligible", "further testing will be required", or mitigation alternatives for the site. Any suggestions concerning site disposition should be stated in terms of their relationships to relevant regional research questions and The Master Plan for Archaeological Resource Protection in Missouri (1987).

E. Archaeological Contractor's Vita:

All contract archaeologists working in Missouri must either have a current vita on file with the SHPO or submit one with each report.

F. Project Correspondence:

Project correspondence must be included as an appendix. This should include such letters as the initial SHPO survey request, and any other relevant correspondence. Please do not include budget information.

APPENDIX E
CONTACT LIST

STOCKTON LAKE REALLOCATION STUDY

U.S. ARMY CORPS OF ENGINEERS-KANSAS CITY DISTRICT

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MISSOURI STATE HISTORIC PRESERVATION OFFICER

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PONCA TRIBE OF NEBRASKA

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PONCA TRIBE OF OKLAHOMA

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APPENDIX F
OSAGE NATION HUMAN REMAINS HANDLING PROCEDURES

Osage Nation Historic Preservation Office

ΩA[A[E KOΣΨ KΨ]EA

Procedures for Handling Human Remains during Authorized Intentional Excavations or during Inadvertent Discoveries of Human Remains

Procedure Statement:

This policy applies whenever the Osage Nation Historic Preservation Office (ONHPO) Director determines that it is prudent and necessary to consult on any projects or activities involving potential excavation of human remains during authorized intentional excavations approved by the Osage Nation.

Purpose of the Procedure:

The Osage people desire to protect their rights to privacy and to Osage Intellectual Property. Due to the continued abuse, misrepresentation, and exploitation of the right of the Osage people, it is necessary that guidelines be established and strictly followed so as to protect the rights of the past, present, and future generations of the Osage people.

This procedure, as required and promulgated by NAGPRA, applies to Native American human remains, funerary objects, sacred objects, and objects of cultural patrimony as defined in the statute and regulations (see glossary) that are excavated intentionally or discovered inadvertently on Federal or Tribal lands.

Towards this end, the Osage Nation shall be consulted by all entities that propose projects or activities involving Osage cultural resources and that such proposed projects or activities be reviewed and approved by the Traditional Cultural Advisors Committee and the Osage Nation Historic Preservation Office through a permitting process or other contractual agreement.

This protocol should in no way be construed as a substitute for mandated consultation with the Osage Nation, nor is it a justification to excavate any human remains outside the specific and discrete standards of archaeological activity. If the planned activity is also subject to review under Section 106 of the National Historic Preservation Act (16 U.S.C. 470), consultation and any agreement for compliance conducted under that Act should be coordinated with the requirements of the NHPA.

Further, any excavation or removal of Native American human remains, funerary objects, sacred objects, or objects of cultural patrimony discovered inadvertently or excavated intentionally as part of a planned activity must be undertaken in accordance with the requirements of the Archaeological Resources Protection Act (ARPA) (16 USC 470) and its implementing regulations as well as the requirements of the Native American Graves Protection and Repatriation Act (NAGPRA) (23 USC 3001). Under NAGPRA, a written plan of action is required for both inadvertent discoveries and intentional excavations (43 CFR 10.5(e)).

Scope:

This policy applies to the ONHPO Director, the Traditional Cultural Advisors committee, NAGPRA Coordinator, and all other designated ONHPO staff members and representatives involved in proposed projects or activities including research and multimedia sources of Osage intellectual property.

Definitions:

- "Human Remains" refers to the physical remains of the body of a person of Native American ancestry.
- "Funerary Objects" refers to objects that, as a part of the death rite or ceremony of a culture, are reasonably believed to have been placed with individual human remains either at the time of death or later, including any items exclusively made for burial purposes or to contain human remains.
- "Sacred Objects" refers to ceremonial objects which are needed by traditional Native American religious leaders for the practice of traditional Native American religions by their present day adherents.
- "Objects of Cultural Patrimony" refers to those objects having ongoing historical, traditional, or cultural importance central to the Native American group or culture itself, rather than property owned by an individual Native American, and which, therefore, cannot be alienated, appropriated, or conveyed by any individual regardless of whether or not the individual is a member of the Indian tribe or Native Hawaiian organization and such objects shall have been considered inalienable by such Native American group at the time the object was separated from such group.
- "Intentional Excavation" includes the planned archaeological removal of human remains, funerary objects, sacred objects, or objects of cultural patrimony found under or on the surface of Federal or tribal lands pursuant to section 3 (c) of the Native American Graves Protection and Repatriation Act. (43 CFR 10.2 (g)(3))
- "Projects" or "Activity" includes, but is not limited to, any Phase 3 cultural resource surveys, archaeological investigations including excavation via meter-by-meter units, and/or other subsurface excavations undefined here or yet to be defined.
- "Agency" refers to the Federal or state organization that has authority under law to conduct archaeological investigations on Federal or state lands and can enter into government-to-government consultation with the Osage Nation.

Governing Laws and Regulations:

- National Historic Preservation Act of 1966, as amended through 2006 (16 U.S.C. 470)
- Protection of Historic Properties, as amended through 2004, (36 CFR Part 800)
- Native American Graves Protection and Repatriation Act (25 U.S.C. 3001 et seq.)
- Archaeological Resources Protection Act, as amended (16 U.S.C. 470)
- American Indian Religious Freedom Act, as amended (42 U.S.C. 1996)
- National Environmental Policy Act (42 U.S.C. 4321, et seq.)
- Executive Order No. 13007
- Agency-Specific Legislation

- Osage Nation Constitution
- Osage Nation Cultural Preservation Act, as amended (ONCA 07-24)
- Osage Grave Protection Act (ONCA 15-75)

Procedure:

With respect to the treatment of human remains encountered during investigations or inadvertently discovered, the Osage Nation requests that all projects or activities adhere to the following:

1) That **No Photographs Be Taken** of the human remains and that hand-drawn illustrations or plan notes be used in documentation and other communication, this requirement will also be stated as an agency responsibility as stipulated in any Memorandum of Agreement for a project. Should unforeseen, unusual circumstances arise, the agency may request that photographs be taken. These photographs will, however, be taken **only after** consultation and concurrence with the Osage Nation and other concerned Tribes consulting on a project; and
2) That all excavations, work, and/or activities in a one hundred (100)-meter radius of the human remains be stopped immediately; and
3) That the Osage Nation Historic Preservation Office Director be immediately notified by phone, within twenty-four (24) hours of finding human remains; and
4) The ONHPO be given the opportunity to visit the location and be provided an on-site orientation of the location where the human remains were discovered prior to any further disturbance or excavation in the location; and
5) That agency staff not conduct excavation, handling, or removal of any human remains without the Osage Nation Historic Preservation Office approval; and
6) That agency staff conduct themselves in a professional and sensitive manner in the vicinity of, and with respect to, the human remains, including limiting handling the remains only to the extent which is necessary and not using the unfortunate circumstance as an opportunity to gain experience or knowledge with respect to the recovery and analysis of human remain; and
7) That only natural materials be used in the process of collection, transportation, and storage of human remains;
8) That each skeletal element be placed in its own container so as to prevent damage to the remains during their collection, transportation, and storage; and
9) That all objects associated with the human remains be collected, transported, and stored with the human remains with which they were associated and remain so throughout the process to and including reburial; and
10) That all objects that may reasonably be determined to be associated with the human remains be considered associated with those remains; it is understood that the agency staff will err on the side of caution, i.e. be liberal in their determination of association in consultation and concurrence with the Osage Nation; and
11) That the agency consult with the Osage Nation Historic Preservation Office for approval to collect, preserve, and process an amount (to be determined in each case) of soil from identified graves; and
12) That, if approved by the ONHPO, all soil samples collected from grave locations be kept with those remains and be processed following consultation specific to those samples, and be processed separately from other samples; and

13) That agency will provide the Osage Nation with copies of all documentation concerning human remains including documentation concerning the transfer of control of the human remains and the associated objects from agency to any curation/storage entities; and
14) That the Osage Nation Historic Preservation Office will be "cc'd" on all correspondence between or among the agency and other entities when the correspondence concerns human remains or associated funerary objects; and
15) That the Osage Nation Historic Preservation Office will provide the name(s) and contact information of any preferred Biological Anthropologist/Archaeologist of which it is aware who may conduct analysis of the collected faunal and human remains on behalf of the agency; and
16) That agency will contact the Osage Nation Historic Preservation Office sufficiently in advance, or when it is notified, of any pre-construction meetings and construction of the project. The Osage Nation reserves the right to request project monitoring at any time during the project planning or execution.