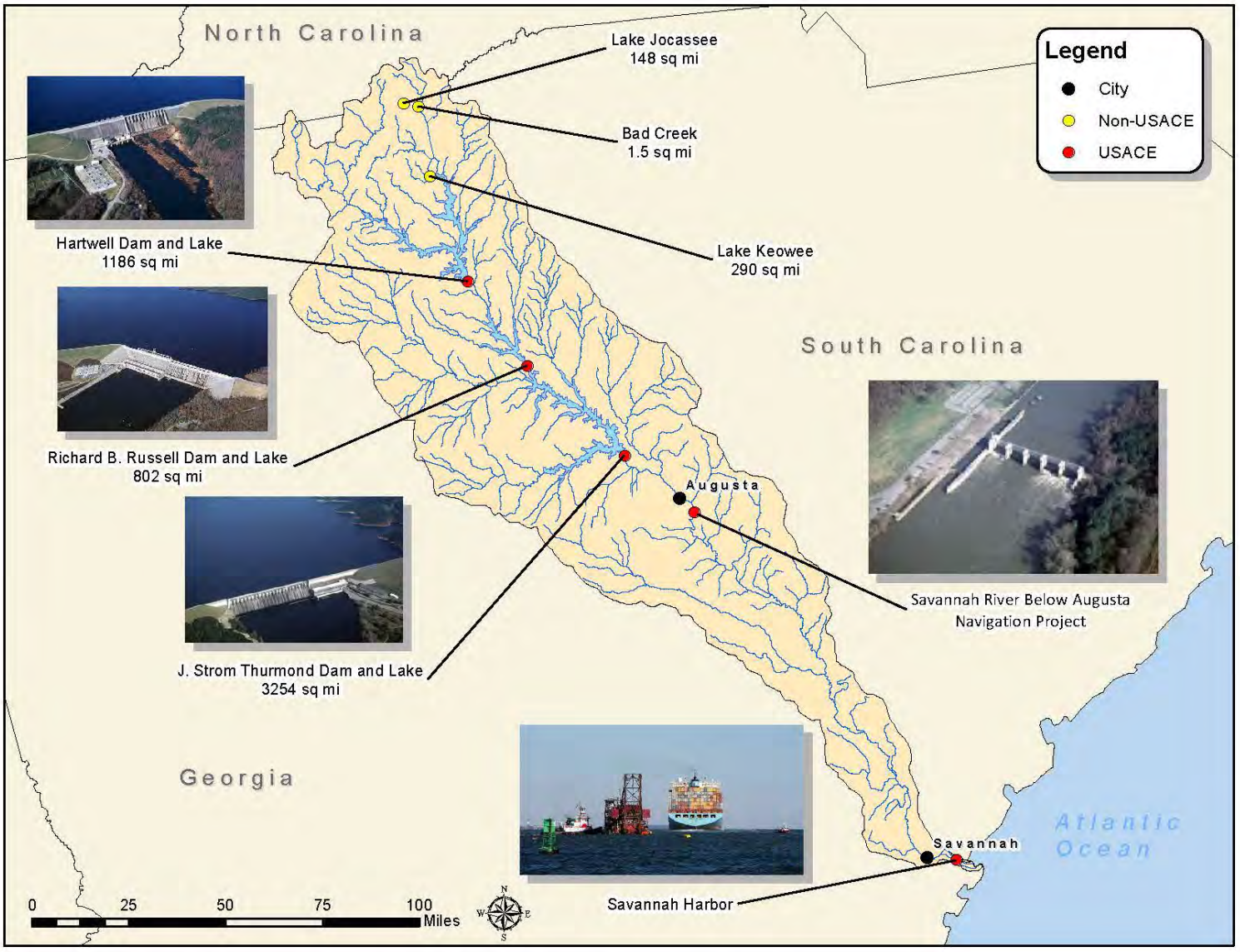
US Army Corps
of Engineers®
Savannah District

Savannah River Basin Comprehensive Study, GA & SC
Interim Study 2

Integrated Feasibility Report and Environmental Assessment
For the Drought Contingency Plan Update



June 2017

EXECUTIVE SUMMARY

The Savannah River Basin Comprehensive Study (SRBCS) Interim 2 evaluated potential changes to the U.S. Army Corps of Engineers (USACE) Drought Contingency Plan (DCP) for the Savannah River Basin. The Georgia Department of Natural Resources (GADNR), the South Carolina Department of Natural Resources (SCDNR), and The Nature Conservancy (TNC) were the non-Federal sponsors for the study. The Project Delivery Team (PDT) was comprised of selected staff from the GADNR, SCDNR, TNC, and USACE.

SRBCS Interim 2 recommends a Drought Contingency Plan (DCP) that would improve management of water resources for all authorized project purposes during prolonged low inflows. Those improvements result from operational changes that impact the timing and magnitude of releases from J. Strom Thurmond (JST) Dam and Reservoir during droughts. Physical modifications to the existing projects or new construction features for the projects were outside of the scope of Interim 2.

The SRBCS Interim 2 formulated, evaluated, and compared a wide array of drought management alternatives. Each alternative includes various elevation triggers and required releases from the JST Dam and Reservoir.

The PDT examined the No Action Alternative (NAA) and six action alternatives through the use of engineering computer model simulations, economic analysis, and an environmental assessment. They evaluated the potential effects of each alternative on all project purposes both in the reservoirs and downstream of the reservoirs.

The team compared the final array of alternatives for their effects on hydropower and recreation using economic factors. They used non-economic factors for the other project purposes: environmental stewardship, navigation, water supply, and flood risk management. The PDT selected percent change as the method to give each project purpose comparable units of measure.

Alternative 2 produces the most positive impacts and least negative impacts on the authorized project purposes. Therefore, Alternative 2 is the Tentatively Selected Plan. The Plan would increase conservation opportunities within the reservoirs by flattening the level 1 and 2 triggers, raising trigger level 3, and slightly decreasing the required discharge for each trigger level. Drought trigger level 1 would be located at the same elevation as the current winter guide curve of 4 feet down from the summer guide curve. The guide curve is USACE's operational target for the reservoir elevation. Drought trigger level 2 would be located 2 feet below drought trigger level 1. Drought trigger level 3 would be located 2 feet below drought trigger level 2, which is 6 feet higher than in the NAA. When in drought trigger level 1, JST would target a daily average release of 4,000 cfs. During level 2, discharges would be 3,800 cfs from February through October, and 3,600 cfs from November through January. During level 3, discharges would be 3,600 cfs from February through October, and 3,100 cfs from November through January.

TABLE OF CONTENTS

Savannah River Basin Comprehensive Study, GA & SC
Interim Study 2

Feasibility Report and Environmental Assessment for the Drought Contingency Plan Update

This report is an integrated feasibility report and environmental assessment complying with requirements of the U.S. Army Corps of Engineers (USACE) and the Council of Environmental Quality (CEQ), and is intended to reduce duplication and paperwork. An **asterisk (*)** in the table of contents identifies sections that are required for National Environmental Policy Act (NEPA) compliance.

TABLES

Tables Page #

FIGURES

Figures Page #

APPENDICES

ACRONYMS

Acronyms	Definition
CAA	Clean Air Act
CEQ	Council of Environmental Quality
CFR	Code of Federal Regulations
CFS	Cubic Feet Per Second
DCP	Drought Contingency Plan (Study)
DHEC	Department of Health and Environmental Control
DNR	Department of Natural Resources
DO	Dissolved Oxygen
EA	Environmental Assessment
EFDC	Environmental Fluid Dynamics Code Model
EFM	Ecosystems Function Model
EO	Executive Order
EPA	United States Environmental Protection Agency
EPD	Environmental Protection Division
EFH	Essential Fish habitat
FEMA	Federal Emergency Management Agency
ER	Engineering Regulation
ESA	Endangered Species Act
FMC	Fishery Management Councils
FONSI	Finding of No Significant Impact
FRM	Flood Risk Management
GA	Georgia
Guide Curve	The pool elevation delineating the boundary between conservation storage and flood storage
HEC	Hydrologic Engineering Center (USACE)
HTRW	Hazardous, Toxic, and Radioactive Waste
HUC	Hydrologic Unit Codes
IPAC	Information, Planning, and Conservation System (USFWS)
JST	J. Strom Thurmond Lake and Dam
MAFMC	Mid-Atlantic Fishery Management Council
MSL	Mean Sea Level
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
NAA	No Action Alternative
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act of 1969
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRHP	National Register of Historic Places
NSBLD	New Savannah Bluff Lock and Dam
NWR	National Wildlife Refuge
PA	Programmatic Agreement

PDT	Project Delivery Team
PCB	polychlorinated biphenyl
PMF	Probable Maximum Flood
ppt	parts per thousand
RBS	River Basin Survey
ResSim	Reservoir Simulation Model
RIV-1	One dimensional Dynamic Hydraulic and Water Quality Model
RM	River Mile
RBR	Richard B. Russell Reservoir
SAFMC	South Atlantic Fishery Management Council
SC	South Carolina
SEPA	Southeastern Power Administration
SHPO	State Historic Preservation Officer
SOP	Standard Operating Procedure
SRB	Savannah River Basin
SRBCS	Savannah River Basin Comprehensive Study
TNC	The Nature Conservancy
TMDL	Total Maximum Daily Load
TSP	Tentatively Selected Plan
UIF	Unimpaired Flow
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geologic Survey
WASP	Water Quality Analysis Simulation Program Model
WY	Water Year

Savannah River Basin Comprehensive Study, GA & SC
Interim Study 2

Feasibility Report and Environmental Assessment
for the
Drought Contingency Plan Update

1.0 Introduction

1.1 Purpose of Study*

The Savannah River Basin Comprehensive Study (SRBCS) Interim 2 examines an array of alternative reservoir operations from the multipurpose dam and reservoir projects on the Savannah River. The goal is to identify the best management of water resources for users both upstream and downstream of J. Strom Thurmond Dam and Lake (JST) during drought conditions. Being the second interim study under the SRBCS, the intent of the study is to re-evaluate the 2012 Drought Contingency Plan (DCP) to determine if modifications are warranted.

The updated study provides the necessary detailed information to determine the amount of flow required during severe and prolonged drought conditions to meet areas affected by drought operations without unacceptable impacts to the authorized project purposes. Alternatives were developed to cover a full range of flows and identify the points at which unacceptable impacts may occur to infrastructure and the environment.

The use of the 52 metrics (Table 17) helped answer these questions. This study uses Unimpaired Flow (UIF) data developed and extended by Georgia Department of Natural Resources (GADNR) Environmental Protection Division (EPD) and other agencies for basin-wide modeling. Savannah District examines the minimum discharges that are needed to best manage water resources to users upstream and downstream of JST and sustain environmental resources during drought conditions. Non-Federal sponsors identified issues based on their current highest priority for the SRBCS. Engineering model runs, an economic analysis, and an examination of environmental impacts led to detailed investigation of alternative reservoir releases. The potential effects on water users (both in the reservoirs and downstream) were quantified. The hydrologic period of record was extended from 1939 through 2013. However, the Project Delivery Team (PDT) evaluated the alternatives based on the period from 1999 through 2013 due to limitations of the water quality models. The period of record used in the analysis includes the two most recent droughts of record, 2007-2009 and 2010-2013.

1.2 Study Authority

The Water Resources Development Act of 1996, Section 414 (Public Law 104-303) is the study authority. The Act states:

SEC. 414 SAVANNAH RIVER BASIN COMPREHENSIVE WATER RESOURCES STUDY.

(a) In General.-The Secretary shall conduct a Comprehensive study to address the current and future needs for flood damage prevention and reduction, water supply, and other related water resources needs in the Savannah River Basin.

(b) Scope.-The scope of the study shall be limited to an analysis of water resources issues that fall within the traditional civil works mission of USACE.

(c) Coordination.-Notwithstanding subsection (b), the Secretary shall ensure that the study is coordinated with the Environmental Protection Agency and the ongoing watershed Study of the Savannah River Basin by the Agency.

Updates to Drought Contingency Plans occur under the study authority and in accordance to ER-1110-2-1941, Drought Contingency Plans, and ER-1165-2-119, Modifications to Completed Works.

1.3 Study and Project Area

The project area consists of the main stem of the Savannah River, which includes all or portions of 44 Counties within Georgia, South Carolina, and North Carolina. While the Savannah River Basin does include a small portion of North Carolina, the change in flows being evaluated at the dams and lakes are south of North Carolina and affect flows downstream. Therefore, no impacts to the North Carolina portion of the Savannah River Basin occur. The drainage basin is approximately 10,577 square miles; of which approximately 5,821 are in Georgia, 4,581 are in South Carolina, and 175 square miles lie in North Carolina.

USACE's five existing projects on the Savannah River (Figure 1) are as follows:

- Hartwell Dam
    - Dam located at River Mile 305
    - Reservoir covers 55,950 acres at full pool
    - Reservoir provides 2,549,600 acre-feet of storage at full pool
    - Reservoir provides 1,416,000 acre-feet of conservation storage at full pool
    - Power generation of 396,000 kilowatts per hour
    - Includes several recreational parks

- Richard B. Russell Reservoir
    - Dam located at River Mile 275
    - Reservoir covers 26,650 acres at full pool
    - Reservoir provides 1,026,244 acre-feet of storage at full pool
    - Reservoir provides 126,800 acre-feet of conservation storage at full pool
    - Power generation of 600,000 kilowatts per hour

- J. Strom Thurmond Dam and Lake
    - Dam located at River Mile 237.7
    - Reservoir covers 70,000 acres at full pool
    - Reservoir provides 2,510,000 acre-feet of storage at full pool
    - Reservoir provides 1,045,000 acre-feet of conservation storage at full pool
    - Power generation of 280,000 kilowatts per hour
    - Includes several recreational parks

- Savannah River Below Augusta Navigation Project
    - New Savannah Bluff Lock and Dam (NSBLD) located at River Mile 187
    - Provides a 9-feet deep, 90-feet wide, navigation channel that has not been maintained for 30 years
    - Provides minor reregulation of daily average releases from JST
    - Includes one recreational park

- Savannah Harbor Navigation Project
    - Savannah Harbor handles the largest number of containers of any port on the South Atlantic coast and is 4th in the nation in import and export of container cargo.
    - The bar channel is 11.5 miles long, 44 feet deep, and 600 feet wide
    - The inner harbor channel is 21 miles long, 42 feet deep, and 500 feet wide
    - Savannah Harbor is currently being deepened by 5 feet from its current authorized navigation depth of 42 feet to 47 feet.

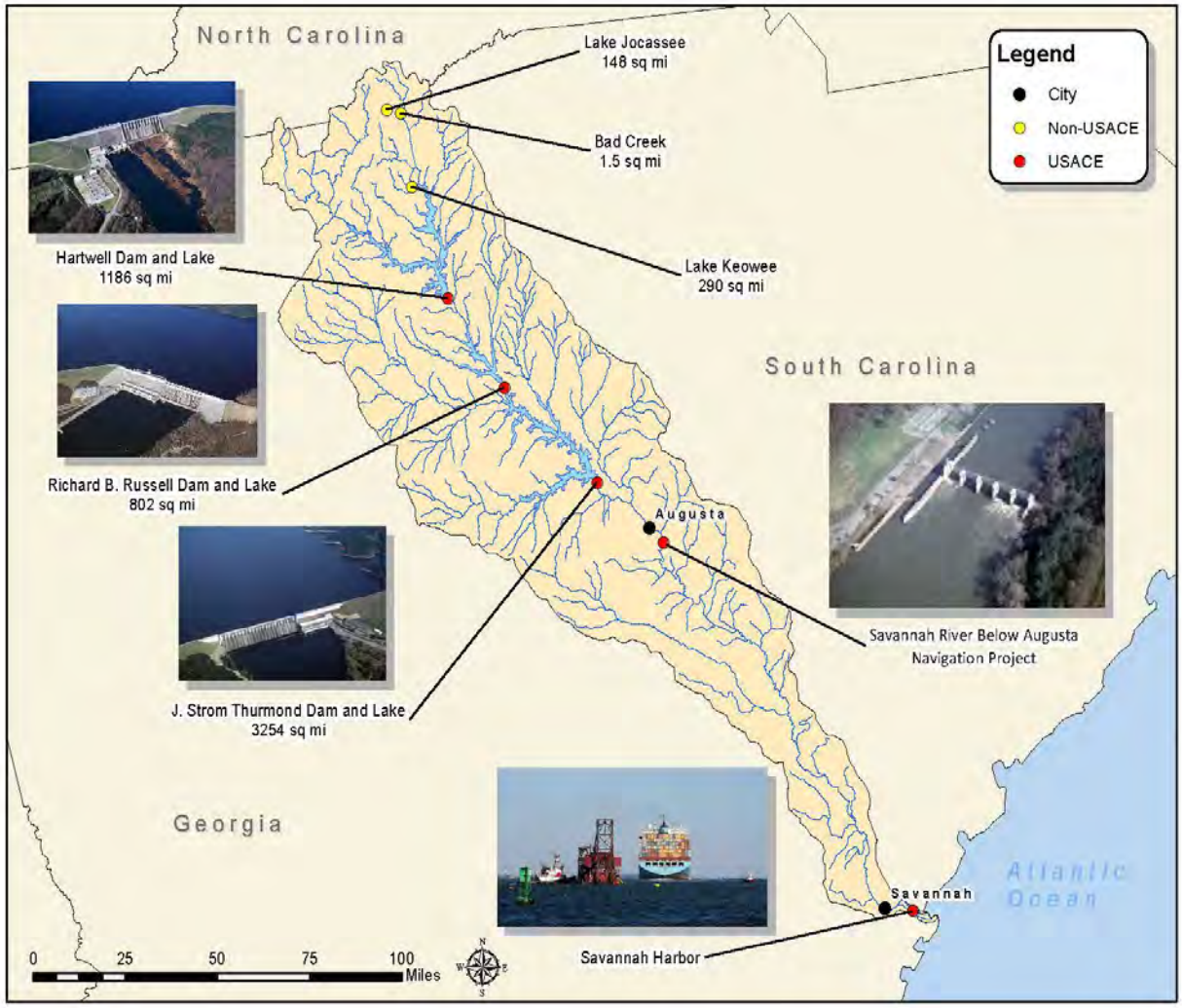


Figure 1: Project Location Map

1.4 History

ER 1110-2-1941 requires USACE to develop drought contingency plans for its reservoir projects. The Savannah District developed the Savannah River Basin Drought Contingency Plan (DCP) in 1989. This addressed the effects of the District's water control management activities on the impoundments it manages and the downstream portion of the river. This document assisted the States of Georgia and South Carolina in their drought contingency planning and water management responsibilities for the Savannah River Basin. Savannah District uses elevation based triggers to respond to different levels of drought severity (Figure 4).

The Savannah River Basin Comprehensive Study is currently divided into three interim studies. Completed in 2006, Interim Study 1 modified the original 1989 DCP by revising the management actions that would be taken at various lake levels. It incorporated an

Unimpaired Flow (UIF) data set developed by GADNR that contained river flow data from 1939 to 2006. At the time of Interim Study 1, the drought of record occurred from 1999-2003. The deliverables from that Interim Study included a DCP, reservoir models, a survey of stakeholders, and the pertinent data needed for the completion of the Savannah River Basin Comprehensive Study.

Significant droughts continued to occur (2007-2009 and 2011-2013), testing the DCP. The current drought of record (2011-2013) resulted in new interest in updating the DCP. A subsequent reanalysis of the 2006 DCP with respect to these 2 droughts resulted in the release of the 2012 Drought Management Plan prior to the end of the 2011-2013 drought.

Interim Study 2, which began in September 2013, is scheduled for completion in September 2017. This study focuses on hydrological data from 1999 through 2013. Unless the NAA is selected, the recommended alternative for the Interim Study 2 would serve as the basis for USACE to update its DCP for the basin. The results of the study help scope Interim Study 3, which can begin once USACE has approval, funding, and a sponsor. As authorized in WRDA 1996, this current study addresses the current and future needs of water resources in the Savannah River Basin. As described in the 2010 SRBC Review Plan, USACE is reassessing the drought rules developed in Phase 1 to determine what modifications, if any, are warranted. Interim Study 3 is the final phase of the SRBCS. The final phase would be a comprehensive examination of modifications to the three-reservoir system to change reservoir operations during flood, normal, and drought conditions.

1.5 Other Planning Studies, Reports, or Efforts

Development of the Probable Maximum Flood and Frequency Flows for the Savannah River system

USACE Savannah District prepared this report in June 2014. The purpose of this study was to develop the Probable Maximum Flood (PMF) inflow hydrograph into Hartwell, Russell, and JST Reservoirs.

Current Storage Balance Agreement between the U.S. Army Corps of Engineers (USACE), Southeastern Power Administration (SEPA), and Duke Energy

In October 2014,Savannah District completed its actions to evaluate and update a new storage balance agreement with Duke Energy. The new agreement would equalize the percent of remaining usable storage capacity at Duke Energy's Jocassee, and Keowee Lakes during droughts with the remaining usable storage at the USACE's Hartwell, Richard B. Russell, and J. Strom Thurmond Reservoirs.

Savannah District completed its actions to evaluate and update its operating agreement between Duke Energy, the Southeastern Power Administration (SEPA), and the USACE

that describes how Duke Energy will release water from its upstream reservoirs to the downstream federal reservoirs.

The District Commander signed the Finding of No Significant Impacts (FONSI) on October 10, 2014 and signed the new operating agreement with Duke Energy and SEPA on October 17, 2014.

The following projects in the Duke Energy system are included in the new agreement: Keowee-Toxaway (Jocassee and Keowee), Oconee Nuclear Station, and Bad Creek. The following projects in the USACE system are included in the new agreement: Hartwell Dam, Richard B. Russell Reservoir, and J. Strom Thurmond Dam and Lake.

The new agreement balances the percent of remaining usable storage between Duke Energy and USACE reservoirs during droughts. The agreement would have kept the reservoirs in the Duke Energy and USACE systems from reaching the bottom of their conservation pools during the drought of record.

The new agreement would result in Duke drawing the Keowee Project down to 790 feet mean sea level (msl) during a severe drought and incorporates Duke's drought tolerance measures (Low Inflow Protocol) to coordinate drought response to protect water supplies in upper basin. The new agreement incorporates the USACE' 2012 Drought Plan. The minimum flows that downstream users experience remain the same as in the 2012 Drought Plan rules. The Selected Alternative (A3) includes mitigation to fully compensate for adverse impacts to recreation in the USACE reservoirs.

A copy of the EA and FONSI can be found at the links below as well as a copy of the current operating agreement:

Storage balance agreement between USACE, SEPA, and Duke Energy

http://www.sas.usace.army.mil/Portals/61/docs/Planning/Plansandreports/Duke/DukeFinalEA14.pdf

Duke Energy Current Operating Agreement - Savannah River Basin FONSI

http://www.sas.usace.army.mil/Portals/61/docs/Planning/Plansandreports/Duke/DukeFONSI14.pdf

Savannah River Basin Drought Plan Revision – September 2012

During the previous drought of record, 2006-2009, the Savannah District again entered the drought contingency planning process and introduced additional conservation measures based on unregulated flows in an adjacent watershed. For Drought Trigger Level 2, if the current 28-day Broad River percentile inflow is greater than the 10th percentile flow, then the prescribed JST Dam releases 4,000 cfs from February through

October. Otherwise, if the current 28-day Broad River percentile inflow is less than or equal to the 10th percentile flow, then the prescribed JST Dam releases 3,800 cfs from February through October. The November to January discharge for Level 2 would be 3,600 cfs and could be extended through February with NOAA Fisheries pre-approval. For Drought Level 1, February through October, if the current 28-day average Broad River flow is greater than the 10th percentile flow, then the JST Dam release targets 4,200 cfs, otherwise 4,000 cfs. For Drought Level 3, February through October, JST generates 3,800 cfs. The November through January discharge would also be reduced to 3,100 cfs and could be extended through February with NOAA Fisheries pre-approval. If requested by either the State of Georgia or South Carolina, the USACE would restore the JST discharge up to 3,800 cfs daily average for the 3,100 cfs release in Level 3. For Levels 1-3, the Hartwell Dam discharge would be reduced as appropriate to maintain balanced pools. To improve drought response requires a representative of basin inflow as a water control management trigger. The United States Geological Survey (USGS) Broad River stream gage near Bell, GA. provided the inflow numbers. It lies within a large unregulated basin with a long period of record (currently at 79 years). As such, it offers a good representation of inflow into the basin as a whole.

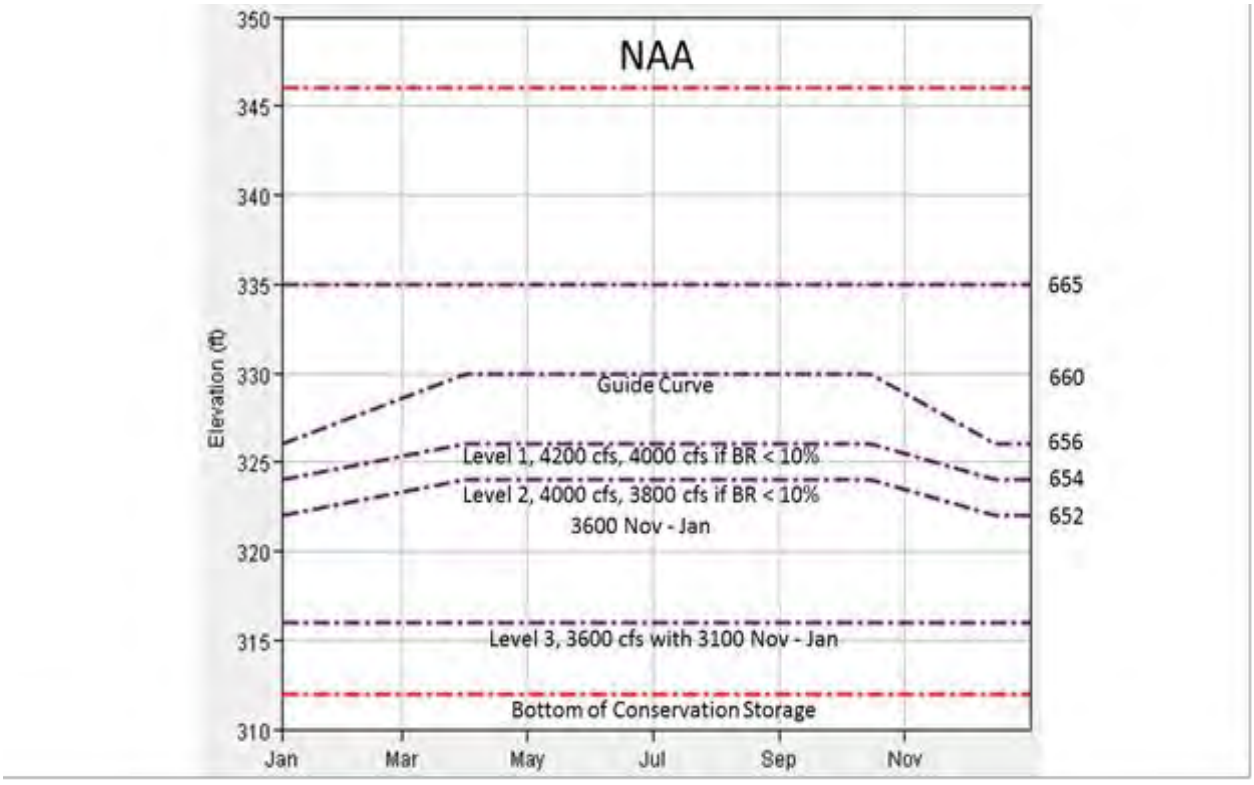


Figure 2: NAA Based on Updated 2012 DCP Discharge Rates

A copy of the EA and FONSI, and appendices can be found at the links below:

Savannah River Basin Drought Plan Revision EA and FONSI 2012:

http://www.sas.usace.army.mil/Portals/61/docs/Planning/Plansandreports/SRB%20Drought%20Revision%20Final%20EA%20%2030July2012.pdf

Savannah River Basin Drought Plan Revision Appendices
http://www.sas.usace.army.mil/Portals/61/docs/Planning/Plansandreports/SRB%20Drought%20Revision%20Final%20EA%20%2030July2012.pdf

Savannah River Basin Level 4 Drought Operations Study

After reviewing public and agency comments received in the spring of 2011, the Savannah District completed an Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) for operations during Level 4 drought conditions on the Savannah River. The Savannah District identifies Level 4 as the bottom of the authorized conservation storage. Storage below this level is considered inactive and used for sediment storage.

The Savannah River basin has never reached Level 4 conditions since the construction of the first major hydropower dam on the Savannah River in 1954. The USACE drought management plan was designed to prevent the three-reservoir system from ever reaching level 4. This EA clarifies actions USACE would take in the unlikely event that drought conditions reach this unprecedented level.

The EA concluded that the daily average releases from the JST Dam will be adjusted from 3,600 cubic feet per second (cfs) to 3,100 cfs from November 1st through the month of January, in the event that Level 4 is ever reached. The new Level 4 operations will:

- Extend the period over which the pools would be depleted;
- Extend the period over which the minimal environmental flows are available downstream; and
- Reduce recovery time for all three reservoirs

A copy of the EA and FONSI and appendices can be found at the links below:

http://www.sas.usace.army.mil/Portals/61/docs/Planning/Plansandreports/Sav%20River%20Basin%20Level%204%20Drought%20Operations%20EA,%20Oct%202011.pdf

Level 4 Drought Operations Appendices:

http://www.sas.usace.army.mil/Portals/61/docs/Planning/Plansandreports/Sav%20River%20Basin%20Level%204%20Drought%20Operations%20EA%20Appendices,%20Oct%202011.pdf

Flood Insurance Studies for Augusta/Richmond County

Table 1 presents a listing of the Federal Emergency Management Agency (FEMA) flood insurance studies for Augusta/Richmond County, Georgia. Additional reports prepared for the study area, such as the 1995 FEMA to Augusta-Richmond County Regional Flood Control Study, are listed in the September 1998 Section 905(b) Analysis and included herein by reference.

Table 1: Flood Insurance Studies for Augusta/Richmond County

Published	Title	Computations
September 25, 2009	Augusta-Richmond County, GA	Prepared by FEMA
March 23, 1999	City of Augusta (Prepared to include City of Augusta and Unincorporated Areas into one Flood Insurance Study)	H&H Computations obtained from prior studies with some updates and additions. Prepared by FEMA.
January 19, 1995	City of Augusta	Hydrology by USACE, Savannah District – Hydraulics by FEMA
January 19, 1995	Richmond County and Unincorporated Areas	Hydrology by USACE, Savannah District – Hydraulics by FEMA
January 3, 1994	FIS – Revisions to Oates Creek and Oates Creek Tributary following construction of Oates Creek Flood Reduction Project.	USACE, Savannah District
February 4, 1987	Richmond County and Unincorporated Areas	H&H by USACE, Savannah District
April 1, 1982	City of Augusta – FIS	H&H by USACE, Savannah District
January 1974	Special Flood Hazard Information Report, Raes Creek, Augusta and Richmond County, GA	USACE, Savannah District
August 1971	Special Flood Hazard Information Report, Savannah River at Augusta, GA.	USACE, Savannah District

Augusta-Richmond County Regional Flood Control Study

USACE conducted a reconnaissance study of Richmond County and adjacent headwater areas and completed a Section 905(b) Analysis under this study authority in September 1998. The Section 905(b) analysis found that flood damages in Augusta, and the lack of sufficient drainage canals and creeks adjacent to developed areas indicate the potential for feasible flood control projects in several areas. Therefore, the USACE determined that there was a federal interest in helping solve flooding problems

in Augusta-Richmond County and made the recommendation to proceed into a feasibility phase. USACE recommended four basins be included in the feasibility study: Rocky Creek basin, Augusta Canal basin, Phinizy Swamp basin, and Raes Creek basin. Three of the recommendations were completed. The Rocky Creek basin feasibility study is scheduled to be complete in 2017.

J. Strom Thurmond Dam and Lake

As authorized by the 1944 Flood Control Act, the multipurpose dam and reservoir project opened in 1952. Flood control, navigation improvement, and power development were the primary justifications for the project but reduction in Savannah Harbor dredging costs, increased recreation and wildlife benefits, and general industrial development were anticipated as well. The undertaking created a reservoir encompassing a surface area of 78,000 acres and a 1,200 mile long shoreline. The completed project is located on the Savannah River 22 miles north of Augusta, Georgia. Flood reduction benefits were evident during the 1964 flood. The project reduced flooding from 38 feet to 25 feet at Augusta, where the flood stage is 32 feet.

Hartwell Dam

Completed in 1963 and authorized under the Flood Control Act of 1950, the Hartwell Project originally authorized three purposes: hydropower, flood control, and navigation. Later, recreation, water quality, water supply, and fish and wildlife management were added. Like Thurmond, the Hartwell power plant is a “peaking plant,” meaning that power is not constantly generated. Power is only generated when electricity is in the greatest demand (approximately 468 million-megawatt hours/annually). Hartwell Lake contains a surface area of 55,900 acres of water with 962 miles of shoreline. Since completion, the dam prevented over $101,998 million in flood damages.

Richard B. Russell Reservoir

The Richard B. Russell Project authorized construction by the 1966 Flood Control Act as Trotters Shoals Lake and completed in 1985. The authorization document outlined the plan of development for the basin with authorized purposes of power production, incidental flood control, recreation, additional stream flow regulation, water supply, and fish and wildlife management. The reservoir reached full pool of elevation 475 msl with a surface area of 26,650 acres in December 1984. The first of four conventional units came on line and began producing power in January 1985. When necessary, substantial quantities of water pass downstream quickly for flood control purposes. The spillway, located on top of the dam, contains 10 large gates, each 50 ft. by 45 ft., for the quick release of water from the lake.

New Savannah Bluff Lock and Dam

The New Savannah Bluff Lock and Dam is managed by the USACE. Since commercial navigation hasn't used the lock since 1979, the Lock and Dam hasn't served its

authorized purpose for over twenty years. As part of the Savannah Harbor Expansion Project (WINN act of 2017), USACE is identifying methods to maintain a pool in Augusta and allow fish to pass the structure.

Augusta, Georgia, Levee

The project was authorized by the 1936 Flood Control Act. The project provides flood protection to the city of Augusta from the Savannah River. The project was completed in 1941, and turned over to the city of Augusta for operation and maintenance. Augusta Canal, originally a part of this study, generally parallels the Augusta Levee.

1.6 Study Sponsor

The USACE is conducting this study in a cost-shared partnership with the following non-Federal sponsors: GADNR, SCDNR, and TNC.

2.0 Existing Conditions and Affected Environment*

2.1 Environmental Setting

The basin includes portions of 27 counties in Georgia, 13 counties in South Carolina and four counties in North Carolina. Although the basin is predominantly rural, metropolitan areas are experiencing significant growth and development pressures. Primarily, growth occurred in the areas of Augusta and Savannah, Georgia, although many smaller cities and towns are also developing. There are several functions the river serves including providing water for drinking, energy, municipal/industrial use, and agriculture. According to the Georgia River Network website, forestry and agricultural practices represents a large percentage of land use within the Savannah River Basin followed by smaller percentages of wetlands, and urban development.

Like other basins of large rivers in the Southeast that flow into the Atlantic Ocean, the Savannah River Basin embraces three distinct areas: the mountain section, the Piedmont Province and the Coastal Plain. As stated in the 2001 Savannah River Basin Management Plan completed by the Georgia Department of Natural Resources, Environmental Protection Division, the mountain section and Piedmont provinces, which makes up about 60 percent of the Savannah River basin, are underlain by crystalline metamorphic and igneous rocks. The Coastal Plain sediments constitute approximately 40 percent of the Savannah River basin. The Coastal Plain differs from the Piedmont Plateau chiefly in the character of the terrain and in the kind of rocks that underlie it. It is built on much younger water-lain deposits of sand, clay, and limestone, and rests on a foundation that is the buried continuation of the crystalline rocks of the Piedmont belt.

Soils and gradient in the Savannah River Basin vary widely across the watershed, ranging from nearly level to very steep, from shallow to very deep, from excessively drained to very poorly drained, and from sandy to clayey. However, some consistencies

with soils exist across the watershed. Going from north to south, degree of slope decreases, water tables are generally lower in the north and higher in the south, and soil textures go from loamy in the Blue Ridge, to clayey in the Southern Piedmont, to sandy or sandy over loamy in the Sand Hills, Coastal Plain, and Atlantic Coast Flatwoods. The majority of the watershed is in the southern Piedmont region are classified as being very deep, well drained, red clay soils. These soils formed from felsic, high grade metamorphic or igneous rocks. Some of the soils in this region have been formed from intermediate and mafic crystalline rocks. These soils have lower permeability and are less acidic than typical Piedmont soils. Additional information of soil composition within the Savannah River Basin watershed can be found in more detail in the 2001 Savannah River Basin Management Plan.

Mild winters and hot summers in the lower portions, and cold winters and mild summers in the mountain area characterize the Savannah River Basin. Mean annual precipitation ranges from 40 to 80 inches per year. Precipitation occurs chiefly as rainfall, and to a lesser extent, as snowfall. Rainfall is fairly evenly distributed throughout the year, but a distinct dry season occurs from mid-summer to late fall. Most rainfall occurs in March and the least in October. The mean annual temperature is about 65 degrees Fahrenheit.

2.2 Significance

This section contains a description of relevant resources that could be impacted by the project. The important resources described in this section are those recognized by laws, executive orders, regulations, and other standards of National, state, or regional agencies and organizations; technical or scientific agencies, groups, or individuals; and the general public. Table 2 provides summary information of the institutional, technical, and public importance of these resources**.**

The following resources have been considered and found to not be affected by the alternatives under consideration: wetlands, essential fish habitat; terrestrial resources, including prime and/or unique farmlands; hydrology and floodplain, Hazardous Toxic and Radioactive Waste (HTRW), and socio-economic resources including demographics, economic conditions, and community cohesion.

Table 2: **Relevant Resources**			
Resource	**Institutional Significance**	**Technical Significance**	**Public Significance**
Wetlands	Clean Water Act of 1977, as amended; Executive Order 11990 of 1977, Protection of Wetlands; Coastal Zone Management Act of 1972, as amended; and the Estuary Protection Act of 1968., EO 11988, and Fish and Wildlife Coordination Act.	They provide necessary habitat for various species of plants, fish, and wildlife; they serve as ground water recharge areas; they provide storage areas for storm and flood waters; they serve as natural water filtration areas; they provide protection from wave action, erosion, and storm damage; and they provide various consumptive and non-consumptive recreational opportunities.	The public places high value on the functions and values that wetlands provide. Environmental organizations and the public support the preservation of wetland habitat.
Aquatic Resources/ Fisheries	Fish and Wildlife Coordination Act of 1958, as amended.	They are a critical element of many valuable freshwater and marine habitats; they are an indicator of the health of the various freshwater and marine habitats; and many species are important commercial resources.	The public places a high priority on aquatic resources/fisheries esthetic, recreational, and commercial value.
Wildlife	Fish and Wildlife Coordination Act of 1958, as amended and the Migratory Bird Treaty Act of 1918	They are a critical element of many valuable aquatic and terrestrial habitats; they are an indicator of the health of various aquatic and terrestrial habitats; and many species are important commercial resources.	The public places high priority on wildlife's esthetic, recreational, and commercial value.
Threatened and Endangered Species	The Endangered Species Act of 1973, as amended; the Marine Mammal Protection Act of 1972; and the Bald and Golden Eagle Protection Act of 1940.	USACE, USFWS, NMFS, NRCS, EPA, GA, and SC cooperate to protect these species. The status of such species provides an indication of the overall health of an ecosystem.	The public supports the preservation of rare or declining species and their habitats.

Table 2: Relevant Resources			
Resource	**Institutional Significance**	**Technical Significance**	**Public Significance**
Cultural Resources	National Historic Preservation Act of 1966, as amended; the Native American Graves Protection and Repatriation Act of 1990; and the Archeological Resources Protection Act of 1979	State and Federal agencies document and protect sites. Their association or linkage to past events, to historically important persons, and to design and construction values; and for their ability to yield important information about prehistory and history.	Preservation groups and private individuals support protection and enhancement of historical resources.
Recreation Resources	Federal Water Project Recreation Act of 1965 as amended and Land and Water Conservation Fund Act of 1965 as amended	Provide high economic value to local, state, and national economies.	Public makes high demands on recreational areas. There is a high value that the public places on fishing, hunting, and boating, as measured by the large number of fishing and hunting licenses sold in Georgia and South Carolina; and the large per-capita number of recreational boat registrations in Georgia and South Carolina.
Aesthetics	USACE ER 1105-2-100, and National Environmental Policy Act of 1969, the Coastal Barrier Resources Act of 1990, and the National and Local Scenic Byway Program.	Visual accessibility to unique combinations of geological, botanical, and cultural features that may be an asset to a study area. State and Federal agencies recognize the value of beaches and shore dunes.	Environmental organizations and the public support the preservation of natural pleasing vistas.
Air Quality	Clean Air Act of 1963,	State and Federal agencies recognize the status of ambient air quality in relation to the NAAQS.	Virtually all citizens express a desire for clean air.
Water Quality	Clean Water Act of 1977, Fish and Wildlife Coordination Act, Coastal Zone Mgt Act of 1972.	USACE, USFWS, NMFS, NRCS, EPA, and States DNRs and wildlife/fishery offices recognize value of fisheries and good water quality. the national and state standards established to assess water quality	Environmental organizations and the public support the preservation of water quality and fishery resources and the desire for clean drinking water.

2.3 Hydrology and Floodplains

The Savannah River basin is primarily located in eastern Georgia and western South Carolina. Its headwaters originate in the Blue Ridge Province of Georgia, and North and South Carolinas. The basin parallels the Georgia and South Carolina border passing through the Piedmont Province and upper and lower Coastal Plains before reaching the Atlantic Ocean.

The U.S. Geological Survey (USGS) has divided the Savannah River basin into seven sub-basins or Hydrologic Unit Codes (HUCs) within Georgia and South Carolina:

1. Tugaloo River
2. Upper Savannah River
3. Broad River
4. Little River
5. Middle Savannah River
6. Brier Creek
7. Lower Savannah River

The study area drains portions of three physiographic provinces: the Blue Ridge Mountains, the Piedmont, and the Coastal Plain. In its middle and upper reaches the river flow is regulated by several reservoirs, including three large multipurpose USACE projects (Hartwell Dam and Lake, Richard B. Russell Project and J. Strom Thurmond Dam and Lake) and two large private power reservoirs (Lakes Keowee and Jocassee). Other structures include the New Savannah Bluff Lock and Dam, the Stevens Creek Dam and the Old Lock and Dam at the Augusta Canal. Most of the natural oxbows and manmade cutoff bends are hydraulically separated from the river during non-drought conditions.

Executive Order (EO) 11988 has an objective to avoid, to the extent possible, long, and short-term adverse impacts associated with occupancy and modification of the base floodplain. Further objectives are the avoidance of direct and indirect support of development in the base floodplain wherever there is a practicable alternative and protection and restoration of natural floodplain functions. USACE regulation for implementing EO 11988 (ER 1165-2-26) defines the base floodplain as the 100-year or one percent chance floodplain. Hartwell Dam and Lake, Richard B. Russell Project, and J. Strom Thurmond Dam and Lake each have 5 feet of flood control storage with the top of the flood control pools at elevation 665.0, 480.0, and 335.0 respectively. The combined storage is 823,000 acre-feet during the summer and 1,318,822 acre-feet during the winter. The alternatives proposed in this document deal with water management during drought conditions, so flood control is outside the scope of this document. Figure 3 shows a picture of the Savannah River system pools.

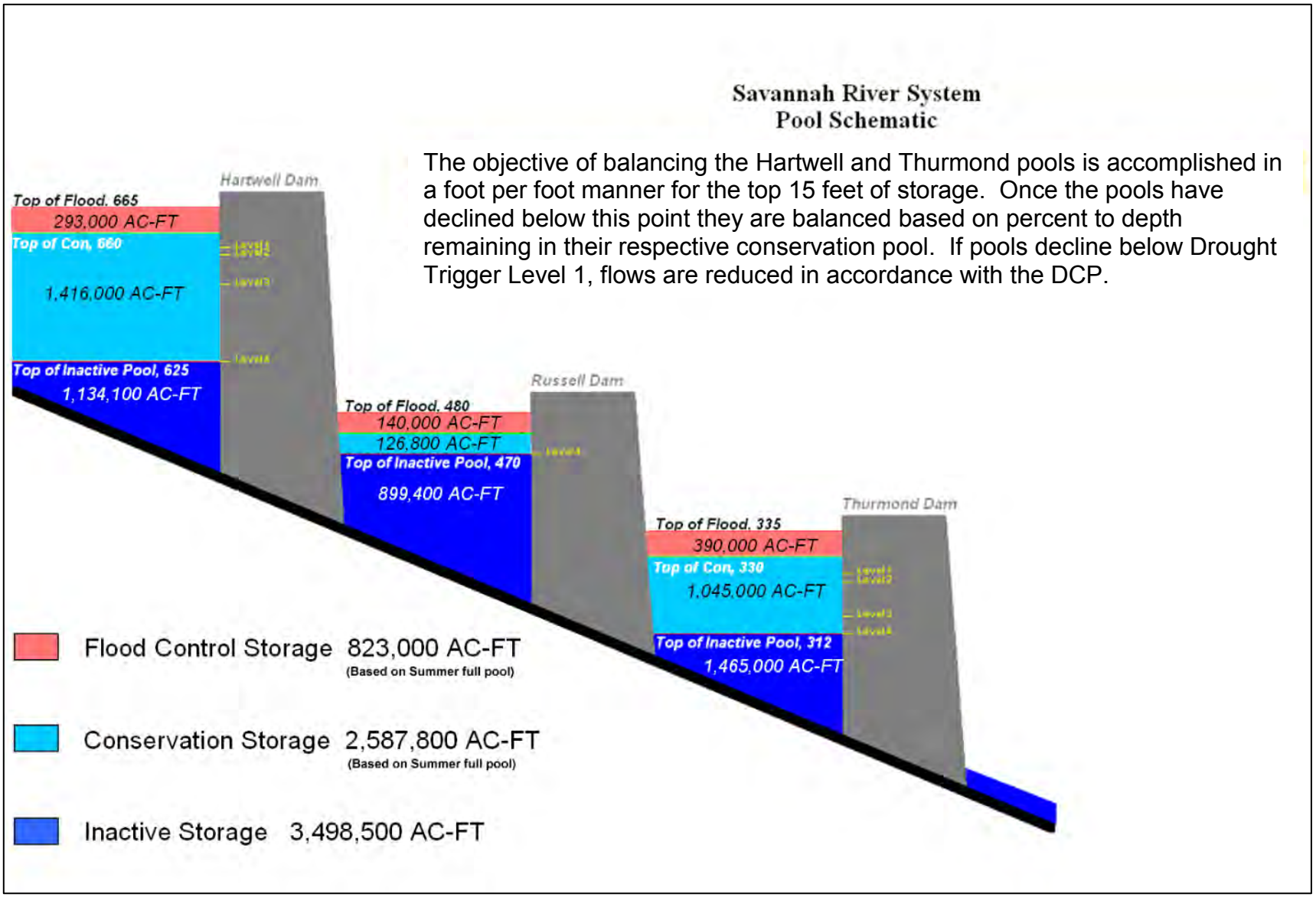


Figure 3: Savannah River System Pool Schematic

2.4 Aquatic Resources and Aquatic Habitat

Within the Savannah River Basin watershed, there are several managed lakes; Hartwell Lake, J. Strom Thurmond Lake, and Richard B. Russell Lake, that provide vast habitat for a wide range of fish species. For instance, Hartwell Lake supports a large warm water fishery and includes species such as: white and striped bass, hybrid bass, largemouth bass, spotted bass, bluegill, pumpkinseed, redear sunfish, yellow perch, walleye, and catfish. Nongame species found within the lake include blueback herring, carp, longnose gar, and spotted sucker. The GADNR and SCDNR both actively stock, on average, 500,000 to 1,000,000 striped bass and hybrid bass annually in Hartwell Lake.

Fish species most commonly found at the Richard B. Russell Lake are largemouth bass, spotted bass, redeye bass, threadfin shad, gizzard shad, blueback herring, bluegill, redear sunfish, channel catfish, brown bullhead, black crappie, yellow perch, white perch, spotted sucker, and common carp. In addition, small numbers of hybrid bass (striped bass x white bass) and striped bass are caught each year in this area. Within the J. Strom Thurmond Lake, the more common fish species found include; largemouth bass, bluegill, redear sunfish, hybrid bass, striped bass, black crappie, brown bullhead, channel catfish, flathead catfish, white perch, yellow perch, threadfin shad, gizzard shad, blueback herring and occasionally robust redhorse can also be found within the J. Strom Thurmond reservoir. GADNR and SCDNR both actively stock hybrid bass and striped bass within the J. Strom Thurmond Lake and on average, 750,000 to 1,000,000 striped and hybrid bass are stocked annually.

In addition to various species of fish within the three lakes, aquatic vegetation is present. In Hartwell Lake, there is a small stand of Water primrose in Eighteen Mile Creek that does not appear to change in distribution or abundance from year to year. There is concern that hydrilla will be introduced from J. Strom Thurmond Lake or Keowee Lake into Hartwell Lake. In an effort to identify the spread of hydrilla as early as possible, boat surveys are conducted periodically throughout the summer and fall of each year. Within the Richard B. Russell Lake, Brazilian elodea has consistently been detected in these same areas of the lake and distribution appears to be very stable. Aquatic plant growth has not reached nuisance levels requiring treatment. The J. Strom Thurmond Lake is dominated by hydrilla. A 2010 survey estimated that approximately 4,959 acres of the lake were covered by this aquatic plant species. The Thurmond project staff monitors the abundance and migration of hydrilla in the reservoir annually. If treatment is required, an appropriate herbicide is selected and used for control, based upon site location, desired level of control, and cost per acre.

The lower Savannah River supports an abundant diversified fish community, common fish species include largemouth bass, chain pickerel, black crappie, yellow perch, redbreast sunfish, bluegill, redear sunfish, warmouth, flier, and pumpkinseed. Important non-game fish include longnose gar, bowfin, white catfish, channel catfish, common carp, spotted sucker, silver redhorse, robust redhorse, striped mullet, and brown bullhead. Diadromous fishes (those fish that spend portions of their life cycles partially in fresh water and partially in salt water) inhabiting the lower Savannah River include: striped bass, American shad, hickory shad, blueback herring, shortnose sturgeon,

Atlantic sturgeon, and the catadromous American eel. Catadromous fish species such as the American eel migrate down rivers to the sea to spawn. For more detailed biological information on aquatic resources in the project area, please see the Savannah River Ecosystem Flow Prescription in Appendix E

2.5 Essential Fish Habitat

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) set forth requirements for the National Marine Fisheries Service (NMFS), regional Fishery Management Councils (FMC), and other federal agencies to identify and protect important marine and anadromous fish habitat. Anadromous fishes spend most of their adult lives at sea, but return to fresh water to spawn. These amendments established procedures for the identification of Essential Fish Habitat (EFH) and a requirement for interagency coordination to further the conservation of Federally-managed fisheries. Table 3 lists the Federally-managed fish species of Georgia and South Carolina, for which Fishery Management Plans have been developed by the South Atlantic Fishery Management Council (SAFMC), Mid-Atlantic Fishery Management Council (MAFMC), and NMFS. In addition, Table 3 shows EFH by life stage and ecosystem type for those species that have designated EFH.

The actions considered in this study would occur over 200 miles upriver, so no direct impacts to EFH would occur. The study focuses on potential indirect impacts that could result to saltmarsh, which is an EFH in the estuary. The structure and function of a saltmarsh are influenced by tide, salinity, nutrients, and temperature. Saltmarsh can be a stressful environment to plants and animals, with rapid changes occurring in these abiotic variables (Gosselink 1980; Gosselink et al. 1974). Although species diversity may be lower than in other systems, the saltmarsh is one of the most biologically productive ecosystems in the world (Teal 1962; Teal and Teal, 1969). The high primary productivity that occurs in the marsh, and the transfer of detritus into the estuary from the marsh, provides the base of the food chain supporting many marine organisms.

2.6 Wetlands

Palustrine forested wetlands dominate the extensive alluvial plain of the Savannah River. Palustrine wetlands include any inland wetland that lacks flowing water, mostly fresh water, and is non-tidal. The wettest parts of the flood plain, such as swales, sloughs, and back swamps are dominated by bald cypress, water tupelo, and swamp tupelo. Slightly higher areas, which are usually flooded for much of the growing season are often dominated by overcup oak and water hickory. Most of the Savannah River floodplain consists of low relief flats or terraces. These areas are flooded during most of the winter and early spring and one or two months during the growing season. Laurel oak is the dominant species on these flats and green ash, American elm, sweetgum, spruce pine, sugarberry, and swamp palm are often present. Swamp chestnut oak, cherrybark oak, spruce pine, and loblolly pine are found on the highest elevations of the flood plain, which are only flooded infrequently during the growing season. The wetlands associated with natural oxbows and manmade cutoff bends begin to dry out even during non-drought conditions.

Table 3: Essential Fish Habitat (EFH) Species for the Project Area (Georgia and South Carolina)						
Management Plan Agency	**Fishery Management Plan (FMP)**	**COMMON NAME OF SPECIES**	**SCIENTIFIC NAME OF SPECIES**	**LIFE STAGES BY ECOSYSTEM (Marine/Estuarine)**		**HABITAT AREAS OF PARTICULAR CONCERN (Identified by)**
SAFMC	Snapper Grouper	Black Sea Bass	*Centropristis striata*			
SAFMC	Coastal Migratory Pelagics	Cobia	*Rachycentron canadum*	ELPJA	LPJA	Snapper Grouper HAPC-oyster shell, inlets, state nursery areas
SAFMC	Snapper Grouper	Crevalle Jack	*Caranx hippos*			
SAFMC	Snapper Grouper	Sheepshead	*Archosargus probatocephalus*			
SAFMC	Shrimp	Brown shrimp	*Farfantepenaeus aztecus*	ELA	PJA	Penaeid Shrimp HAPC – tidal inlets, state nursery and overwintering
SAFMC	Shrimp	White shrimp	*Lytopenaeus setiferus*	LA	PJS	
SAFMC	Shrimp	Pink shrimp	*Farfantepenaeus duorarum*	LA	PJS	Penaeid Shrimp HAPC – tidal inlets, state nursery and overwintering
SAFMC	Coastal Migratory Pelagics	Spanish mackerel	*Scomberomorous maculatus*	JA	J	
SAFMC	Snapper Grouper	Gray snapper	*Lutjanus griseus*	LA	PJA	
SAFMC	Snapper Grouper	Lane snapper	*Lutjanus synagris*	A	J	
SAFMC	Council Authority (no FMP)	Striped Bass	*Morone saxatilis*	A	ELPJS	
MAFMC	Bluefish	Bluefish	*Pomatomus saltatrix*	LJA	JA	
MAFMC	Summer Flounder	Summer flounder	*Paralichthys dentatus*	LJA	LJA	
NMFS	Highly Migratory Species	Atlantic sharpnose shark	*Rhizoprionodon terraenovae*	J		
NMFS	Highly Migratory Species	Blacknose shark	*Carcharhinus acronotus*	J		
NMFS	Highly Migratory Species	Bonnethread shark	*Sphyrna tiburo*	JA		

Table 3: Essential Fish Habitat (EFH) Species for the Project Area (Georgia and South Carolina)						
Management Plan Agency	**Fishery Management Plan (FMP)**	**COMMON NAME OF SPECIES**	**SCIENTIFIC NAME OF SPECIES**	**LIFE STAGES BY ECOSYSTEM (Marine/Estuarine)**		**HABITAT AREAS OF PARTICULAR CONCERN (Identified by)**
NMFS	Highly Migratory Species	Bull shark	*Carcharhinus leucas*	J		
NMFS	Highly Migratory Species	Dusky shark	*Carcharhinus obscurus*	J		
NMFS	Highly Migratory Species	Finetooth Shark	*Carcharhinus isodon*	ELPJSA		
NMFS	Highly Migratory Species	Lemon shark	*Negaprion brevirostris*	J		
NMFS	Highly Migratory Species	Sandbar shark	*Carcharhinus plumbeus*	J		
NMFS	Highly Migratory Species	Sandtiger shark	*Odontaspis taurus*	J		
NMFS	Highly Migratory Species	Scalloped hammerhead	*Sphyrna lewini*	J		
NMFS	Highly Migratory Species	Spinner shark	*Carcharhinus brevipinna*	JA		

Notes:

1. **These Essential Fish habitat species were compiled from Essential Fish Habitat: A Marine Fish Habitat Conservation Mandate for Federal Agencies: February 1999 (Revised 09/2010).**
2. **Organizations responsible for Fishery Management Plans include: SAFMC = South Atlantic Management Council; MAFMC = Mid-Atlantic Fishery Management Council; NMFS = National Marine Fisheries Service.**
3. **Life stages include: E = Eggs, L = Larvae, P = Post Larvae, J = Juveniles, S = Sub Adults, A =Adults**

On the Savannah River downstream of Interstate Highway 95, tidal palustrine emergent wetlands, also known as tidal freshwater marsh, become prevalent. Tidal palustrine emergent wetlands are flooded twice daily by tidal action in the area. A diverse mixture of plants, including giant cutgrass, spikerushes, and up to 58 other plant species, vegetate these marshes (Pearlstine et al. 1990, Applied Technology and Management 1998).

Major primary producers in the salt marsh community are grasses that have little immediate nutritional value to fish and wildlife but support an important detritus-based food web (Teal 1962). In contrast, the fleshy broad leaf plants characteristic of fresh marshes generally are high in nitrogen and low in fiber content and direct grazing or feeding on these plants occur in high incidence (Odum et al. 1984).

Freshwater marsh vegetation also contributes to the food web base that supports the area's freshwater fishery. The leaves of the larger macrophytes (aquatic plants that grow in or near water) in this community are used as attachment places by mollusks, insect nymphs, rotifers, hydra, and midge larvae. These are all important fish foods. The submerged littoral zone is vital to the development of freshwater fish, as well as some marine and estuarine species, as these areas are the principal spawning sites and provide nursery and juvenile habitats.

2.7 Terrestrial Resources and Wildlife

Wildlife associated with forested wetlands within the study area are numerous and diverse. The furbearers are an important component of these wetlands and include beaver, muskrat, mink, otter, bobcat, gray fox, raccoon, and opossum. Deer, turkey, and even black bear in the more isolated areas, use the bottomlands. Palustrine emergent wetlands also provide excellent habitat for furbearers including the mink, beaver, and river otter. Terrestrial species from surrounding areas often utilize the fresh marsh edge for shelter, food, and water. These include raccoon, opossum, rabbit, and bobcat.

The study area is part of the Atlantic Flyway. Forested wetlands provide important wintering habitat for many waterfowl species and nesting habitat for wood ducks. Many species of woodpeckers, hawks, and owls use the bottomlands and swamps.
The primary game birds are the bobwhite quail, eastern wild turkey, and the mourning dove. The most common bird species found in the mature forests include the pine warbler, cardinal, summer tanager, Carolina wren, ruby-throated hummingbird, blue jay, hooded warbler, eastern towhee, and tufted titmouse. The red-cockaded woodpecker, a Federally-listed endangered species, is found in mature longleaf pine habitats.

The study area also provides excellent habitat for a large number of reptiles and amphibians. Wetland habitats support many kinds of frogs including the bullfrog, bronze frog, southern leopard frog, several species of tree frogs, cricket frogs, and chorus frogs. Turtles found in the wetlands include the river cooter, Florida cooter, pond slider, eastern chicken turtle, snapping turtle, mud turtle, and stinkpot. Snakes found in the wetlands include the red-bellied water snake, banded water snake, brown water snake, eastern mud snake, rainbow snake, and eastern cottonmouth. The American

alligator can be observed in streams and ponds of the Coastal Plain study area. For more detailed biological information on terrestrial resources and wildlife in the project area, see the Savannah River Ecosystem Flow Prescription in Appendix E

2.8 Threatened, Endangered and Protected Species

The Endangered Species Act (ESA) of 1973 (16 USC 1531-1543) regulates activities affecting plants and animals classified as endangered or threatened, as well as the designated critical habitat of such species.

Research on the U.S. Fish and Wildlife Service's Information, Planning, and Conservation System (IPAC) website (http://ecos.fws.gov/ipac/) indicated several federally listed species within the project area to be aware of, many of which cover the entire project area while others are concentrated on the northern or southern half of the Savannah River Basin. Within the Savannah River Basin, there are a total of 40 federally listed endangered species, 17 federally listed threatened species, and 3 federally listed candidate species as well as over 50 species of birds that are protected by the Migratory Bird Treaty Act. American Bald Eagle, which are within the project area, are not only protected by the Migratory Bird Treaty Act, but the Bald and Golden Eagle Protection Act, and are considered birds of conservation concern. The USFWS IPAC website also identified critical habitat for many of the endangered and threatened species within the Savannah River Basin project area including the potential of critical habitat for Atlantic Sturgeon within the middle and lower reach of the basin. Table 4 identifies the species that have been listed by the U.S. Fish and Wildlife Service as occurring or possibly occurring within the Savannah River Basin project area.

Table 4: Federal Endangered, Threatened and Candidate Species Likely to Occur in the Savannah River Basin Study Area

Category	Common Name	Scientific Name	Federal Status	Critical Habitat Designated Y/N
Amphibians	Frosted Flatwoods Salamander	*Ambystoma cingulatum*	Threatened	Y
Amphibians	Striped Newt	*Notophthalmus perstriatus*	Candidate	N
Arachnids	Spruce-fir Moss Spider	*Microhexura montivaga*	Endangered	Y
Birds	Kirtland's Warbler	*Setophaga kirtlandii (= Dendroica kirtlandii)*	Endangered	N
Birds	Piping Plover	*Charadrius melodus*	Threatened	Y
Birds	Red Knot	*Calidris canutus rufa*	Threatened	Y
Birds	Red-cockaded Woodpecker	*Picoides borealis*	Endangered	N

Table 4: Federal Endangered, Threatened and Candidate Species Likely to Occur in the Savannah River Basin Study Area				
Category	**Common Name**	**Scientific Name**	**Federal Status**	**Critical Habitat Designated Y/N**
Birds	Wood Stork	*Mycteria americana*	Threatened	N
Clams	Appalachian Elktoe	*Alasmidonta raveneliana*	Endangered	Y
Clams	Carolina Heelsplitter	*Lasmigona decorata*	Endangered	Y
Clams	Littlewing Pearlymussel	*Pegias fabula*	Endangered	N
Ferns and Allies	Black Spored Quillwort	*Isoetes melanospora*	Endangered	N
Ferns and Allies	Mat-forming Quillwort	*Isoetes tegetiformans*	Endangered	N
Fishes	Atlantic Sturgeon	*Acipenser oxyrinchus oxyrinchus*	Endangered	Proposed by NMFS
Fishes	Shortnose Sturgeon	*Acipenser brevirostrum*	Endangered	N
Fishes	Spotfin Chub	*Erimonax monachus*	Threatened	Y
Flowering Plants	American Chaffseed	*Schwalbea americana*	Endangered	N
Flowering Plants	Canby's Dropwort	*Oxypolis canbyi*	Endangered	N
Flowering Plants	Dwarf-flowered Heartleaf	*Hexastylis naniflora*	Threatened	N
Flowering Plants	Green Pitcher-plant	*Sarracenia oreophila*	Endangered	N
Flowering Plants	Harperella	*Ptilimnium nodosum*	Endangered	N
Flowering Plants	Little Amphianthus	*Amphianthus pusillus*	Threatened	N
Flowering Plants	Miccosukee Gooseberry	*Ribes echinellum*	Threatened	N
Flowering Plants	Michaux's Sumac	*Rhus michauxii*	Endangered	N
Flowering Plants	Mountain Sweet Pitcher-plant	*Sarracenia rubra ssp. jonesii*	Endangered	N
Flowering Plants	Persistent Trillium	*Trillium persistens*	Endangered	N
Flowering Plants	Pondberry	*Lindera melissifolia*	Endangered	N
Flowering Plants	Relict Trillium	*Trillium reliquum*	Endangered	N

Table 4: Federal Endangered, Threatened and Candidate Species Likely to Occur in the Savannah River Basin Study Area				
Category	**Common Name**	**Scientific Name**	**Federal Status**	**Critical Habitat Designated Y/N**
Flowering Plants	Small Whorled Pogonia	*Isotria medeoloides*	Threatened	N
Flowering Plants	Smooth Coneflower	*Echinacea laevigata*	Endangered	N
Flowering Plants	Spreading Avens	*Geum radiatum*	Endangered	N
Flowering Plants	Swamp Pink	*Helonias bullata*	Threatened	N
Flowering Plants	Virginia Spiraea	*Spiraea virginiana*	Threatened	N
Flowering Plants	White Fringeless Orchid	*Platanthera integrilabia*	Proposed Threatened	N
Lichens	Rock Gnome Lichen	*Gymnoderma lineare*	Endangered	N
Mammals	Carolina Northern Flying Squirrel	*Glaucomys sabrinus coloratus*	Endangered	N
Mammals	Gray Bat	*Myotis grisescens*	Endangered	N
Mammals	Indiana Bat	*Myotis sodalis*	Endangered	N
Mammals	Northern Long-eared Bat	*Myotis septentrionalis*	Threatened	N
Mammals	North Atlantic Right Whale	*Eubalaena glacialis*	Endangered	Y
Mammals	West Indian Manatee	*Trichechus manatus*	Endangered	Y
Reptiles	Bog Turtle	*Clemmys muhlenbergii*	Threatened	N
Reptiles	Eastern Indigo Snake	*Drymarchon corais couperi*	Threatened	N
Reptiles	Gopher Tortoise	*Gopherus polyphemus*	Candidate	N
Reptiles	Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	Endangered	N
Reptiles	Leatherback Sea Turtle	*Dermochelys coriacea*	Endangered	Y
Reptiles	Loggerhead Sea Turtle	*Caretta caretta*	Threatened	Y

In addition to federally-listed species, both the state of South Carolina and the state Georgia have identified rare, threatened, and endangered species within the project area comprising of amphibians, birds, crayfish, dragonflies, fish, mammals, mussels/snails, plants, and reptiles. This information can be found in the Environmental Appendix A of this report. In total, there are 71 state listed rare species, 118 threatened state listed species, and 147 endangered state list species. In the state of Georgia, there are 71 rare species, 105 threatened species, and 133 endangered species. In the state of South Carolina, there are 13 threatened species, 14 endangered species, and no state listed rare species. This information can be found in Environmental Appendix A of this report.

A Memorandum of Understanding (MOU) among the Georgia Department of Natural Resources, the North Carolina Wildlife Resources Commission, the South Carolina Department of Natural Resources, the Georgia Power Company, the Duke Energy, the Duke Energy Progress, the South Carolina Electric & Gas Company, the Georgia Wildlife Federation, the U.S. Geological Survey, the U.S. Fish and Wildlife Service, the U.S. Forest Service, and the South Carolina Aquarium was developed to maintain and describe a Conservation Committee actively committed to the restoration of the robust redhorse.

2.9 Air Quality

The Clean Air Act (CAA), which was last significantly amended in 1990, requires the U.S. Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. The CAA established two types of national ambient air quality standards-primary and secondary. Primary standards are levels established by the EPA to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly. Secondary standards are levels established to protect the public welfare, including protection from decreased visibility and damage to animals, crops, vegetation, and buildings.

The EPA Office of Air Quality Planning and Standards has set NAAQS for six principal pollutants which are called “criteria” pollutants. Those pollutants are Carbon Monoxide, Lead, Nitrogen Dioxide, Particulate Matter (PM10), Particulate Matter (PM2.5), Ozone, and Sulfur Dioxide. All counties within the Savannah River Basin watershed are listed as in attainment of EPA’s air pollution standards.

2.10 Water Quality

Savannah District monitors water quality at Hartwell Dam and Lake, Richard B. Russell Project, and J Strom Thurmond Dam and Lake at established locations in each lake. The primary objectives of the monitoring program are to document water quality conditions (particularly temperature and Dissolved Oxygen (DO) with emphasis on the influence of dam operations (hydroelectric generation, pumped storage operations, and operation of oxygenation systems) on water quality. Monitoring is also conducted through continuous monitoring inside the penstock (upstream from the turbines) at Hartwell Dam and Lake, Richard B. Russell Project, and J Strom Thurmond Dam and

Lake and in the immediate tailrace areas. Generally, water quality within the lakes is at or above state water quality standards however, like most deep reservoirs in the southeastern United States, they experience thermal stratification which can affect DO levels within the lakes especially during the summer months.

To help regulate DO levels throughout the year, the lakes have several procedures they follow. For example, USACE has installed modifications at Hartwell Dam, referred to as "turbine vents," that allow air to be diffused into the water as it flows past the turbines during generation. The result is an increase of 2 to 3 mg/l in DO levels in the tailwater. DO concentrations of the release waters from Hartwell can be expected to be below 5 mg/l from late summer through early fall, with the lowest readings from August through September.

At Richard B. Russell Dam, USACE uses a hypolimnetic DO injection system (a deep water aeration system) in Richard B. Russell Lake to maintain DO discharges through the dam at or above 5 mg/l throughout the year. The DO system at Richard B. Russell generally operates during the period from July – October each year. In addition to improving the DO of water released through Richard B. Russell Dam, the DO system also improves water quality in the lower portion of Richard B. Russell Lake, particularly the area downstream of the Highway 72 Bridge.

The turbines at J. Strom Thurmond Dam were replaced during a major rehabilitation effort that was completed in 2007. The new turbines include a self-aspirating design that is an advanced form of turbine venting. This venting adds 2 to 3 mg/l of DO to the water as it passes through J. Strom Thurmond Dam. In addition to turbine venting, the USACE installed an oxygen injection system in J. Strom Thurmond Lake that began operating in 2011. This system is located in the Modoc, SC area of J. Strom Thurmond Lake approximately 5.5-miles upstream of J. Strom Thurmond Dam. The primary objective of this system is to improve cool water fishery habitat in the lower one third of J. Strom Thurmond Lake, but the system also improves the DO of water immediately upstream of J. Strom Thurmond Dam. Thus the operation of the J. Strom Thurmond Lake DO system in combination with the turbine venting at J. Strom Thurmond Dam results in the DO concentration below J. Strom Thurmond Dam remaining near or above 5 mg/l throughout the year.

Along the Savannah River, water use classifications consist of Recreation, Drinking Water, and Coastal Fishing. Portions of the lower Savannah River are listed as impaired on the 2012 Section 303(d) Lists of Impaired Waters for both South Carolina and Georgia. The 2012 South Carolina Section 303(d) list identifies numerous areas along the Savannah River as impaired for fish consumption due to mercury levels and aquatic life use due to turbidity and zinc levels. Reaches of the Savannah River listed as impaired for fish consumption include North Augusta State Park, Jackson Landing, Steel Creek, Little Hell Landing, Cohen's Bluff, Johnson's Landing, Stokes Bluff Landing, B&C Landing, Beck's Ferry, and Millstone Landing. Additionally, the Savannah River off B&C Landing off State Route S 27-201 is listed as impaired for aquatic life use (SC DHEC 2012). The 2012 Georgia Section 303(d) list includes a 59-mile stretch of the Savannah River from Brier Creek to Ebenezer Creek that is listed as

impaired for fish consumption and drinking water due to mercury levels caused by nonpoint sources (GA DNR 2012).

The U.S. EPA has prepared Total Maximum Daily Loads (TMDLs) for portions of the Savannah River as follows:

- Fecal coliform – Savannah River in Richmond County
- Lead – Savannah River between Butler and McBean Creeks
- Oxygen-depleting substances – Savannah River from the Seaboard Coastline Railroad Bridge (RM 27.4) to the coast

Seasonal DO sags occur in the summer months in the estuarine portion of the river. US EPA's 2006 TMDL called for zero discharge of oxygen-depleting substances from Augusta to the coast. In 2015, this TMDL was replaced by a Subcategory 5R Document for Point Source Dissolved Oxygen Impaired Water in the Savannah River Basin. Georgia and South Carolina worked with a Technical Modeling Advisory Group, and the Savannah River/Harbor Dischargers Group to develop the documentation contained in the 5R Document to support Georgia's decision to place Savannah Harbor under subcategory 5R on Georgia's 2014 Integrated Section 303(d) List. EPA approved Georgia's 2014 Integrated Section 303(d) list on May 13, 2016. The 5R Document is based on the results of the Savannah River and Harbor DO Calculator Version 4.0 (June 2010), which was developed as an efficient method to evaluate oxygen-demanding substance reduction strategies that allows the DO water quality standard to be met. The Savannah River/Harbor Dischargers Group applied the Savannah River and Harbor DO Calculator to develop a wasteload reduction implementation strategy that most practicably allow the DO water quality criterion to be met. The States will implement the requirements of the 5R Document through their point source discharge permitting programs. The recently-installed oxygen injection system in the forebay of JST Lake improved water quality below the JST Dam. Flows immediately below JST Dam are expected to contain at least 5 mg/L of DO throughout the year, which meet both the Georgia and South Carolina standards for DO.

The State of South Carolina uses the current Drought Plan Level 3 discharge from Thurmond Dam of 3,600 cfs (pers. comm., Larry Turner, SC DHEC) at the Savannah River Augusta gage for their wasteload assimilation calculations in permitting point source discharges in the Augusta area DHEC adjusts this flow upward as one moves down the river to account for the additional tributary inputs. The State of Georgia uses the 7Q10 values of 3,800 cfs at the Augusta gage, 4,160 cfs further downstream at the Millhaven U.S. Geological Survey (USGS) flow gauging station, and 4,710 cfs at the Clyo USGS gage in its decisions on the permitting of point source discharges (pers. comm., Paul Lamarre, GA DNR-EPD).

2.11 Cultural Resources

2.11.1 Resources Located on USACE-Managed Lands

The Savannah River Basin has a long history of human occupation with earliest evidence of settlement dating as far back as the Paleoindian Period, ca. 9,500 B.P. The

basin has long been an area of archaeological interest for researchers. Within the basin, USACE manages three multi-purpose projects (Hartwell Dam and Lake, Richard B. Russell Project and J. Strom Thurmond Dam and Lake) as well as New Savannah Bluff Lock and Dam (NSBLD), a project authorized to improve commercial navigation from the upper limits of the Savannah Harbor to the head of navigation in Augusta, Georgia.

Prior to the impoundment and subsequent inundation of J. Strom Thurmond Lake (aka Clarks Hill), Hartwell Lake and RBR Lake cultural resources investigations of varying degrees of comprehensiveness were conducted. Recent archaeological investigations at J. Strom Thurmond and Hartwell have focused primarily on the upland areas (i.e., above 335 ft. above mean sea level [msl] and 660 ft. msl, respectively), although smaller shoreline surveys have been conducted at JST.

Archaeological fieldwork conducted in the late 1940s and early 1950s through the Smithsonian Institution's River Basin Survey (RBS) identified more than 200 sites at JST, with limited excavation conducted at a minimum of 21 sites by former Smithsonian Institution and University of Georgia personnel (Elliott 1995). The survey focused on site visits to locales reported by local collectors, previously recorded sites and visits to likely village sites as determined through archival research and previous experience of working in similar environmental settings. Some of the recorded sites were discovered during excavation of the reservoir. Nearly 100 of the sites were determined to be flooded by the inundation of JST (i.e., at or below 335 ft. msl) and almost the same number was situated outside of the flood pool.

More recently shoreline surveys of JST Lake have been conducted that resulted in the recordation of numerous previously unrecorded archaeological sites. In 1983-84 the U.S. Forest Service identified 54 sites, 38 of which had been previously unrecorded. Sites ranged from the Early Archaic period (9,900 B.P. – 8,000 B.P.) to the early twentieth century (Elliott 1995). Anderson et al. (1994) conducted a terrestrial and underwater survey of a two mile section of lake shore and a 440-acre upland tract that identified 14 upland sites, 32 sites along the shoreline as well as one underwater site. Only the underwater site had been previously located by the RBS in the 1940s-1950s.

Archaeological surveys conducted in the mid-late 1990s at JST Lake by cultural resources firms contracted by Savannah District have focused exclusively on upland areas. These large-scale surveys were conducted to comply with Section 110 of the National Historic Preservation Act (NHPA), as amended, in areas that were managed for timber. As a result of the surveys over 1600 archaeological sites, isolated finds, and rock piles have been recorded. A wide array of site types is represented at JST Lake, ranging from prehistoric camp sites to nineteenth and twentieth century mills, homesteads and cemeteries.

Of the three multi-purpose projects, RBR has been subjected to the most archaeological investigations. Surveys were conducted in 1970 (Hutto) and 1978 (Taylor and Smith) in areas that would be impacted by construction or impoundment; 48 and over 400 site locations were recorded, respectively. More than 35 of the sites recorded by Taylor and Smith were excavated as part of the Richard B. Russell Cultural Resource Mitigation

Program, which was managed by Savannah District and the National Park Service. The program included testing and data recovery at a variety of prehistoric and historic sites.

Until recently, surveys at RBR Project have been conducted of the upland areas to comply only with Section 106 of the NHPA. In 2010 a large-scale, 2,465-acre Section 110 of the NHPA survey was conducted by Brockington and Associates that identified 31 previously undocumented archaeological sites (Sweeney and Whitely 2011). Additional investigation was recommended at six sites to definitively determine National Register of Historic Places (NRHP) status. Fieldwork was limited to the upland areas surrounding the lake. Another Section 110 NHPA compliance survey of 2,561 acres was completed in 2016, which recorded 59 archaeological sites and 20 isolated finds (Pope et al. 2016). The eligibility of 15 sites remains unknown as the boundary extends beyond USACE-managed lands and the entire site was therefore not delineated. Three sites require additional investigation to definitively determine NRHP status. Undiagnostic lithic scatters were the predominant sites encountered.

Hartwell Lake lies in the Upper Savannah River Basin, an area which has also received considerable archaeological research attention. Construction of the proposed Hartwell dam prompted the first archaeological investigations of the area by Joseph Caldwell in 1952. The reconnaissance-level survey examined the uppermost 8 miles of the Savannah River, approximately 40 miles of the Tugaloo River, and 32 miles of the Seneca-Keowee Rivers (Caldwell 1953). Caldwell recorded 54 archaeological sites and provided management recommendations based on a flood pool level of 665 ft. msl for the proposed lake. Six of the sites were recommended for additional excavations and one site was recommended for additional testing. Among the sites excavated were three mound sites, Chauga, Estatoe, and Tugalo. A review in 2010 of the Caldwell survey revealed that several of the sites had been incorrectly plotted (Sweeney and Whitley 2011). Using historic and modern aerial photographs and maps, researchers determined that 19 of Caldwell's 54 site locations were incorrectly plotted. The rectified data shows that four of the sites recorded by Caldwell lie above the flood pool (i.e., above 665 ft. msl). Additional investigations were recommended to refine the site locations.

Cultural resources investigations of selected upland areas at Hartwell Lake were conducted in the late 1970s and early 1980s to comply with Section 106 of the NHPA, resulting in the identification of 92 archaeological sites. A large-scale, approximately 3,727 acre Section 110 of the NHPA survey was conducted in 2010 (Sweeney and Whitley 2011). Water levels during the field survey ranged from 660.58 - 661.19 ft. msl which prohibited investigation of shoreline areas. The survey resulted in the recordation of 47 previously unrecorded archaeological sites. The most frequent archaeological site types encountered during the survey were historic homesteads or dwellings and low density prehistoric artifact scatters. None of the sites were recommended eligible for the NRHP.

In 2012, when the Drought Contingency Plan was last updated, Savannah District drafted a Programmatic Agreement (PA) (Appendix D) as specified under 36 CFR 800.14b (1) (ii) to develop a survey strategy to understand the effects of hydrologic changes on cultural resources at J. Strom Thurmond and Hartwell Lakes. The PA

allows Savannah District to complete needed studies and postpone its determination of effects while studies are taking place. Although the PA was developed to comply with Section 106 for the Drought Contingency Plan update in 2012, it is written to address impacts associated with all water level fluctuations. The PA contains a strategy for identifying shoreline and submerged archaeological sites and assessing the impacts that may be caused by hydrologic changes. Studies outlined in the PA will be implemented as funding becomes available. Once the surveys and assessments are complete the impacts to archaeological sites can be determined. To date, no investigations have been conducted to comply with the PA due to funding constraints. Undertakings and effects on cultural resources are assessed on a project by project basis to comply with Section 106.

Savannah District coordinated with the Georgia and South Carolina State Historic Preservation Offices when drafting the PA and incorporated all comments into the agreement in August 2012. Coordination with tribes was also conducted at that time. Only the Catawba Indian Nation expressed interest in being a concurring party. The agreement was never signed by any of the parties, however, USACE interprets the document as legally binding. USACE will continue to operate under the terms of the 2012 PA to fulfill Section 106 compliance for the present study.

2.11.2 Resources below JST Dam off USACE-Managed Lands

Numerous cultural resource sites have been recorded within the Savannah River Basin along the banks of and on islands within the Savannah River that are located downstream of JST Dam. Two National Historic Landmarks are located either in or along the Savannah River below JST Dam. National Historic Landmarks are nationally significant historic places designated by the Secretary of the Interior because they possess exceptional value or quality in illustrating or interpreting the heritage of the United States. Stallings Island, located in Columbia County, Georgia, approximately 8 miles upstream of Augusta, Georgia, was a major prehistoric settlement 4,500 to 3,500 years ago. The 16-acre island is the type site for the Stallings Culture, which is known for its fiber-tempered pottery, the oldest known pottery in North America. The site was designated a National Historic Landmark in 1961 and was donated to the Archaeological Conservancy in 1997.

The Historic Augusta Canal and Industrial District, designated in 1977, is also located downstream of JST Dam. The Historic Augusta Canal and Industrial District consists of a 9-mile canal, constructed in 1845-46 and enlarged in 1874-77; the two headgates, the canal impoundment area, canal dam and attached fish ladder, stone quarry, Municipal Pumping Station, and lock Keeper's house; and four textile mills. There are 7 non-contributing buildings within the district; six of the buildings have been determined eligible for inclusion in the National Register individually. The Historic Augusta Canal and Industrial District encompasses 450 acres in downtown Augusta. The Augusta Canal is also a National Heritage Area, recognized as a place that represents the Industrial Revolution in the American South. Augusta Canal received this designation in 1996.

The NSBLD is located approximately 33 river miles downstream from the J. Strom Thurmond multipurpose project and approximately 13 river miles downstream from the City of Augusta, Georgia. The NSLBD property lines extend into Richmond County, Georgia and Aiken County, South Carolina. The pool created by the dam extends upstream to commercial facilities at the City of Augusta. The NSBLD consists of a lock chamber, dam, operations building, and a 50-acre park and recreation area. Construction of a lock and dam was authorized under the Rivers and Harbors Act of 1930 and construction began in 1935. The lock and dam were officially dedicated on June 26, 1937. A recreation plan that included picnic tables and open green space was formally added in 1962.

The structure is eligible for the NRHP under Criterion A (transportation history) and Criterion C (engineering). The contributing features of the structure include its physical components, including the dam, gates, operation building, guide walls (including wooden extensions), bumper cells and shoreline abutments; along with a portion of the river both upstream and downstream. Due to considerable changes to the recreation area/park plan since 1962, the recreation area was not considered a contributing feature nor was it included within the NRHP boundary for NSBLD.

2.12 Demographics and Economic Conditions

The project area consists of the main stem of the Savannah River Basin, which includes all or portions of 44 counties within Georgia, South Carolina, and North Carolina. Because impacts to hydropower production will affect a far greater population than those in direct proximity to the basin, the socioeconomic study area will include the entirety of the states of Georgia and South Carolina.

Georgia was home to an estimated 10,006,693 people in 2015. Of these, 60.2 percent identified as White, 30.9 percent as Black, and 3.6 percent as Asian. The state's median age was 35.9 years. Of the population over 16 years of age, 62.3 percent were in the civilian labor force. The unemployment rate was 9.7 percent. Per capita income was $25,737, and 18.4 percent of the population fell below the poverty threshold.

South Carolina was home to an estimated 4,777,576 people in 2015. Of these, 67.2 percent identified as White, 27.5 percent as Black, and 1.4 percent as Asian. The state's median age was 38.6 years. Of the population over 16 years of age, 60.1 percent were in the civilian labor force. The unemployment rate was 9.5 percent. Per capita income was $24,604, and 17.9 percent of the population fell below the poverty threshold.

Increasing population growth and economic development is expected to bring increases in water demand. The Georgia Governor's Office of Planning and Budget projects the state's residential population to increase by 1.9 million between 2015 and 2050, a growth of 15.8 percent. South Carolina's Office of Revenue and Fiscal Affairs projects a population growth of 13.0 percent, or 628,500 people, during the same period.

2.13 Noise

For purposes of regulation, noise is measured in dBA or A-weighted decibels. This unit uses a logarithmic scale and weights sound frequencies. Table 5 shows typical noise levels and corresponding impressions. The project area within the Savannah River Basin is not densely populated or heavily industrialized, though forest and agricultural practices are employed within the Savannah River Basin. Watershed noises associated with traffic and agriculture and forestry practices are the predominant sources of noise in the project area. Naturally occurring noises (buzzing of insects, bird

Further information on study area population, including age, sex, race, housing, families/living arrangements, education, health, local economy, transportation, income, poverty, business, and geography can be found on the U.S. Census Bureau website: http://www.census.gov/quickfacts/table/PST045215/00.

Table 5: Typical Noise Levels and Impressions

Source	Decibel Level	Subjective Impression
Normal breathing	10	Threshold of hearing
Soft whisper	30	---
Library	40	Quiet
Normal conversation	60	---
Television audio	70	Moderately loud
Ringing telephone	80	---
Snowmobile	100	Very loud
Shouting in ear	110	---
Thunder	120	Pain threshold

2.14 Recreation

The Savannah River Basin provides excellent opportunities for water resource-based recreation (fishing, hunting, boating, water skiing, birding and swimming), and non-water based recreation (hiking, camping, hunting, and birding). The three lakes in the Upper Savannah River Basin – Hartwell Dam and Lake, Russell B. Russell Project, and J. Strom Thurmond Dam and Lake– offer a variety of recreational opportunities. Hartwell Lake is consistently one of the top 5 most visited Corps sites in the U.S., and offers a variety of recreational opportunities. Additional information is available at the following links:

http://www.sas.usace.army.mil/About/Divisions-and-Offices/Operations-Division/Hartwell-Dam-and-Lake/Plan-A-Visit/, and
http://www.sas.usace.army.mil/About/Divisions-and-Offices/Operations-Division/J-Strom-Thurmond-Dam-and-Lake/Plan-a-Visit/, and
http://www.sas.usace.army.mil/About/Divisions-and-Offices/Operations-Division/Richard-B-Russell-Dam-and-Lake/Plan-a-Visit/.

Designated swim areas are located in the USACE recreation areas and campgrounds along the shoreline. The lake affords the avid sports fisherman and the weekend angler equal opportunities for a rewarding fishing experience. Coves and quiet water areas provide the water skier with excellent locations to pursue this sport. The lake appeals to all boaters, whether their specialty is canoeing, sailing, or motorboating. Picnicking, sightseeing, and other outdoor experiences can also be enjoyed at the many public recreation areas located around the lakes. Additional information on recreation on these lakes can be found at:

https://www.recreation.gov/recreationalAreaDetails.do?contractCode=NRSO&recAreaId=453, and
https://www.recreation.gov/recreationalAreaDetails.do?contractCode=NRSO&recAreaId=455, and
https://www.recreation.gov/recreationalAreaDetails.do?contractCode=NRSO&recAreaId=454.

In times of drought, when the lake levels of Hartwell and J. Strom Thurmond Lakes drop 6 feet below summer Guide Curve elevations, designated swimming areas are closed and drought information sheets are disseminated to the public. These sheets instruct the public to only use marked navigation channels, since unmarked hazards become more prevalent increasing risks of boating accidents outside the channel. List of boat ramp closures can be found at:

http://www.sas.usace.army.mil/About/Divisions-and-Offices/Operations-Division/Hartwell-Dam-and-Lake/Plan-A-Visit/Boating/Status-of-Corps-Boat-Ramps/ and
http://www.sas.usace.army.mil/About/Divisions-and-Offices/Operations-Division/J-Strom-Thurmond-Dam-and-Lake/Boat-Ramp-Open-Closure-List/.

In 2004, as part of the SRBC Interim Study 1, Savannah District and Zapata Engineering, P.A., prepared a report titled Savannah River Basin Water Use Data Collection Presentation of Findings. The study findings conclude that during periods of low water, approximately 39 percent of the recreational users surveyed said that they would make a water-based recreational trip to the same lake. Forty-one percent would make a water-based recreation trip elsewhere. Twenty percent would not make a water-based recreation trip. Therefore, during periods of drought, 61 percent of the water resource-based recreation trips would not be made to Hartwell and J. Strom Thurmond Lakes.

Respondents of this survey also indicated that their recreational activities are seriously impacted when lake levels drop an average of 7.5 feet below full pool. According to some lake managers, water recreation is more difficult and less convenient during periods of drought because recreationists may have to travel further distances to a useable ramp for access to the lake. They may consider the lake aesthetically unpleasing, and they may recognize the increased risk of damaging their boat and personal safety.

Boat Ramps and Private Docks

Public boat-launching ramps and private docks provide recreational access to the lakes of the Savannah River Basin.

Hartwell Lake

There are 95 public boat-launching ramps and marinas located on Hartwell Lake. From lake elevation 660 to 658.01 feet msl all 95 public boat-launching ramps are useable. Starting at and below lake level 658 feet msl, the first 6 boat-launching ramps become unusable. Table 6 shows the availability of boat ramps for various elevations on Hartwell. If lake levels were to ever drop to 638 feet msl, then all the ramps are unusable. Table 7 shows that all listed ramps are unavailable in Drought Level 4, which begins at 625 feet msl.

Table 6: Available Boat Ramps on Hartwell

Elevation (feet msl)	Available	Total Lost	Percent Lost
660 to 658.01	95	0	0.00%
658	89	6	6.32%
657	83	12	12.6%
656	82	13	13.7%
655	79	16	16.8%
654	78	17	17.9%
653	72	23	24.2%
646	52	43	45.3%
638	0	95	100.00%

Table 7: Hartwell Lake - Unusable Ramps by Lake Level 658 to 652 feet msl	
NAME OF BOAT RAMP	**LAKE LEVEL RAMP BECOMES UNUSABLE (feet msl)**
Sadlers Creek State Park.	658.0
Tugaloo State Lower	658.0
Jacks Landing, SC	658.0
Holders Access, SC	658.0
Lakeshore	658.0
Mountain Bay	658.0
Reed Creek, GA	657.5
Rocky Ford, GA	657.5
Brown Road, SC	657.0
Hurricane Creek, SC	657.0
Seneca Creek, SC	657.0
Walker Creek, GA	657.0
Cove Inlet, SC	656.5
Durham, SC	655.7
South Union, SC	655.5
Bradberry, GA	655.0
Timberland, SC	654.0
Darwin Wright City Park.	653.0
Tillies, SC	653.0
White City, SC	653.0
Barton Mill, SC	653.0
Port Bass, SC	653.0
Seymour, GA	653.0
Paynes Creek (inner right)	652.6
Paynes Creek (left)	652.6
Big Oak Left Lane (New)	652.5
Tabor, SC	652.5
Townville, SC	652.3
Twelve Mile (new left lane)	652.0
Eighteen Mile Creek	652.0

Lake Hartwell has a record low of 637.5 feet msl on 9 Dec 2009. As a result of the low water, Savannah District closed all of its boat ramps on Hartwell Lake on October 25, 2008.

The District's policy is that three feet of water should be present at the end of a ramp for the safe launching of recreational boats. Gravel had been placed at the end of five ramps to allow their continued use. However, such use is at the boat owner's risk.

There are approximately 11,000 private boat dock permits issued on Hartwell Lake. This number is almost double of what was reported in the March 1989 SRBDCP. In that report, it was roughly estimated that about 50 percent of the private docks were unusable below lake level 652 feet msl and about 90 percent were unusable at 643 feet

msl. Since the 1989 DCP report, development has expanded to areas adjacent to shallow coves; therefore, it is probable that more than 50 percent of private docks would be rendered unusable at 652 feet msl.

RBR Lake

RBR Lake had a record low of 469.5 feet msl on 20 Jan 2009. There are approximately 30 public boat-launching ramps on RBR Lake. All of these ramps are useable until lake levels reach 466 feet msl. Lake levels at RBR Lake are not projected to drop more than five feet below full pool through drought Level 3 and early into Level 4. Therefore, public boat-launching ramps on RBR Lake were not adversely impacted during the drought of record. Since RBR is the first lake to be drained in a Level 4 water management scenario, all 30 public boat-launching ramps would be unusable.

JST Lake

Since 1985, JST Lake has a record low of 312.79 feet msl on 15 Feb 1989. There are 84 public boat-launching ramps and marinas located on JST Lake. There are approximately 1962 private boat docks on the JST Lake. Above lake elevation 326 feet msl to 330 feet msl all ramps are useable and allow for the launching of boats with up to 3 feet of draft. Table 8 shows the availability of boat ramps for certain elevations on JST.

Table 8: Available Boat Ramps on JST

Elevation (feet)	Available	Total Lost	Percent Lost
326 to 330	84	0	0.00%
326	83	1	1.19%
325	79	5	6.0%
324	72	12	14.3%
323	67	17	20.2%
317	51	33	39.3%
315	38	46	54.8%
312	6	78	92.9%
306	0	84	100.00%

Table 9 shows the ramps above 315 feet msl and the elevations at which they become unavailable. In addition, there are six ramps, not identified in Table 9, that remain usable between elevations 312 and 306 feet msl.

Table 9: J. Strom Thurmond - Unusable Ramps by Lake Level 326 to 315 feet msl

NAME OF BOAT RAMP	LAKE LEVEL RAMP BECOMES UNUSABLE (feet msl)
Wildwood Park (5 ramps)	326.0
Hwy 28 Access Ramp	326.0
Long Cane Creek Ramp	325.7
Catfish Ramp	325.5
Calhoun Falls Ramp	325.0
Broad River Campground	325.0
Double Branches Ramp	324.8
Cherokee Recreation Area (2 lanes)	324.7
Mistletoe State Park (2 lanes)	324.2
Soap Creek Park	324.0
Little River Quarry Ramp	324.0
Scotts Ferry (New Ramp)	323.8
Leroys Ferry Campground	323.6
Clay Hill Campground	323.5
Winfield Subdivision (2 lanes)	323.1
Mt Pleasant Ramp	322.4
Bussey Point	321.0
Chamberlain Ferry Ramp	321.0
Modoc Campground	321.0
Murray Creek Ramp	321.0
Parkway Ramp	321.0
Fishing Creek/Hwy 79 Ramp	320.7
Soap Creek Subdivision	320.0
Scotts Ferry (New Ramp)	318.8
Wildwood Park (2 lanes)	315.0
Wildwood Park (2 lanes)	317.0
Wildwood Park (2 lanes)	320.0
Cherokee Recreation Area (2 lanes)	318.2
Soap Creek Marina	318.0
Raysville Marina	317.6
Soap Creek/Hwy 220 Ramp	317.0

Downstream of JST Lake

There are approximately 61 boat ramps along the Savannah River downstream of Lake Thurmond. Of these, 54 are publically-owned and 7 are privately-owned. The names, owners, and locations of these ramps are displayed in Table 10.

Table 10: Boat Ramps along the Savannah River Downstream of JST Lake				
Name of Boat Ramp	**Owner/ Manager**	**Number of Boat Ramps**	**County**	**State**
Linder McCurdy Road Ramp	Columbia County	1	Columbia	GA
Furys Ferry Ramp	US Forest Service	1	McCormick	SC
Stevens Creek Ramp	SCE&G	1	Edgefield	SC
Riverview Park Ramp	City of N. Augusta	2	Aiken	SC
Augusta Riverwalk Marina	Private	2	Richmond	GA
Hwy 1 Ramp	Richmond County	1	Richmond	GA
Ramp above Lock & Dam	GADNR	1	Richmond	GA
Ramp below Lock & Dam	Augusta Rec & Parks	2	Richmond	GA
Silver Bluff Ramp	Aiken County	1	Aiken	SC
Jackson Ramp	Aiken County	2	Aiken	SC
Vogtle Ramp	Southern Company	2	Burke	GA
Yuchi Wildlife Mgmt Area	GADNR	1	Burke	GA
Brigham's Landing Ramp	Burke County	1	Burke	GA
Steel Creek Ramp	SCDOT	1	Allendale	SC
Little Hell Landing	SCDNR/SCDOT	1	Allendale	SC
Stoney Bluff ramp	Burke County	1	Burke	GA
White Woman's Landing Ramp	Screven County	1	Screven	GA
Johnson's Landing Ramp	Allendale County	2	Allendale	SC
Burton’s Ferry (Hwy. 301 Bridge)	GADNR	2	Screven	GA
Possum Eddy Ramp	GADNR	1	Screven	GA
Dicks Lookout Ramp	GADNR	2	Screven	GA
Cohen's Bluff Ramp	SCDNR	1	Allendale	SC
Miller Lake Ramp	GADNR	1	Screven	GA
Poor Robins Ramp	GADNR	2	Screven	GA
Blue Springs Ramp	Screven County	1	Screven	GA
Stokes Bluff Ramp	SCDOT	2	Hampton	SC
Tuckasee King	GADNR	2	Effington	GA
B & C Public Landing Ramp	SCDOT	1	Jasper	SC
Ebenezer Landing Ramp	Effington County	1	Effington	GA
Beck's Ferry Public Ramp	SCDOT	2	Jasper	SC
Millstone Ramp (Hardeeville, SC)	Jasper County	2	Jasper	SC
Port Wentworth (Houlihan) Ramp	Chatham County	4	Chatham	GA
Stevens Landing Ramp	Chatham County	1	Chatham	GA
Savannah Bend Marina	Private	1	Chatham	GA
Bahia Bleu Marina	Private	1	Chatham	GA
Thunderbolt Public Boat Ramp	Chatham County	1	Chatham	GA
Turner's Creek Ramp	Chatham County	1	Chatham	GA
Diamond Cswy Skidaway Narrows	Chatham County	6	Chatham	GA
Lazaretto Creek Ramp	Chatham County	2	Chatham	GA

Swimming

Swimming opportunities are also available for the public between the months of May and September at the Hartwell and J. Strom Thurmond Lake at the 40 combined USACE-operated swimming beach areas. At 6 feet below summer Guide Curve elevations, designated swimming areas become dry. However, adverse impacts become noticeable at designated swimming areas when lake levels drop 3 feet below summer Guide Curve elevations. The following paragraphs discuss the facilities that exist on the three USACE reservoirs.

Hartwell Lake

At Hartwell Lake, there are 23 USACE-operated swimming beach areas located in 13 recreation areas. When lake levels reach 654 feet msl, all designated swimming areas are dry. However, when the lake level drops below 657 feet msl, swimming areas become less desirable due to the reduced water area available for swimming. When this happens, swimming occurs outside the designated swimming area, increasing the risk of fatalities or injury. During the 1986 drought, when swimming beaches were unusable, recreation fatalities associated with swimming activities increased from three to nine. When the beaches were back in service in 1987, no recreation fatalities associated with swimming activities occurred.

RBR Lake

There are no USACE-operated swimming areas at RBR.

JST Lake

At JST Lake, there are 64 USACE-operated swimming beach areas. When lake levels reach 324 feet msl, the designated swimming areas are dry. However, when the lake level drops below 327 feet msl, swimming beaches become less desirable due to the reduced water area available for swimming. When this happens, swimming occurs outside the designated swimming area, increasing the risk of fatalities or injury.

2.15 Aesthetics

The continually changing channel of the Savannah River across its flood plain has built a diverse landscape of bluff, levees, swamps, lakes, and creeks. Ecosystems within the basin include agricultural systems, upland forests, bottomland hardwoods, pine plantations, free flowing streams, water impoundments (dams), swamps, and freshwater and marine marshes. Equally diverse is the array of plants and animals living in the habitats created by the river. The Savannah River Basin is home to more than 50 species of rare, threatened, and endangered plants and animals, including the swallow-tailed kite, the rocky shoals spider lily, and the smooth coneflower. Much of the water in the upper basin is retained in several large dams, including those forming Lake Hartwell, Lake Russell, and Lake Thurmond which provide a wide range of recreation opportunities including fishing, boating, and swimming. The lower part of the basin is characterized by a meandering course with few tributaries and slow currents. The

natural beauty of the Lower Savannah River has been preserved by a number of factors. Among these are: (1) the flood plain forests are generally intact, (they have not been exploited extensively for timber, except for the economically valuable cypress); (2) the pattern of large landholdings extensively used for forestry and recreation has resulted in a low population level in the region, thereby leaving no motive for intensive development; and (3) the major uses of the area, that of recreation (hunting, fishing, and boating), have had little permanent effect on the natural environment.

2.16 Hydropower

The Southeastern Power Administration (SEPA) (http://energy.gov/sepa/southeastern-power-administration) markets hydropower generated at Hartwell, RBR and JST lakes and dams. SEPA markets the energy through contracts negotiated between SEPA and certain preference customers. Ten hydropower facilities provide the energy and capacity requirements of the contract. These projects are located in the Savannah, Alabama-Coosa-Tallapoosa (ACT), and Apalachicola-Chattahoochee-Flint (ACF) Basins. Under normal conditions, if a certain basin or portion of a basin is unable to meet the demands expected, then that shortage can usually be transferred to, or "made up" in, another basin. However, a drought typically adversely impacts all three basins, affecting SEPA's ability to meet the minimum contract requirements. SEPA may purchase replacement energy for the system generation when USACE does not generate enough power to meet the requirements of SEPA's contract. SEPA purchased substantial amounts of power during the 2008-2010 drought to meet their contract requirements. Replacement energy cost was $80.4 million ($108/MWH) and additional pump energy cost was $99.6 million ($37/MWH). The pump energy generation offset $291 million of additional replacement energy cost.

Unlike the open market replacement rate of $108 per MWH experience during the 2008-2010 drought, the 2016 replacement energy average rate per MWH is $49.64. The price of replacement energy has been driven down by low natural gas prices.

Augusta Canal: The Augusta Canal Authority owns and operates the Sibley Mill and King Mill hydroelectric power stations. Melaver Incorporated owns and operates a hydroelectric power station called Enterprise Mill on the Augusta Canal.

Pumping Cost: The RBR Pumped Storage Project began commercial operation in July 2002. Pumped Storage consists of pumping water from below the RBR dam into the RBR reservoir during times of low demand for electricity and using this water to generate during times of high demand. Pumped Storage is not possible when JST lake levels fall to approximately 312 feet msl. Current operation of the four pumped storage units includes several operational restrictions to minimize fish entrainment and fishery habitat impacts.

2.17 Water Supply

A non-Federal interest may acquire a contract to use storage within the USACE reservoirs under the authority of the Water Supply Act of 1958 and Public Law 88-140 (43 U.S.C. 390c.-f). Such a contract is obtained by the non-Federal interest upon completion of payment of the first costs (investment costs) of the reallocation. The non-Federal interest remains responsible for its proportionate share of the annual operation and maintenance costs of the project, and of reconstruction, rehabilitation, and replacement costs for project features allocated to its water supply storage. The storage remains subject to equitable reallocation among project purposes due to sedimentation. Additionally, water supply is also provided under historic riparian rights. In these instances, riparian users have rights to the volume of water that they withdrew at the time of construction of the reservoir.

Hartwell Lake

There are eight water supply users with intakes in Hartwell Lake. The contracted amount of storage accounts for 26,574 acre feet of conservation storage. Two - Anderson County Joint Municipal Water System and the City of Lavonia - currently hold water storage contracts with Savannah District. Although Hart County Water and Sewer Utility Authority does not have an intake, it does have a water storage contract. Hart County currently uses water from intakes owned by the Cities of Lavonia and Hartwell. The amount of water that they use to service these two cities is allocated to their water storage contract with Savannah District. The other six water supply users with intakes have riparian rights (City of Hartwell, Clemson University Musser Fruit Farm, Clemson University, Clemson Golf Course, J. P. Stevens, and Milliken Company). Clemson University's Musser Fruit Farm intake becomes inoperable at 653 feet msl. When the intake is inoperable, they use water from the City of Seneca, but only if it is absolutely necessary because of the increased cost. Irrigation occurs between the months of June and August.

RBR Lake

There are six water supply intakes on RBR Lake. The contracted amount of storage accounts for 872 acre feet of conservation storage. Two - City of Elberton and Santee Cooper - currently hold water storage contracts in RBR Lake with Savannah District. Three have riparian rights (RBR State Park Golf Course, Mohawk Industries, and Calhoun Falls). One, the City of Abbeville, is in relation to mitigation for RBR construction. The highest intake elevation is 468.8 feet msl.

JST Lake

There are eight water supply users with intakes on JST Lake. The contracted amount of storage accounts for 3,741 acre feet of conservation storage. The City of Lincolnton, City of Washington, City of McCormick, City of Thompson, Columbia County, Savannah Lakes POA Monticello Golf Course and Savannah Lakes POA Tara Golf Course currently hold water storage contracts with Savannah District. Hickory Knob State Park Golf Course has riparian rights. The City of Lincolnton has three intakes, one each at

321, 314, and 307 feet msl. If the highest intake at 321 feet msl is exposed, then the other two intakes can meet the water needs so that there are no shortages during a drought such as occurred from March 3, 2007 to November 26, 2009. This condition is the same for the City of Thompson and Columbia County that have three intakes one each at 320, 312 and 304. The golf courses have intake elevations at 324 feet msl.

Downstream of JST Lake

Savannah District does not have storage contracts for downstream water supply needs.

Sixteen major water supply users exist downstream of Thurmond Dam. Each intake has a minimum normal stream flow from JST to maintain adequate stage for their intakes. Flow requirements by user are listed in Table 11.

Table 11: Flow Requirements at Downstream Intake Locations

Downstream Intakes	Elevation (feet)	Flow Requirement
Augusta-Richmond County (Diesel Pumps)	119.5	1,500
City of North Augusta	108	3,100
Kimberly Clark Corporation Beech Island	109	3,100
SCE&G Urquhart Station	111	3,100
DSM Chemicals Augusta, Inc.	103.9	3,100
PCS Nitrogen Fertilizer, L.P.	103.9	3,100
General Chemical Corp., Augusta Plant	111	3,100
D/S of NSBL&D (Cretaceous Sand)		3,600
International Paper Corporation - Augusta Mill	94	3,600
DOE Savannah River Operation (Westinghouse SRS G Area Misc Ind)	79	3,600
Southern Nuclear Operating Co., Inc. (Vogtle)	70	2,600
Georgia Power Co - Plant McIntosh	7.5	4,000
GA Pacific (Fort James Operating Company)	5.16	4,000
Beaufort Jasper W&SA Main Plant	3	4,000
Savannah City Water Supply	-10.22	4,000
Tronox Pigments (Savannah), Inc.	-4.1	4,000
Weyerhaeuser Company	-10.5	4,000
International Paper Corporation	-5	4,000

The major municipal users include Augusta and users near the coast. The City of Augusta operates and withdraws water from the Augusta Canal. The City of North Augusta withdraws water from the pool upstream of the New Savannah Bluff Lock and Dam (roughly river mile 187.5). The Beaufort-Jasper County Water Supply Authority withdraws water at river mile 39.3, while the City of Savannah's M&I Plant is located on Abercorn Creek, approximately at river mile 29. The other municipal users consist of Columbia County and Edgefield County.

Industrial users with intakes in the New Savannah Bluff Lock and Dam (NSBL&D) pool include North Augusta, Mason's Sod, Kimberly Clark, Urquhart Station, PCS Nitrogen, DSM Chemical and General Chemical, and South Carolina Electric and Gas. Users below NSBL&D include International Paper, Savannah River Site, Savannah Electric – Plant McIntosh, Georgia-Pacific, the Savannah National Wildlife Refuge and Plant Vogtle. Plant Vogtle currently withdraws 60 cfs from the Savannah River Basin and an expansion project is currently under construction and will require an additional consumptive use withdrawal of approximately 60 cfs in several years. This additional withdrawal will eventually come out of the usual local flows that are often 4,000 to 5,000 cfs during a drought. The Corps' operations directly impact water supply downstream of JST, which is operated in part to provide water supply.

2.18 Environmental Justice

The concept of environmental justice is based on the premise that no segment of the population should bear a disproportionate share of adverse human health or environmental effects. Executive Order (EO) 12898, Federal Actions to Address Environmental Justice in Minority and Low Income Populations requires each Federal agency to make achieving environmental justice part of its mission. Specifically, the agency must identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations. In addition, EO 1298 requires each federal agency to conduct its programs, policies, and activities so that they do not exclude, deny benefits to, or discriminate against persons (including populations) because of race, color, or national origin. As no impacts of any alternatives will be felt disproportionately by any minority or low-income groups, no issues of environmental justice are present.

3.0 Formulation of Alternatives

3.1 Problems, Opportunities, Objectives, and Constraints

3.1.1 Problems

- Low rainfall and high evapotranspiration during droughts depletes the reservoirs, causing a shortage of water to satisfy most project purposes (hydropower, recreation, water supply, navigation).

- Growth in population increases demand for water.
- Flows are inadequate through environmentally-sensitive shoals near Augusta.

3.1.2 Opportunities

- Modify discharges from the three-reservoir system.

3.1.3 Objective

- The objective is to maximize positive impacts and minimize negative impacts on authorized project purposes during drought conditions.

3.1.4 Constraints

- Georgia and South Carolina cannot approve any reductions in Dissolved Oxygen (DO) levels in the harbor based on the 2015 Subcategory 5R Document for Point Source Dissolved Oxygen Impaired Water in the Savannah River Basin.

3.1.5 Assumptions

- Fifty-two performance metrics (Table 14) allow sufficient identification of project impacts from the alternatives.

3.2 Planning Horizon

- All alternatives were modeled using hydrologic data covering the period from 1999-2013, which encompass two droughts of record.
- All alternatives were modeled using a forecasted 2050 water use.
- The economic analysis covers a thirty-four year period of analysis from 2017-2050.

3.3 Alternative Formulation Process

The PDT was comprised of representatives from Georgia Department of Natural Resources (GADNR), South Carolina Department of Natural Resources (SCDNR), The Nature Conservancy (TNC), and USACE. The scope of work did not include activities requiring Congressional reauthorization. The scope of work focuses only on operational changes in water resources management. Operational changes consist of the timing of and amount of discharge from the JST Dam during drought periods. Availability of funding and the sponsors' interests guided the focus of the scope of work.

The PDT developed alternatives to cover a full range of flows and identify the points at which unacceptable impacts occur to infrastructure and the environment. During the development of the Project Management Plan, the PDT defined the first four alternatives. Two additional alternatives were to be developed after the PDT examined preliminary results of the first four.

Savannah District evaluated the effects that each alternative had on each project purpose: environmental, flood risk management, hydropower, navigation, recreation, and water supply. The PDT compared the effects of the alternatives on hydropower and recreation using an economic measures whereas the other project purposes used non-economic measures. Since the units of measure for the effects on the project purposes are not equally comparable, percentage change was selected as the method to give each project purpose comparable units of measure. Once the project purposes were measurable in the same unit, comparison ranking could be conducted. Then Savannah District evaluated the effects of the alternative on each project purpose in terms of percentage change from the NAA. Next, all seven alternatives (including NAA) were ranked from 1 to 7; with 1 being the greatest positive impact and 7 being the greatest negative impact. Finally, project purpose impact rankings were combined and averaged to determine the final impact ranking of each alternative.

3.3.1 Future Without Project Condition

The future without project condition or NAA represents the most likely anticipated future condition if there is no change to the current DCP.

3.3.2 Future With Project Condition Alternatives

The PDT set out to evaluate an array of alternatives that cover a full range of potential drought flow scenarios. None of these alternatives include a flattening of the guide curves, which would reallocate storage from the flood control storage to conservation storage (this is beyond the scope of this study). Ultimately, the team identified six Future With Project (FWP) condition alternatives. The States of Georgia and South Carolina conducted population and water use projections. Based on these projections, inputs into HEC-ResSim reflected the projected 2050 water supply use. See Current & 2050 Water Usage Table in Engineering Appendix.

3.3.3 Description of Alternatives

In all of the Interim Study 2 alternatives, the highest priority is given to the rules defining operation while in the flood pool. The drought trigger levels (Table 12) are based on the reservoir elevations at both Hartwell and JST Lakes. The USACE reservoirs are operated as a system. Trigger flow restrictions will be initiated when either Hartwell or Thurmond decline through a drought trigger level. As pools recover, the JST flow restriction will not reset to the next higher level of restrictions until both the Hartwell and Thurmond pools have risen 2 feet above the trigger level that set the restriction. Drought triggers restrict the releases from JST. Hartwell releases only what it needs to stay in balance with JST. There are no drought triggers in the Russell pool. The same Hydropower rules and Russell Pump rules appear in all of the alternatives. Also, all alternatives target a maximum channel capacity of 30,000 cfs at Augusta, a minimum release requirement of 3,600 cfs at Thurmond, and a minimum of 3,600 cfs at the Augusta gage. Individual alternatives may override minimum release requirements.

Table 12: Drought Trigger Levels at Hartwell and JST, (2012 NAA)					
Trigger Level	1 Apr–15 Oct (feet MSL)		15 Dec–1 Jan (feet MSL)		Action
	Hartwell Lake	JST Lake	Hartwell Lake	JST Lake	
1	656	326	654	324	If Broad River inflows > 10% of historical flow rate, set JST Lake outflow to 4,200 cfs. If Broad River inflows <= 10% of historical flow rate, set JST Lake outflow to 4,000 cfs.
2	654	324	652	322	If Broad River inflows > 10% of historical flow rate, set JST Lake outflow to 4,000 cfs. If Broad River inflows <= 10% of historical flow rate, set JST Lake outflow to 3,800 cfs. Set JST Lake outflow to 3,600 cfs November through January.
3	646	316	646	316	Set JST Lake outflow to 3,800 cfs. Set JST Lake outflow to 3,100 cfs November through January.
4	625	312	625	312	Set JST Lake outflow to 3,600 cfs. Set JST Lake outflow to 3,100 cfs November through January. Continue release as long as possible, then outflow = inflow.

3.3.3.1 No Action Alternative (Future Without Project Condition)

The NAA (Figure 4) drought trigger level 1 and drought trigger level 2 triggers vary seasonally. The trigger for drought level 1 is located 4 feet below the summer guide curve and 2 feet below the winter guide curve. The trigger for drought level 2 is located 6 feet below the summer guide curve and 4 feet below the winter guide curve. Drought trigger level 3 does not vary seasonally and is 14 feet below the summer full pool.

When in drought trigger level 1, Thurmond targets a daily average release of 4,200 cfs if the Broad River 28 day average flow is greater than its 10th percentile and 4,000 cfs if the Broad River 28 day average flow is less than its 10th percentile.

When in drought trigger level 2 during February through October, Thurmond targets a daily average release of, 4,000 cfs if the Broad River 28 day average flow is greater than its 10th percentile. The target is 3,800 cfs if the Broad River 28-day average flow is less than its 10th percentile.

When in drought trigger level 3 during February through October, Thurmond targets a daily average release of 3,800 cfs.

There is a wintertime flow reduction during November through January where Thurmond would target a daily average release of 3,600 cfs when in drought trigger level 2 and 3,100 cfs if in drought trigger level 3.

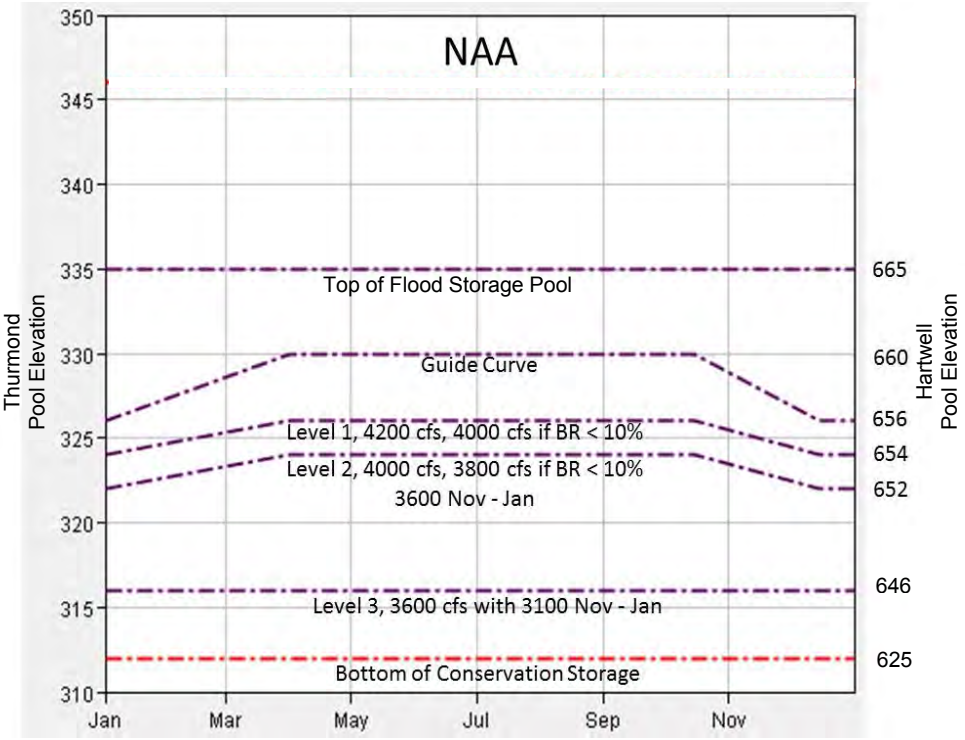


Figure 4: NAA Description Diagram

3.3.3.2 Alternative 1 (Extreme Low Flow)

Alternative 1 (Figure 5) was developed with the lowest releases to identify the minimum flow breakpoints. Drought triggers are at the same elevations as NAA, but with lower flows. When in drought trigger level 1, Thurmond would target a daily average release of 3,800 cfs from February through April, and then 3,500 cfs from May through January. When in drought trigger level 2, Thurmond would target a daily average release of 2,800 cfs from February through April, and then 2,500 to 2,800 cfs from May through January. When in drought trigger level 3, Thurmond would target a daily average release of 1,800 cfs from February through April, and then 1,500 cfs from May through January.

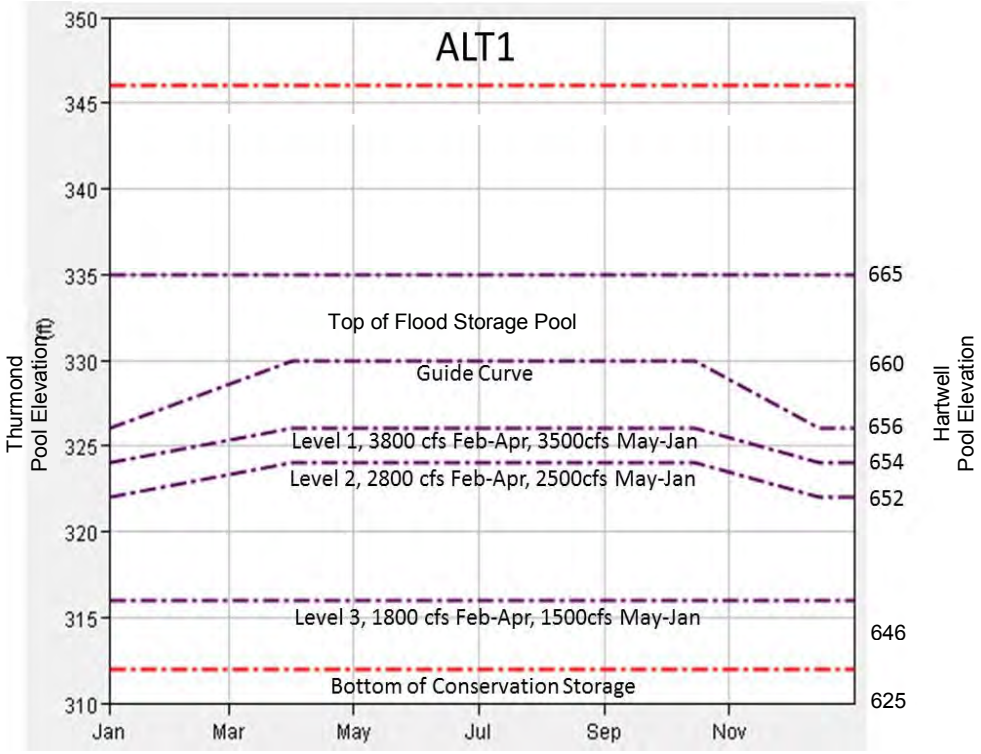


Figure 5: Alternative 1 Description Diagram

3.3.3.3 Alternative 2 (Raise Level 3)

Alternative 2 (Figure 6) addresses increased conservation opportunities by raising trigger level 3, and slightly decreasing the required flows for each trigger level. The drought triggers do not vary seasonally in this alternative. Drought trigger level 1 is located at the same elevation as the winter guide curve (4 feet down from summer guide curve). As such, weekly declarations will define the required releases for each declaration period. Decisions, based on lake levels, may switch from normal to flood management to drought levels. Drought trigger level 2 is located 2 feet below drought trigger level 1. Drought trigger level 3 is located 2 feet below drought trigger level 2.

When in drought trigger level 1, Thurmond would target a daily average release of 4,000 cfs. When in drought trigger level 2, Thurmond would target a daily average release of 3,800 cfs from February through October, and 3,600 cfs from November through January. When in drought trigger level 3, Thurmond would target a daily average release of 3,600 cfs from February through October, and 3,100 cfs from November through January.

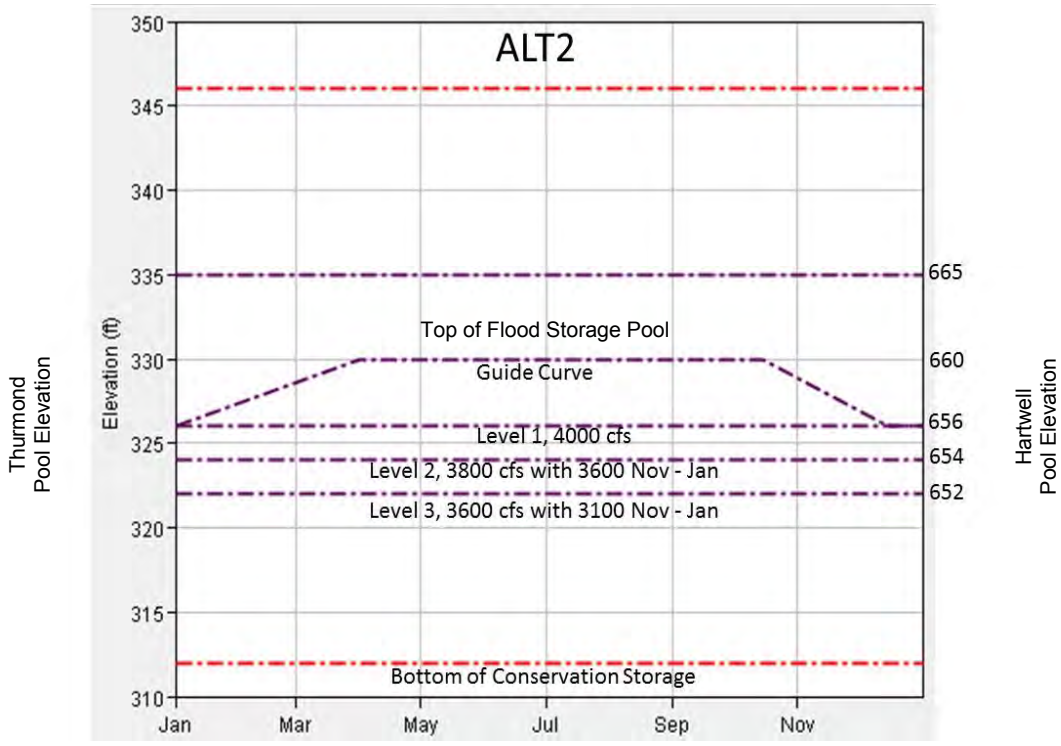


Figure 6: Alternative 2 Description Diagram

3.3.3.4 Alternative 3 (Environmental)

Alternative 3 (Figure 7) uses the drought trigger levels at the same elevations as the NAA. The environmental flow targets were based on a flow prescription plan (Appendix E) developed during the environmental stakeholder workshop on July 23-24, 2014. The However, environmental targets are given a higher priority than meeting drought trigger requirements. Drought trigger flow targets are only met if the environmental targets can be met as well. This alternative evaluates impacts to project purposes when operating to meet environmental flow targets. This alternative includes the Broad River gauge index as an indicator of drought severity.

The drought trigger level 1 trigger is located four feet below the summer guide curve and two feet below the winter guide curve. The drought trigger 1 flow target is 4,000 cfs from February through October and 2,800 cfs from November through January.

The drought trigger level 2 trigger is located six feet below the summer guide curve and four feet below the winter guide curve. The drought trigger 2 flow target is 3,800 cfs from February through October and 2,800 cfs from November through January.

The drought trigger level 3 trigger is located eight feet below the summer guide curve and six feet below the winter guide curve. The drought trigger 3 flow target is 3,600 cfs from February through October and 2,800 cfs from November through January.

There is a daily average minimum release requirement of 3,600 cfs at Thurmond when in the conservation pool.

There is also a minimum flow requirement of 3,600 cfs at Waynesboro to protect the Savannah River Site water intakes.

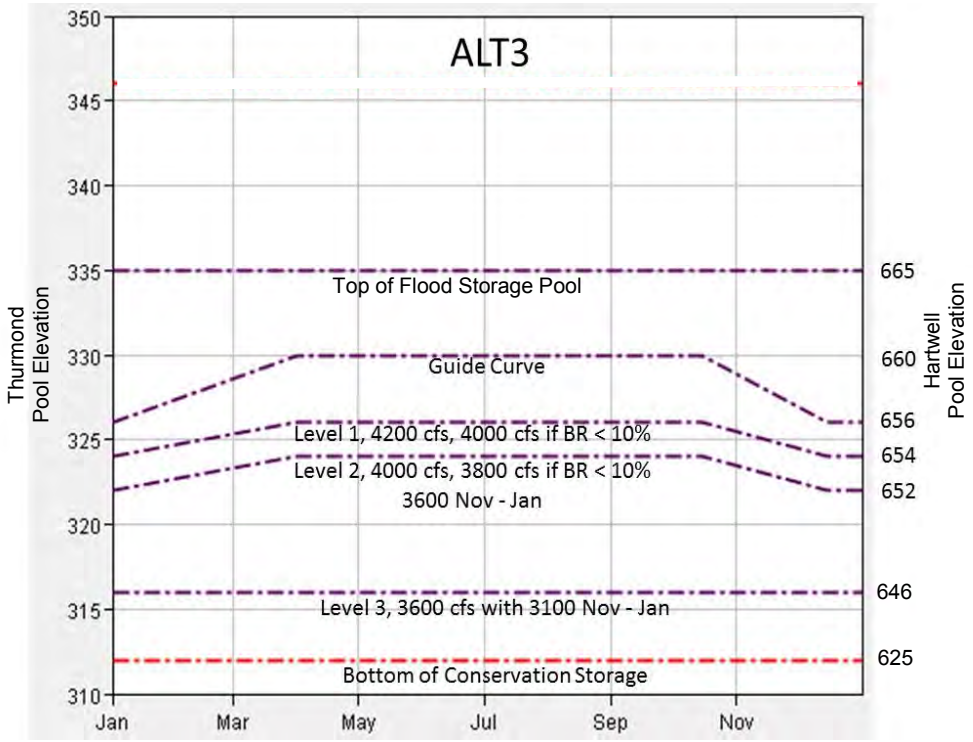


Figure 7: Alternative 3 Description Diagram

Environmental features:

This alternative uses environmentally based rules to define seasonal varying maximum flows, minimum flows, max rate of change, and pulse flows.

Alternative 3 is the environmental flow alternative based on the flow prescriptions developed by TNC, using input from the environmental flow workshop. All of the desired flow targets were initially input into the HEC-ResSim model. The environmental rules held a higher priority than other project purposes while in the conservation pool.

The initial model simulations indicated that the environmental objectives defined from the workshop required too high of a release from Thurmond, ultimately emptying the reservoirs. The PDT then refined the environmental prescription and developed a revised set of operational rules which comprise Alternative 3.

The prescription was broken into “wet,” “average,” “dry,” and “drought” conditional groups (Tables 13, 14, and 15). The “wet” condition occurs when the system is above

the guide curve. In this interim study, existing flood management rules did not change and were given higher priority than all other rules. The “average” condition group occurs when the system is below guide curve but above drought trigger level 1. The “dry” condition occurs when the system is in drought trigger level 1. The “drought” condition occurs when the system is in drought level 2 or drought level 3.

The “wet” condition limits Thurmond releases to a maximum decrease of 1,000 cfs/day when Thurmond is releasing between 2,000 cfs and 6,000 cfs, daily average. This rule attempts to prevent the Augusta Shoals from drying too quickly. Seasonal pulses target river flows up to 30,000 cfs at Clyo for up to 15 days. Seasonal pulses target river flows of 17,000 cfs at Millhaven for up to 2 two weeks during spring fish spawn. Seasonally varying minimum flow limits were are set targeted for at the Augusta Shoals ranging from 1,900 cfs to 3,300 cfs. Seasonally varying minimum flow limits of 7,500 cfs are set targeted at Millhaven. Seasonally varying minimum flow limits ranging from 5,000 to 6,000 cfs are targeted at Clyo. Seasonally varying maximum flow limits of as low as 10,000 cfs are targeted at Millhaven to coincide with spring fish spawn. A max flow limit of 7,500 cfs is targeted at Clyo, which attempts to preserve as much water in the reservoirs when it is not needed to meet the other environmental flow objectives.

The Average group rates of decrease in the Thurmond release targeted 1,000 cfs/day, when Thurmond was releasing between 2,000 cfs and 6,000 cfs, which focused on the shoals. Seasonal pulses at Clyo targeted releases of as much as 15,000 cfs for up to 15 days. Seasonal pulses at Millhaven targeted 2 week release of 17,000 cfs for up to 2 weeks during spring fish spawn. Seasonally varying minimum flow limits were set for the Augusta Shoals ranging from 1,500 cfs to 2,500 cfs. Seasonally varying minimum flow limits of 7,500 cfs were set for Millhaven. Seasonally varying minimum flow limits were set for Clyo ranging from 5,000 cfs to 6000 cfs. Seasonally varying minimum flow limits of as low as 1,500 cfs were added for the Augusta Shoals to coincide with spring fish spawn. Seasonally varying maximum flow limits of as low as 10,000 cfs were set for Millhaven to coincide with spring fish spawn. A max flow limit of 7,500 cfs was set at Clyo attempting to preserve as much water in the reservoirs when it was not needed to meet the other environmental flow objectives.

The Dry group rates of decrease in the Thurmond release targeted 1,000 cfs/day, when Thurmond was releasing between 2,000 cfs and 6,000 cfs, which focused on the shoals. Rates of change rules, focusing on the Millhaven objectives, were placed on the Thurmond release targeting 500 cfs/day, when Thurmond was releasing less than 5,000 cfs and 1,000 cfs/day, when Thurmond was releasing between 5,000 cfs and 10,000 cfs, and 2,500 cfs/day when Thurmond was releasing more than 10,000 cfs. A single 4 day pulse at Clyo targeted releases of as much as 12,000 cfs in May. Monthly 1 day pulses at Millhaven targeted releases of 5,000 cfs. Seasonally varying minimum flow limits were set for the Augusta Shoals ranging from 1,500 cfs to 2,000 cfs. Seasonally varying minimum flow limits were set for Millhaven ranging from 2000 cfs to 3,400 cfs. Seasonally varying minimum flow limits were set for Clyo ranging from 5000 cfs to 6,000 cfs. Seasonally varying minimum flow limits of as low as 1,500 cfs were added for the Augusta Shoals to coincide with spring fish spawn. Seasonally varying maximum flow limits of 4,000 cfs were set for Millhaven between March 15 and

October 1. A max flow limit of 7,500 cfs was set at Clyo attempting to preserve as much water in the reservoirs when it was not needed to meet the other environmental flow objectives as described in the Flow Prescription Plan (Appendix E) developed in 2003 and then revised in 2015. The Flow Prescription Plan described base flows, ranges of variability, and pulse and flood flows to benefit the full range of ecosystem resources and processes in the Savannah River.

The Dry group rates of decrease in the Thurmond release targeted 1,000 cfs/day, when Thurmond was releasing between 2,000 cfs and 6,000 cfs, which focused on the shoals. Rates of change rules, focusing on the Millhaven objectives, were placed on the Thurmond release targeting 500 cfs/day, when Thurmond was releasing less than 5,000 cfs and 1,000 cfs/day, when Thurmond was releasing between 5,000 cfs and 10,000 cfs, and 2,500 cfs/day when Thurmond was releasing more than 10,000 cfs. Seasonal pulses at Clyo targeting releases of as much as 12,000 cfs in May. Monthly 1 day pulses at Millhaven targeted releases of 5,000 cfs. Seasonally varying minimum flow limits were set for the Augusta Shoals ranging from 1,500 cfs to 2,000 cfs. Seasonally varying minimum flow limits were set for the Millhaven ranging from 2,000 cfs to 3,400 cfs. Seasonally varying minimum flow limits were set for the Clyo ranging from 4,000 cfs to 5,000 cfs. Seasonally varying minimum flow limits of as low as 1,500 cfs were added for the Augusta Shoals to coincide with spring fish spawn. Seasonally varying maximum flow limits of 3,600 cfs were set for the Millhaven between March 15 and October 1.

		Flow Type	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Wet Year	Shoals	Min Base Flow	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
		Max Base Flow												
		Ramping / Variation Rate (+/- cfs)	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
		Pulse Flows	Monthly: 20-40000 cfs; Jan-Feb 2-3 d.; Mar-Apr 14 d.									(1) 20000 cfs; 2-3 d.		
		Flood Flows	No recommendation											
			Justifications for flows very similar to wet years. Concerns about hypolimnetic release with pulses and channel scouring from floods. Anadromous fish were a strong driver; native fish assemblage and needs not well understood.											
	Floodplain	Min Base Flow			6500-8200									
		Max Base Flow			10000									
		Ramping / Variation Rate (+/- cfs)			500									
		Pulse Flows	(5-8) 30-40000 cfs pulse; 7 d.; 4yr return											See Jan-Mar
		Flood Flows	No specific recommendation; group cited 2yr flood of +/- 90000 cfs as pre-dam norm											
			Justification for Mar-May elevated base flow is pelagic fish spawn and egg suspension; pulse flows provide fish passage at NSBLD, floodplain spawning (blueback herring), nutrient and carbon exchange, woody debris movement, seed and larval fish transport, predator-free bird nesting habitat, invasive removal. Flood discussion cites same benefits, plus maintaining floodplain topography and jurisdictional wetland conditions.											
	Estuary	Min Base Flow	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
		Max Base Flow												
		Ramping / Variation Rate (+/- cfs)	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
		Pulse Flows				(1) 30000 cfs; 14 d.								
		Flood Flows		50,000 cfs for 30d. once every 5 years										
			Pre-dam flow regime considered an inappropriate basis for estuary recommendations due to harbor deepening from 12 to 42' (circa 2003). In addition to benefits cited under Average Year, wet year base flows will enhance habitat for striped bass, American eel, sturgeon, southern flounder, striped mullet, and will enhance striped bass spawning. Pulse justifications same as Average Year. Flood flow rec. to support nearshore marine fish productivity, sediment and nutrient replenishment, species mixing, and turbidity protection for young fish.											

Pulse / flood (unsustained / periodic)
Max flow - do not exceed
Base Flow
Variation above min flow with natural ramp and frequency
No recommendation in Meyer et al 2003

Table 13: Environmental flow prescription for wet conditions

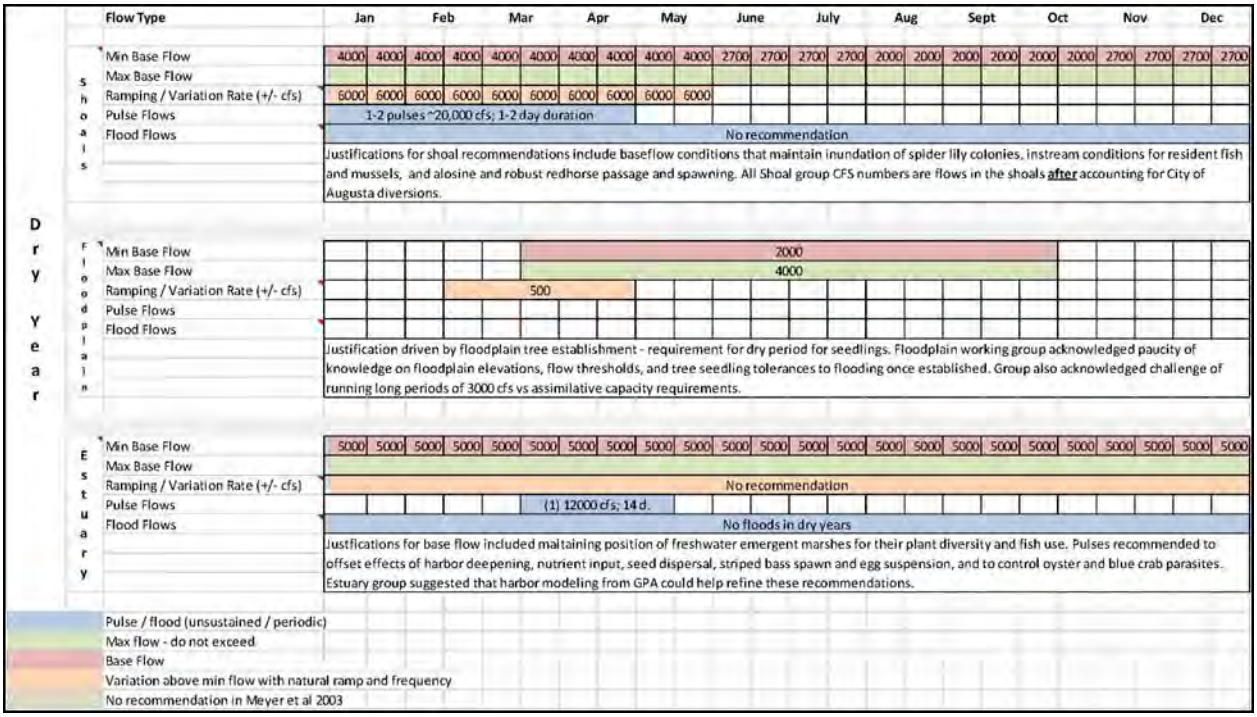


Table 14: Environmental flow prescription for dry conditions

Table 15 Environmental flow prescription for drought conditions

There is a Daily average minimum release requirement of 3,600 cfs at Thurmond when in the conservation pool. Flood Management rules can over-ride pushing the Thurmond release to zero cfs if there is flooding downstream. There is also a minimum flow requirement of 3,600 cfs targeted at Waynesboro to protect the Savannah River Site water intakes (Figure 8).

In this alternative, the environmental targets are given a higher priority than the system power rules. The system power commitments will only be met after the environmental rules have been met. System power commitments vary monthly.

Engineering Appendix Section 7.5 contains additional information on the environmental rules and system power commitments.

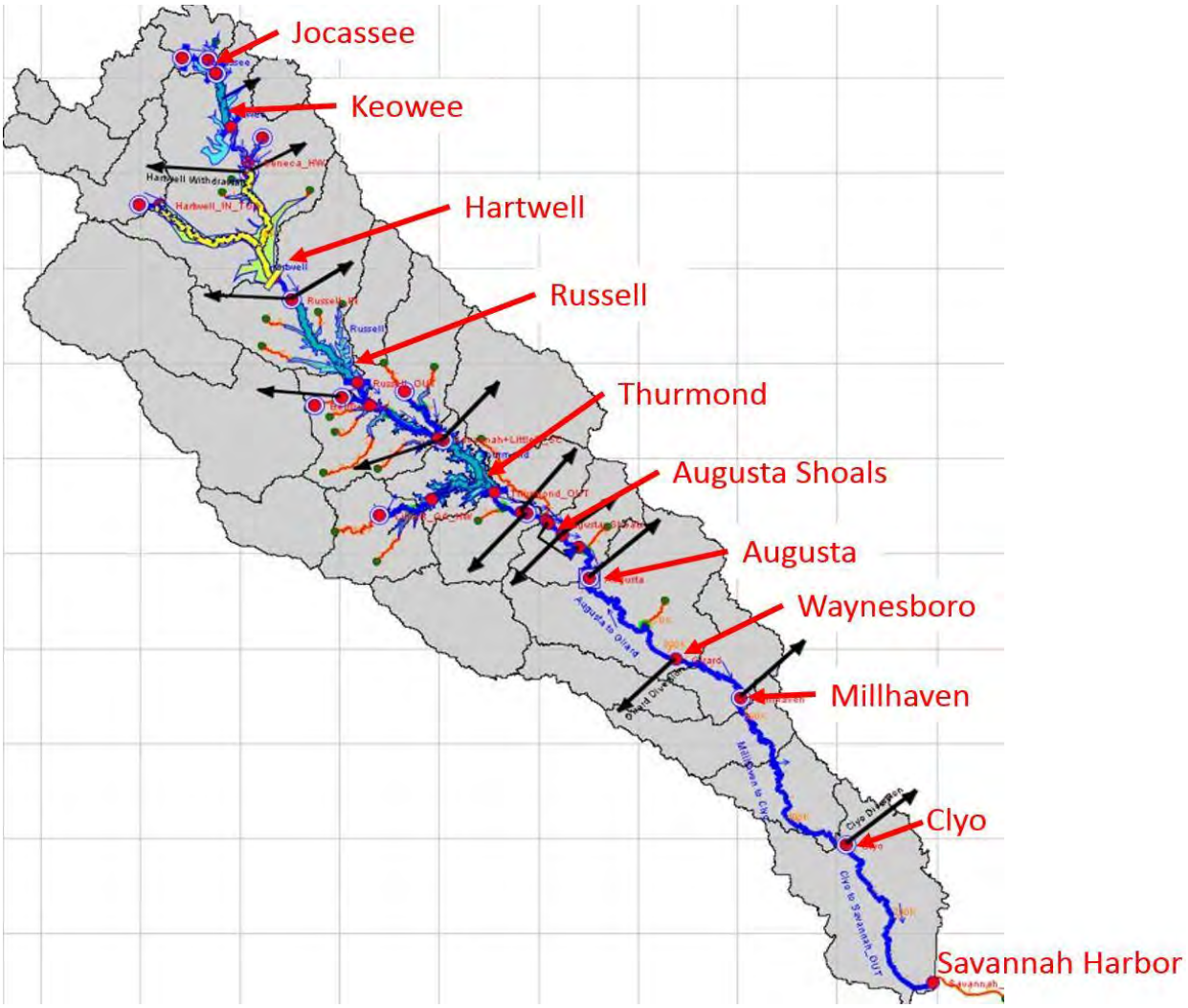


Figure 8: Key Metric Locations

3.3.3.5 Alterative 4 (3,600 cfs at all levels)

Alternative 4 (Figure 9) addresses a low flow target that once triggered, would remain active throughout the drought. This plan uses only drought trigger level 1 of the NAA. When in drought trigger level 1 or lower, Thurmond would target a daily average release

of 3,600 cfs. There would be a wintertime flow reduction November through January, where Thurmond would target a daily average release of 3,100 cfs.

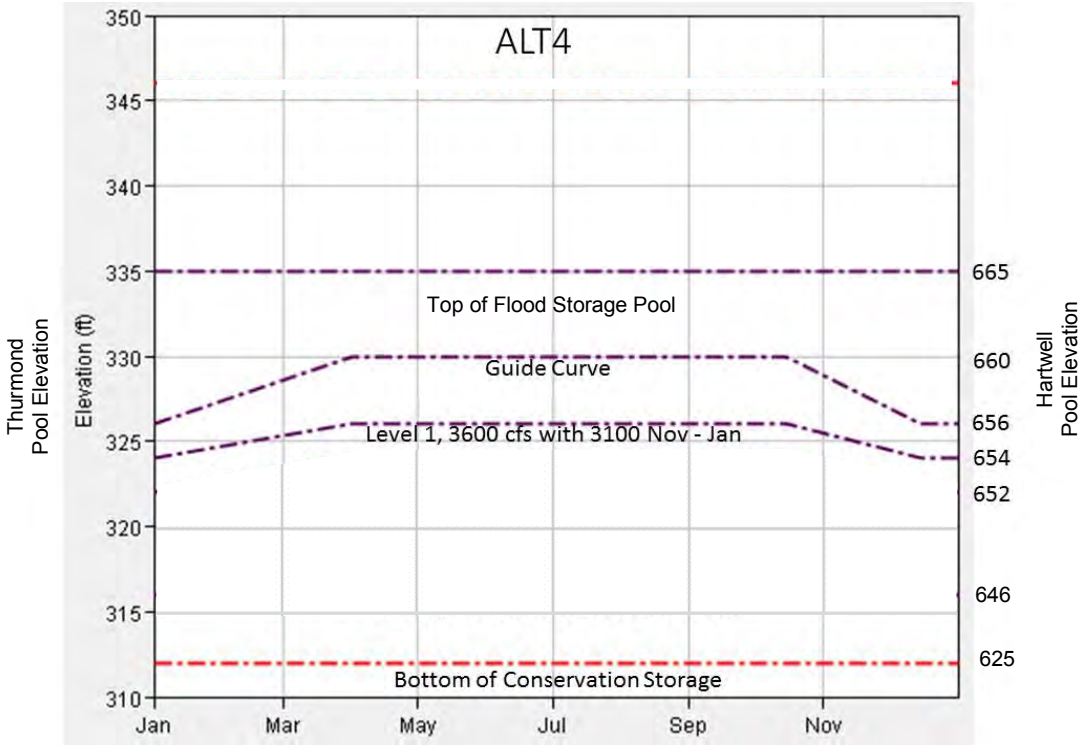


Figure 9: Alternative 4 Description Diagram

3.3.3.6 Alternative 5 (Environmental)

Alternative 5 (Figure 10) has the same trigger levels as Alternative 3 as well as the environmental flow targets based on a flow prescription plan. However, Drought Trigger Level 3 is raised to 2 feet below Level 2. The Normal Drought Flow targets were dropped 200 cfs from ALT-3 to 4,000, 3,800, and 3,600 cfs for levels 1, 2, and 3. The wintertime flow reduction was also dropped to 2,800 cfs. The Waynesboro minimum flow of 3,600 cfs was retained.

There is also a minimum flow requirement of 3,600 cfs at Waynesboro to protect the Savannah River Site water intakes.

The environmental targets will be given a higher priority than the system power rules, as in Alternative 3.

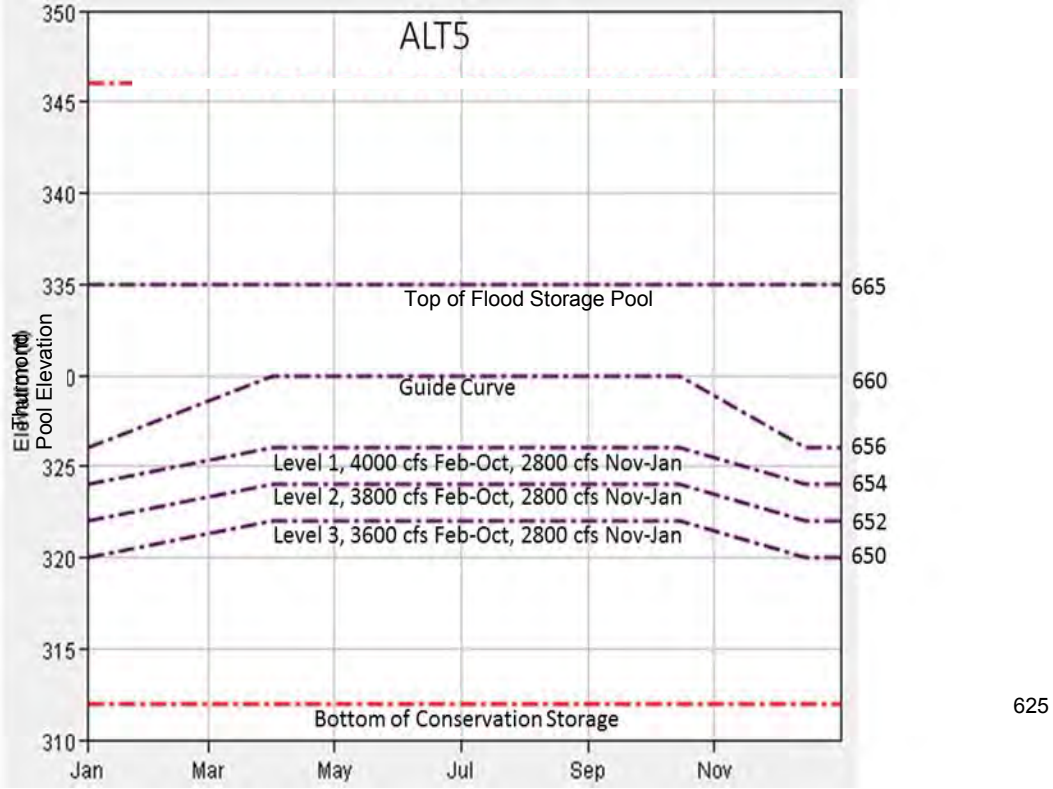


Figure 10: Alternative 5 Description Diagram

3.3.3.7 Alterative 6

Alternative 6 (Figure 11) has the same environmental features as Alternatives 3 and 5. However, drought flow targets were set at a higher priority than the environmental releases, and the flow associated with the targets were increased to use more of the conservation storage as the system goes through extreme drought. The objective is to release 90 percent of the conservation storage during the period of record. The drought trigger levels are located at the same elevations as in Alternative 5. The drought trigger 1 flow target is 6,875 cfs from February through October and 2,800 cfs from November through January. The drought trigger 2 flow target is 5,875 cfs from February through October and 2,800 cfs from November through January. The drought trigger 3 flow target is 4,875 cfs from February through October and 2,800 cfs from November through January.

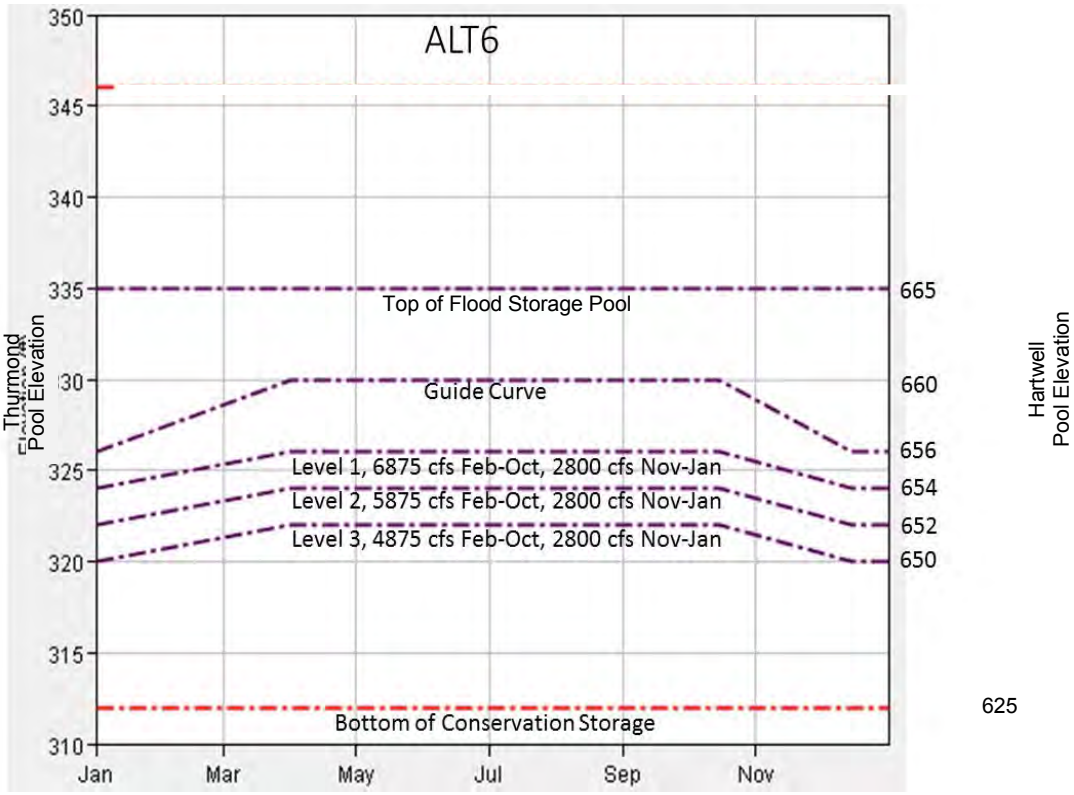


Figure 11: Alternative 6 Description Diagram

Summary of alternatives

See table 16 below for a summary description of the six alternatives and the NAA.

Table 16: Summary description of the six alternatives and the NAA.

Level	NAA	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6
1	Thurmond target 4200 cfs if BR>10% Qin Thurmond target 4000 cfs if BR<=10% Qin	Thurmond target 3800 cfs (Feb - Apr) Thurmond target 3500 (May - Jan)	Thurmond target 4000 cfs at 326	Dry Ecosystem Flow Prescription Thurmond target 4200 cfs if BR >10% Qin Thurmond target 4000 cfs if BR<=10% Qin	Thurmond target 3600 cfs Thurmond target 3100 cfs (Nov - Jan)	Modified Dry Ecosystem Flow Prescription Thurmond target 4000 cfs Thurmond Max 2800 (Nov - Jan)	Modified Dry Ecosystem Flow Prescription Thurmond target 6875 cfs Thurmond Max 2800 (Nov - Jan)
2	Thurmond target 4000 cfs if BR >10% Qin Thurmond target 3800 cfs if BR<=10% Qin Thurmond target 3600 cfs (Nov - Jan)	Thurmond target 2800 (Feb - Apr) Thurmond target 2500 (May - Jan)	Thurmond target 3800 cfs at 324 Thurmond target 3600 cfs (Nov - Jan)	Drought Ecosystem Flow Prescription Thurmond target 4000 cfs if BR>10% Qin Thurmond target 3800 cfs if BR<=10% Qin Thurmond target 3600 cfs (Nov - Jan)	Thurmond target 3600 cfs Thurmond target 3100 cfs (Nov - Jan)	Modified Drought Ecosystem Flow Prescription Thurmond target 3800 cfs Thurmond Max 2800 (Nov - Jan)	Morified Drought Ecosystem Flow Prescription Thurmond target 5875 cfs Thurmond Max 2800 (Nov - Jan)
3	Thurmond target 3800 cfs Thurmond target 3100 cfs Nov - Jan	Thurmond target 1800 (Feb - Apr) Thurmond target 1500 May - Jan	Thurmond target 3600 cfs at 322 Thurmond target 3100 cfs Nov - Jan	Drought Ecosystem Flow Prescription Thurmond target 3800 cfs Thurmond target 3100 cfs Nov - Jan	Thurmond target 3600 cfs Thurmond target 3100 cfs Nov - Jan	Modified Drought Ecosystem Flow Prescription Thurmond target 3600 cfs Thurmond Max 2800 (Nov - Jan)	Morified Drought Ecosystem Flow Prescription Thurmond target 4875 cfs Thurmond Max 2800 (Nov - Jan)
4	Thurmond target 3600 cfs Thurmond target 3100 cfs	Thurmond target 3600 cfs Thurmond target 3100 cfs	Thurmond target 3600 cfs Thurmond target 3100 cfs	Thurmond target 3600 cfs Thurmond target 3100 cfs	Thurmond target 3600 cfs Thurmond target 3100 cfs	Thurmond target 3600 cfs Thurmond target 2800 (Nov - Jan)	Thurmond target 3600 cfs Thurmond target 2800 (Nov - Jan)

10% Qin is defined as the 10th percentile flow at the Broad River (BR) near Bell piedmont reference streamgage for reservoir inflow
Alt 1 Extreme Flow Reductions (Levels 1,2,3)
Alt 2, NAA with Level 3 raised to 322
Alt 3, NAA Level 3 at 646 Environmental Rules for Levels 0 thru 3
Alt 4, NAA with Level 3 at 646, 3600 cfs Spec flow in Levels 1 and below with 3100 Nov thru Jan in Levels 1and below
Alts 5, Similar to Alt 3 but removed Environmental rules when not in drought.
Alts 5, adaptive 2800 cfs Max Target at JST (Levels 1, 2, 3)
Alts 5, added SRS min 3600 cfs at Waynesboro
Alts 5, Rate of Rise/Rate of Fall 500 cfs/day at flows below 3600 cfs (applies to Thurmonds Outflow)
Alts 5, Millhaven Min 3400 cfs except 2000 cfs 15Oct - 31Jan. 5000 cfs pulse on 1st and 15th of each month, with (4 day 12000 cfs pulse 15 May in Level 1 only)
Alts 5, Shoals Min 1500 cfs, 2000 cfs in Feb and March
Alt 6, Alt 5 with increased Drought Trigger Flow Restrictions targeting a minumum of 10% Conservation Storage Remaining

3.4 Performance Measures

Three different models were used to identify differences between the performance of the alternatives. The team used HEC-ResSim to identify the performance in the reservoirs, EPDRIV-1 to identify impacts in the riverine portion of the basin, and EFDC/WASP to identify impacts in the estuary. The difference in performance between each alternative highlighted the uniqueness of each alternative. The team filtered the model output data to determine how well each alternative performed compared to the NAA. The team measured the effects for each performance metric as a percent difference from the NAA.

Savannah District asked the States and TNC what information they would like to see to evaluate impacts from the proposed changes to the Drought Plan. The PDT then developed a series of 52 metrics for comparison (Table 17) to evaluate the impacts of the alternatives when compared to the NAA. The PDT collaborated to determine which agency would produce the data and complete modeling to produce information to satisfy the metrics. The following metrics were used to develop six business lines: Environmental, Flood Risk Management, Hydropower, Navigation, Recreation, and Water Supply (General Information was used in multiple business lines).

Table 17: Metrics Compared

	Evaluation Metric	USACE Business Line
1	Exceedance curve of reservoir elevation (Jocassee, Keowee, Hartwell, Russell, Thurmond)	General Information
2	Exceedance curve of reservoir release (Thurmond)	General Information
3	Minimum lake elevation (Jocassee, Keowee, Hartwell, Russell, Thurmond)	Recreation
4	Power generation (Bad Creek, Jocassee, Keowee, Hartwell, Russell, Thurmond)	Hydropower
5	Pumping (Bad Creek, Jocassee, Russell)	Hydropower
6	Power generation (Bad Creek, Jocassee, Keowee, Hartwell, Russell, Thurmond)	Hydropower
7	Lake recreational impact (Jocassee, Keowee, Hartwell, Russell, Thurmond)	Recreation
8	Numbers of days in different drought trigger levels (Hartwell, Thurmond)	Navigation, Flood Risk Management
9	Lake levels or flows are lower than the lowest level or flow at which water supply intake becomes inoperable	Water Supply
10	Identify lake elevations level at intakes (some highest intakes may not be critical)	Water Supply
11	Identify critical elevation/flow for intakes	Water Supply

12	Number of days that critical water supply intake becomes inoperable (Hartwell, Russell, Thurmond)	Water Supply
13	Number of days when power contracts are not met by the Corps projects	Hydropower
14	Power shortages (total Megawatts) for the Corps projects	Hydropower
15	Cost of replacement power purchased by SEPA	Hydropower
16	Total power generation by the Duke projects	Hydropower
17	Inability to maintain stable lake levels during lake spawning periods (defer to biologists)	Environmental
18	Number of days boat ramps and docks are unusable (# ramps x days) in Hartwell and Thurmond	Recreation
19	Number of days some percentage of ramps and docks are unusable in Hartwell and Thurmond	Recreation
20	Are there critical lake elevations for safe boating?	Recreation
21	Are there critical lake elevations for fishing?	Recreation
22	Number of days lake levels are below any intakes and critical intakes	Water Supply
23	Number of days swimming areas are closed due to low water in Hartwell and Thurmond	Recreation
24	Stream flow exceedance at Augusta diversion dam	Environmental
25	Flow exceedance through the Augusta Canal	General Information
26	Stream flow exceedance at Augusta gage (downstream of the shoals)	Environmental
27	Frequency analysis for Augusta Canal and Shoals	Environmental
28	Number of days when flows in the shoals are less than recommended; (FERC Agreement)	Environmental
29	Stream flow exceedance at Burtons Ferry and Clyo	General Information
30	Effect on the DO in the River	Environmental
31	Effect on water temperature in the River	Environmental

32	Number of days Augusta Canal would have to cut back on hydropower to meet shoals minimum	Hydropower
33	Number of days Augusta would need to run diesel pumps to pull raw water due to implementation FERC Agreement	Hydropower
34	Number of days river levels are below any intakes and critical intakes	Water Supply
35	Number of days boat access ramps in river are unusable (# ramps x days)	Recreation
36	Number of days DO standards are not met in river	Environmental
37	Impacts to fish spawning/habitat in shoals	Environmental
38	Number of days DO standards are not met in river (per node)	Environmental
39	Number of days when flow of river is less than 7Q10	Environmental
40	Effect on the downstream fish spawning downstream of the New Savannah Bluff Lock and Dam	Environmental
41	Effect on the DO in the Harbor	Environmental
42	Effect on temperature in the Harbor	Environmental
43	Effect on salinity in the Harbor	Environmental
44	Effect on the downstream fish spawning in the Harbor	Environmental
45	Effect on the downstream fish populations in the Harbor	Environmental
46	Number of days City of Savannah would be impacted by high salinity levels in Abercorn Creek	Environmental
47	Number of days DO standards are not met in estuary	Environmental
48	Salinity levels in river near Savannah National Wildlife Refuge freshwater intakes	Environmental
49	Number of days DO standards are not met in estuary (per node)	Environmental
50	Location of fresh/saline water interface near coast for wetland analysis	Environmental
51	Number of days Savannah intake (Abercorn Creek) exceeds desirable salinity levels	Environmental
52	Average Flow for numbers of days above channel capacity in Augusta (30,000 cfs)	Navigation, Flood Risk Management

Figure 12 below shows a breakdown by agency of which agency prepared which model that the PDT used to identify and evaluate the impacts from the alternatives. Each of the models used are USACE-certified and approved.

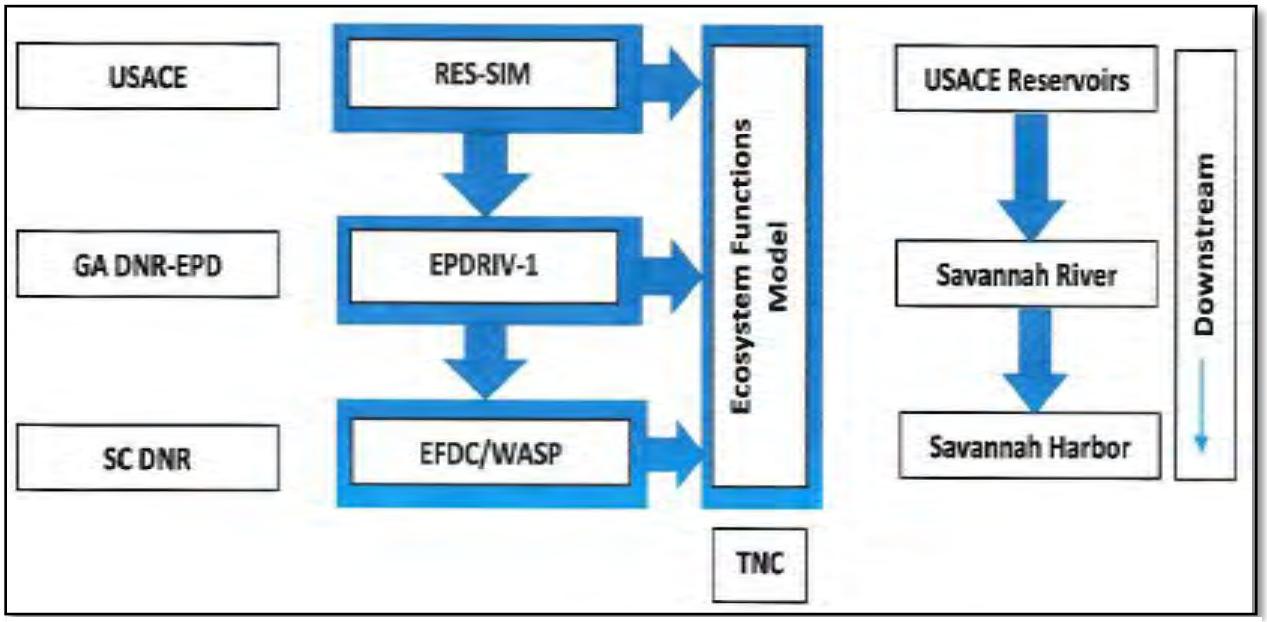


Figure 12: Certified and Approved Models

3.5 Process of Evaluation

Hartwell, Thurmond and Russell are authorized as multipurpose projects that include hydropower and water supply, but other USACE mission areas could be impacted by this modification to the drought plan. Not all the mission areas can be compared using a monetary unit. Percent change was used as a single comparable unit. As such, project impacts for these are weighted equally.

Savannah District combined and grouped the 52 performance metrics into six USACE business lines (similar to Congressionally Authorized Project Purposes): Hydropower, Recreation, Environmental, Water Supply, Navigation, and Flood Risk Management (Table 18).

3.5.1 Hydropower:

The evaluation of impacts to hydropower is based on the following metrics:

- Energy generation at Hartwell, Russell, and Thurmond.
- Pumping costs at Richard B. Russell.
- Cost of replacement power purchased by SEPA.
- Number of days Augusta would need to run diesel pumps to pull raw water due to implementation of FERC agreement.

3.5.1.1 Energy

All of the alternatives include Hydropower Energy objectives for the USACE projects. The Savannah River system generation target varies weekly. The table below (Table 18) describes that target.

Table 18: Southeastern Power Administration			
Weekly Minimum Energy Requirements (MWH)			
	Savannah River System	RBR Pump Units	Savannah Total
January	22,033	5,200	27,233
February	21,514	5,200	26,714
March	18,069	2,600	20,669
April	18,504	0	18,504
May	19,348	2,600	21,948
June	20,735	5,200	25,935
July	25,995	5,200	31,195
August	26,835	5,200	32,035
September	25,485	5,200	30,685
October	22,104	5,200	27,304
November	21,084	5,200	26,284
December	21,904	5,200	27,104

3.5.1.2 Capacity

The system also has Hydropower Capacity Generation objectives. Typically, each plant has to meet the ability to generate at full capacity for four hours per day five days per week. The PDT chose not to write specific capacity rules in HEC-ResSim. Rather the HEC-ResSim output for each alternative was evaluated to determine if each project was able to meet the capacity objectives.

Table 19 displays Augusta Canal hydropower generation and water requirements. The Augusta Canal Authority provided this information.

Table 19: Augusta Canal Hydropower Generation and Water Requirements									
Canal User	**Rated HP**	**100%**		**90%**	**80%**			**70%**	
		cfs	**kw**	**cfs**	**kw**	**cfs**	**kw**	**cfs**	**kw**
Waterworks		900	N/A	900	N/A	900	N/A	900	N/A
Sibley (3 units)	3832	1024	1900	920	1700	819.2	1520	716.8	1275
King (2 units)	3300	881	1950	790	1750	704.8	1560	616.7	1355
Enterprise (2 units)	1906	560	1000	500	890	448	800	392	675
Total	9038	3365	4850	3110	4340	2872	3880	2625.5	3305
Loss in kw production/hour	N/A	0	0	0	510	493	970	739.5	1545
Daily replacement cost/kw	N/A	N/A	0		$979	N/A	$1,862	N/A	$2,966

Table provided by Augusta Canal Authority

3.5.2 Recreation:

A series of metrics were developed to identify impacts to recreational interests on the projects. The availability of the USACE facilities were weighted based on a day use economic factor, and estimated annual visitation. The total recreational benefit was based on a combination of the following two features.

1. Impacts on boat usage was estimated based on availability of usable boat ramps.
    a. Elevation for each USACE boat ramp was collected
    b. Elevation for downstream boat ramps was collected
2. Impacts on beach usage was estimated based on availability of usable beaches in the 3 USACE projects. Typically, beach closures occur at six feet below summer full pool.

The HEC-ResSim model output the daily elevations. Using that information, the ability to access these facilities was counted on a daily basis. The difference between alternatives was then compared.

3.5.3 Environmental:

The performance measurements that were assigned to the environmental business line were subdivided into three ecoregions (lakes, river, and estuary/harbor) of the river basin (Table 20). Each of the performance measures were examined and each alternative was given a percentage change from the NAA (Appendix C). The Savannah District environmental team determined a ranking for each alternative for each ecoregion, including the NAA. These rankings were then averaged to provide a single overall environmental ranking for each alternative.

Table 20 Environmental Method to Evaluate Performance Measures		
Region	**Performance Measure**	**Method of evaluation**
Lake	Inability to maintain stable lake levels during lake spawning periods	Savannah District used outputs from the Reservoir Simulation Model that was run for each alterative, including the NAA to see how each alternative meet our target of maintaining stable lake levels.
River	Number of days when flows in the Augusta Shoals are less than recommended; (FERC Agreement)	During our modeling efforts for the various alternatives, Savannah Districtensured that there was adequate flow in the shoals as documented in the FERC Agreement
River	Effect on the DO in the River	Savannah District used data collected by GA DNR to determine DO concentrations for the various alternatives by averaging the results for the 6 locations modeled for both the 90% exceedance and the minimum dissolved oxygen calculations provided.
River	Effect on water temperature in the River	Savannah District used data collected by GA DNR to determine temperatures for the various alternatives by averaging the results for the 6 locations modeled for both the 10% exceedance and the minimum temperature calculations provided.
River	Number of days DO standards are not met in river	GA DNR provided the Savannah District environmental team member a page summary of the output of the Savannah River model showing the number of days during the 15 year period of record (1999-2013) when DO concentrations are less that a daily average of 5 mg/l at various locations. Savannah District averaged the results from all of the locations from the various alternatives to determine the change from the no action alterative
River	Impacts to fish spawning/habitat in shoals	During our modeling efforts for the various alternatives, Savannah District ensured that there was adequate flow in the shoals as documented in the FERC Agreement to ensure no impacts to fish spawning or habitat for rare, threatened, or endangered species in the shoals
River	Number of days DO standards are not met in river (per node)	GA DNR provided the environmental team member a page summary of the output of the Savannah River model showing the number of days during the 15 year period of record (1999-2013) when DO concentrations are less that a daily average of 5 mg/l at various locations. The team then looked at each location for the various alternatives to determine the change from the no action alterative
River	Number of days less than the No Action Alterative 7Q10: 1. Shoals Node 2. Augusta Node 3. Millhaven Node 4. Clyo Node	GA DNR provided the group with the 7Q10 Flow information for the Savannah River which included data on four locations for the NAA along with the 6 other alternatives. To evaluate the alternatives to the NAA, the data per location was averaged for all locations.

Table 20 Environmental Method to Evaluate Performance Measures		
Region	**Performance Measure**	**Method of evaluation**
River	Effect on the downstream fish spawning downstream of the New Savannah Bluff Lock and Dam (find DO for the river and temperature for April and May--- Stripped bass spawning window)	GA DNR was able to provide the environmental team data for dissolved oxygen concentration and water temperature for the months of April and May for three reaches within the River. April 1 to May 31 are critical for striped bass spawning so Savannah District wanted to see how the NAA compared with the 6 alternatives for this timeframe. The two factors that are very important to the success of spawning for striped bass are dissolved oxygen levels and water temperatures. The team averaged the DO and water temperature data for the months of April and May per location and then averaged the data for the 3 locations together to compare the alternatives to the NAA to get the percentage change. Savannah District then added the percent change for DO and water temperature together to get the overall value for this metric.
Estuary/Harbor	Effect on the DO in the Harbor	SC DNR provided average annual dissolved oxygen levels within the water column for the harbor for the 8 various zones. In order to calculate the difference between the various alternatives and the NAA, Savannah District averaged the annual dissolved oxygen values within the water column per zone for each alternative, to then see how it compared to the NAA
Estuary/Harbor	Effect on temperature in the Harbor	SC DNR provided average annual temperatures for the harbor for the 8 various zones. In order to calculate the difference between the various alternatives and the NAA, Savannah District averaged the annual temperature values per zone for each alternative, to then see how it compared to the NAA
Estuary/Harbor	Effect on salinity in the Harbor	SC DNR provided average annual salinity for the harbor for the 8 various zones. In order to calculate the difference between the various alternatives and the NAA, averaged the annual salinity values per zone for each alternative, to then see how it compared to the NAA
Estuary/Harbor	Effect on the downstream fish spawning in the Harbor	In order to calculate effect of alternatives on fish spawning in the harbor, Savannah District used the results from following parameters from the EFM model: estuary pulse (spring seasonal), estuary pulse (February), and estuary pulse (May). Savannah District added each of these parameter results together, to then compare to the 6 alternatives to the no action alterative to get the percent difference.

Table 20 Environmental Method to Evaluate Performance Measures		
Region	**Performance Measure**	**Method of evaluation**
Estuary/Harbor	Effect on the downstream fish populations in the Harbor	Savannah District decided to use the values for DO levels within the harbor to evaluate the effects of the various alternatives on downstream fish populations in the harbor as that is one of the most critical factors of their survival
Estuary/Harbor	Salinity levels in river near Savannah National Wildlife Refuge freshwater intakes find the node that is closest for this information	Savannah District used the sampling location closest to the Savannah River Wildlife Refuge from data collected from SC DNR to compare alternatives for this parameter which was LBR-02 using both the average annual salinity as well as the 90 percentile annual salinity
Estuary/Harbor	Number of days DO standards are not met in estuary	SC DNR provided information on the number of days daily dissolved oxygen levels were below the 5 mg/l standard by an overall average to compare the NAA with the 6 other alternatives.
Estuary/Harbor	Number of days DO standards are not met in estuary (per zone) (5mg/l)	SC DNR provided information on the number of days daily dissolved oxygen levels were below the 5 mg/l standard by zone to then be able to compare each alterative with the NAA.
Estuary/Harbor	Number of days DO standards are not met in estuary (per zone) (5mg/l) during 3 summer months (May, June, July, August)	SC DNR provided information on the number of days daily dissolved oxygen levels were below the 5 mg/l standard by zone to then be able to compare each alterative with the NAA. The team then filter that information to just focus on the critical summer months to see how the various alternatives compared with the NAA.

3.5.4 Water Supply:

The States of Georgia and South Carolina conducted population and water use projections. Based on these projections, inputs into HEC-ResSim reflect the projected water supply use at 2050. Both seasonally varying withdrawals and returns were modeled in HEC-ResSim. Typically water supply intakes are placed at levels that would not be impacted even at the lowest ranges of the conservation pool.
A 3,600 cfs minimum flow requirement was placed on Waynesboro to ensure that the downstream water supply intakes were always met. In-Lake water supply metrics were examined to compare how often pool elevations had dropped to levels that impact water supply intakes. Downstream water supply metrics were examined to compare how often river elevations had dropped to levels that impact downstream water supply intakes.

3.5.5 Navigation:

The Savannah River Below Augusta remains a Congressionally authorized navigation project. However, due to the lack of commercial use, it has fallen into an inactive status and is no longer maintained. Any navigation is now considered incidental to flood management. The flow window for navigation occurs when flow from Thurmond is

between 10,000 cfs and 20,000 cfs. The number of days between 10,000 cfs and 20,000 cfs was used as an indicator of how often navigation was available.

3.5.6 Flood Risk Management:

The USACE reservoirs have specific flood management rules for each project. These rules can be broken into two categories. The first set of rules are focused on managing releases to preserve the integrity of the dam. The second set of rules focuses on minimizing downstream damages. The impact of these rules are not obvious during drought periods; however, they become evident during wet periods. The same flood management rules are present in all of the alternatives. The different alternatives impact the timing and magnitude of releases from the projects. The conservation of water in the reservoirs can lead to increased flood impacts. The metric chosen to compare the action alternatives to the NAA was the percentage change in average flow for number of days above channel capacity (30,000 cfs) in Augusta. Raw data, please see the engineering appendix B. Since the Interim Study 2 examined various scenarios for operating during droughts, estimated flood damages that would occur when the reservoirs are full were not computed or used as a basis of comparison for the alternatives.

4.0 Evaluation of Alternatives and Environmental Impacts*

4.1 Hydrology and Floodplains

Future Conditions with No Action Alternative:

Selection of the NAA would not have impacts on the hydrology and floodplains within the project area.

Future Conditions with Alternative 1:

With implementation of Alternative 1, there would be lower flows down the river, and therefore the natural oxbows and manmade cutoffs would be more disconnected hydraulically than under the NAA. Because many of these areas are already hydraulically disconnected under NAA conditions, the impacts associated with Alternative 1 are expected to be minor.

Future Conditions with Alternatives 2 through 6:

Savannah District does not anticipate any significant impacts to the hydrology and floodplains within the Savannah River Basin from the various alternatives, as the alternatives do not change where the water goes, just the timing and quantities of the water flowing within the project area during droughts. Other that Alternative 4, these alternatives would not increase timing, duration, or height of flooding. It is expected that water flows associated with these alternatives may reconnect some of the natural oxbows and manmade cutoffs within the project area.

4.2 Aquatic Resources and Aquatic Habitat

Drought conditions are not inherently poor for all aquatic resources. Droughts are a natural part of the ecological cycle. The alternatives are not intended to eliminate all impacts associated with drought, but the analysis identifies and compares the impacts expected from each alternatives. Five metrics focused on aquatic resources and aquatic habitat:

1. Maintain stable lake levels during spawning season:
    - The team used outputs from the Reservoir Simulation (ResSim) Model to identify how each alternative would meet the target of maintaining stable lake levels during spawning season. The results showed a positive percentage. To determine the percentage of time that the lakes were unable to maintain stable levels during spawning season, the value presented was subtracted from 100. Each of those results were compared to the NAA.

2. Impact to fish spawning in the shoals:
    - During the modeling efforts for the various alternatives, the team ensured that there would be adequate flow in the shoals as described in the 2014 FERC Agreement to ensure that there were no impacts to fish spawning activities at the site.

3. Effect on downstream fish populations in the harbor:
    - The team used DO levels within the harbor to evaluate the effects on downstream fish populations since DO is one of the most critical factors of their survival.

4. Effect on downstream fish spawning in the harbor:
    - To calculate the effect on fish spawning in the harbor, the team used the results from the following parameters from the EFM model: estuary pulse (spring seasonal), estuary pulse (February), and estuary pulse (May) and, added each of these parameter results together. The team then compared to the six alternatives to the no action alterative to get the percent difference.

5. Effect on fish spawning downstream of the New Savannah Bluff Lock and Dam:
    - The team used results for DO levels and water temperatures for the months of April and May for three reaches within the river portion of the Savannah River Basin: Augusta node, Millhaven node, and Clyo node. They averaged the DO and water temperature data for the months of April and May for the period of record (1999 to 2013) per location, and combined the data for the 3 locations. They then compared the alternatives to the NAA to get the percentage change. The team added the percent change for DO and water temperature together to get the overall value for this metric.

The project team worked to develop evaluation metrics focused on those aquatic resources that could most likely impacted by the various alternatives including fish spawning habitat and overall fish habitat within the Savannah River Basin. The slight changes in water flow from the various alternatives should not change water levels within the lakes to have impacts to the aquatic vegetation presently located in the lakes and would not increase the spread of invasive aquatic vegetation species such as hydrilla. See Figure 13.

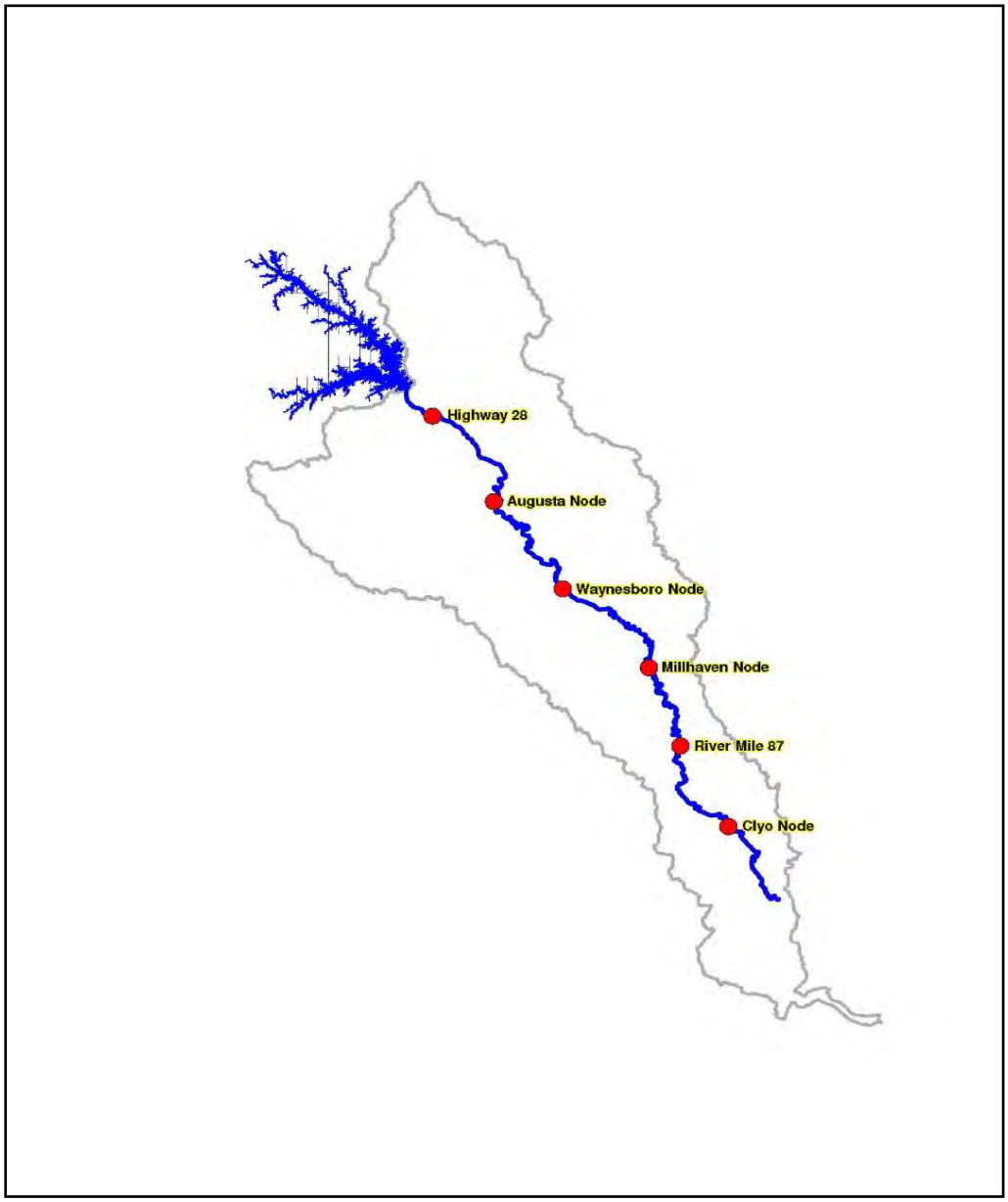


Figure 13: Map of GADNR's Water Quality Sampling Locations within the Savannah River.

Future Conditions with No Action Alternative:

Selection of the NAA would not have a change in impacts on the aquatic resources and aquatic habitat above those that were approved from development of the present DCP.

Future Conditions with Alternative 1:

With implementation of Alternative 1, there would be no impacts to fish spawning and fish habitat within the Augusta Shoals, as adequate water flow as prescribed by the draft 2014 FERC Agreement. Alternative 1 would also provide a slight benefit when compared to the NAA with regard to effects on the fish spawning downstream of the New Savannah Bluff Lock and Dam and in the harbor. With Alternative 1, DO levels would decrease slightly in the harbor thereby slightly impact the fish populations in this portion of the Savannah River Basin by minimizing the amount of DO that would available for fish populations. With implementation of Alterative 1, the ability to maintain stable lake levels during the spawning season would be challenging. As shown in Appendix C, under the environmental section, four of the five lakes evaluated (Russell, Thurmond, Jocassee, and Hartwell) showed that they would be less likely to maintain stable lake levels when compared to the NAA. Lake Keowee remained consistent with the NAA. Alternative 1 should not have adverse impacts on aquatic resources and aquatic habitat within the shoals or within the river. This alternative would have impact to aquatic resources that are in existing cutoff bends. These area would have less flow and have the potential to dry up first. Within the harbor, because DO levels only decrease by 0.11 percent from the NAA, the overall impacts to aquatic species within the harbor should be minimal and insignificant. During drought conditions, there may be some difficulty maintaining stable lake levels during the spawning season. This could cause some minor impacts to those aquatic species that spawn in the following lakes: Russell, Thurmond, Jocassee, and Hartwell. The data analyzed in the environmental section of Appendix C for Alterative 1 indicated that with slight decrease in habitat within the lakes with the ability to maintain stable lake levels during spawning season, but would not have any negative impacts to fish spawning and fish populations within the shoals or the river portion of the Savannah River Bain. The slight decrease in DO levels in the harbor is minimal when compared to the NAA and therefore the impacts from Alterative 1 to fish spawning and fish populations in the harbor is anticipated to minimal.

Future Conditions with Alternative 2:

With implementation of Alternative 2, there would be no impacts to fish spawning and fish habitat within the Augusta Shoals, as adequate water flow as prescribed by the draft 2014 FERC Agreement. Alternative 2 would also provide a slight benefit to fish spawning downstream of the New Savannah Bluff Lock and Dam, fish spawning in the harbor, and fish population in the harbor by increasing DO levels in those areas within the Savannah River Basin as shown in the environmental section of Appendix C. With implementation of Alternative 2, the ability to maintain stable lake levels during spawning season would be challenging. Two of the five lakes evaluated (Russell and Jocassee) showed that they would be more likely to maintain stable lake levels when compared to the NAA. The remaining three lakes (Thurmond, Keowee, and Hartwell) would remain consistent with the NAA. Based on the data analyzed in the

environmental section of Appendix C, Alternative 2 is not anticipated to have adverse impacts on aquatic resources and aquatic habitat within the shoals, the river, and harbor when compared to the NAA by improving overall DO levels in those areas of the Savannah River Basin. Within the lakes, Alternative 2 would remain consistent with or outperformed the NAA in regards to maintaining stable lake levels during spawning season. Therefore, the species that use those lakes should not be adversely impacted and should actually see an improvement in conditions in the Russell and Jocassee lakes.

Future Conditions with Alternative 3:

With implementation of Alternative 3, there would be no impacts to fish spawning and fish habitat within the Augusta Shoals, as adequate water flow as prescribed by the draft 2014 FERC Agreement. Alternative 3 would provide a slight benefit to fish spawning downstream of the New Savannah Bluff Lock and Dam and fish spawning in the harbor by increasing DO levels in those areas within the Savannah River Basin shown under the environmental section of Appendix C. With implementation of Alternative 3, the ability to maintain stable lake levels during the spawning season would be a challenge. The evaluation showed that four of the five lakes (Russell, Thurmond, Keowee, and Jocassee) would be less likely to maintain stable lake levels. Hartwell Lake remained consistent with the NAA.

Overall, Alternative 3 would not have adverse impacts on aquatic resources and aquatic habitat within the shoals or within the river and harbor by providing higher DO levels than the NAA in those portions of the Savannah River Basin. During drought conditions, there may be some difficulty maintaining stable lake levels during the spawning season which could cause some minor impacts to those aquatic species that would spawn in lakes Russell, Thurmond, Keowee, and Jocassee.

Future Conditions with Alternative 4:

With implementation of Alternative 4, there would be no impacts to fish spawning and fish habitat within the Augusta Shoals, as adequate water flow as prescribed by the draft 2014 FERC Agreement. Alternative 4 would provide a slight benefit to fish spawning downstream of the New Savannah Bluff Lock and Dam and fish spawning in the harbor by providing higher DO levels in those areas. With implementation of Alternative 4, the ability to maintain stable lake levels during spawning season is varied. Two of the five lakes evaluated (Russell and Jocassee) showed that they would be more likely to maintain stable lake levels when compared to the NAA. Keowee and Hartwell lakes remained consistent with the NAA, while Thurmond Lake showed it would be less likely to maintain stable lake levels during spawning season.

Overall, based on the data analyzed in the environmental section of Appendix C, Alternative 4 would not have adverse impacts on aquatic resources and aquatic habitat within the shoals, the river and harbor by providing higher DO levels than the NAA in those portions of the Savannah River Basin. Within the lakes, there could be minor impacts to those aquatic species that would use Thurmond to spawn, but aquatic species would see an improvement in conditions within the Russell and Jocassee lakes.

Future Conditions with Alternative 5:

With implementation of Alternative 5, there would be no impacts to fish spawning and fish habitat within the Augusta Shoals, as adequate water flow as prescribed by the draft 2014 FERC Agreement. Alternative 5 would provide a slight benefit to fish spawning downstream of the New Savannah Bluff Lock and Dam and fish spawning in the harbor by increased DO levels in those areas. With implementation of Alternative 5, the ability to maintain stable lake levels during spawning season is varied. Two of the five lakes evaluated (Russell and Jocassee) showed that they would be more likely to maintain stable lake levels. Keowee and Hartwell lakes remained consistent with the NAA, while Thurmond Lake showed it would be less likely to maintain stable lake levels during spawning season when compared to the NAA.

Overall, based on the data analyzed in the environmental section of Appendix C, Alternative 5 should not have adverse impacts on aquatic resources and aquatic habitat within the shoals, the river, and harbor by providing higher DO levels when compared to the NAA in those portions of the Savannah River Basin. Within the lakes, there could be minor impacts to those aquatic species that would use Thurmond lake to spawn, but aquatic species would see an improvement in conditions within the Russell and Jocassee Lakes.

Future Conditions with Alternative 6:

With implementation of Alternative 6, there would be no impacts to fish spawning and fish habitat within the Augusta Shoals, as adequate water flow as prescribed by the draft 2014 FERC Agreement. Alternative 6 would provide a slight benefit to fish spawning downstream of the New Savannah Bluff Lock and Dam and fish spawning in the harbor by increasing DO levels in those areas. With implementation of Alternative 6, the ability to maintain stable lake levels during spawning season would be a challenge. Four of the five lakes evaluated (Thurmond, Keowee, Jocassee, and Hartwell) showed that they would be less likely to maintain stable lake levels. Russell Lake showed an improvement in the ability to maintain stable lake levels when compared to the NAA.

Overall, based on the data analyzed in the environmental section of Appendix C, Alternative 6 should not have adverse impacts on aquatic resources and aquatic habitat within the shoals, the river, and harbor by providing higher DO levels when compared to the NAA in those portions of the Savannah River Basin. During drought conditions, there may be some difficulty maintaining stable lake levels during spawning season which could cause some minor impacts to those aquatic species that would use the Thurmond, Keowee, Jocassee and Hartwell lakes to spawn, but aquatic species would see an improvement in conditions at Russell.

4.3 Essential Fish Habitat

Future Conditions with No Action Alternative:

Selection of the NAA would have no effects on Essential Fish Habitat.

Future Conditions with Project Alternatives 1 through 6:

All six alternatives being evaluated have the potential to alter Essential Fish Habitat in the estuary in the lower Savannah River Basin area. Although the reduced flow volume would change velocities, the extent of those changes would be too small to be measurable. The changes in salinity within the harbor from the alternatives being evaluated are minor and would not change or alter the EFH habitat. As the EFH habitat extends up river only as far as the tide goes the majority of the river and lake portions of the Savannah River Basin would not impact EFH habitat. As a result, Savannah District has determined that these temporary changes to Essential Fish Habitats in the harbor portion of the Savannah River Basin project area are minor and do not warrant mitigation.

4.4 Wetlands

Future Conditions with No Action Alternative:

The NAA (which uses the existing DCP) would have no effects on existing wetlands and stream crossings within the project area.

Future Conditions with Alternative 1

This alternative could impact existing cutoff bends and wetlands in and adjacent to these bends. These areas could have less flow and have the potential to dry up first. This will be a minor change compared to NAA since many of these areas are cut off from the river even during non-drought conditions. With implementation of Alternative 1, wetlands have the potential to dry up which could have minimal indirect negative impacts on the wildlife that would use these areas.

Future Conditions with Project Alternatives 2 through 6:

All five alternatives being evaluated would have negligible effects on wetland and stream crossings in the project area due to the benign nature of the action. The alternatives being evaluated do not change where the water goes, but only adjusts the timing and quantities of the water flowing within the Savannah River Basin project area during drought conditions when water levels in the lakes and river are already low. Wetlands in and adjacent to the cutoff bends would be impacted similarly to the NAA since the flows into these areas would be similar or slightly higher. The slight changes in salinity are minor and would not alter the existing composition of the wetlands in river and harbor portions of the project area or change what could or could not inhabit the area. The water flows associated with these alternatives may increase natural wetting of some of the natural oxbows and manmade cutoffs.

4.5 Terrestrial Resources and Wildlife

Future Conditions with No Action Alternative:

The NAA (which uses the existing DCP) would have no effects on existing terrestrial and wildlife resources within the project area.

Future Conditions with Project Alternative 1:

This alternative could impact existing cutoff bends and wetlands in and adjacent to these bends. These area could have less flow and have the potential to dry up first. This will be a minor change compared to NAA since many of these areas are cut off from the river even during non-drought conditions. With implementation of Alternative 1, wetlands have the potential to dry up which could have minimal indirect negative impacts on the terrestrial resources and wildlife that use these areas.

Future Conditions with Project Alternatives 2 through 6:

All six alternatives being evaluated would have negligible effects on terrestrial and wildlife resources in the project area due to the benign nature of the action of adjusting the timing and quantities of water flow within the Savannah River Basin. Water flows associated with these alternatives have the potential to add minimal water to the wetlands which could have a minimal indirect positive impact on the terrestrial resources and wildlife that use those areas.

4.6 Threatened, Endangered and Protected Species

Future Conditions with No Action Alternative:

The NAA (which uses the existing DCP) would have no effects on threatened and endangered species.

Future Conditions with Project Alternatives 1 through 6:

The State-listed robust redhorse, shoals spider lily, Altamaha arc mussel, Savannah lilliput (mussel) and the federally-listed Atlantic sturgeon and shortnose sturgeon are the main endangered species that may be affected by small changes in flow. At a scientific workshop held in April 2013, it was concluded that higher flows throughout the year would provide a healthier freshwater marsh plant community and allow more fish habitat.

Each of the six alternatives was formulated to provide the recommended flows as identified in the draft 2014 FERC Agreement (1,500 cfs minimum for Augusta Shoals) which provides important spawning habitat for the federally-listed mussels, robust redhorse, and shoals spider lily, as well as provide spawning habitat for shortnose and Atlantic sturgeon. These flows will ensure that the proper amount of flows and water will be available for the listed species above to avoid any negative impacts during drought conditions. Anadromous species are unlikely to be within the shoals or upper

river areas during the time of the proposed flow reduction. Therefore, no adverse effects are anticipated to these species. Staging and foraging areas for these species may see slight alterations in salinities, but the data under the environmental section of Appendix C indicates those effects would be minimal, so these highly mobile species should easily adapt to these fluctuations.

Therefore, the minimal changes of water flows from the six alternatives being evaluated "may affect, but is not likely to adverse effect" these state and Federal listed species. More details may be found in the Environmental Appendix C.

4.7 Air Quality

Future Conditions with No Action Alternative:

The NAA would have no effects on air quality.

Future Conditions with Project Alternative 2:

With implementation of Alternative 2, hydropower operations would slightly increase when compared to the NAA. Therefore, there would not need to be as much power generation from alternative power sources, such as coal or natural gas, which release more greenhouse gasses into the atmosphere.

Future Conditions with Project Alternatives 1, 3, 4, 5, and 6:

With implementation of these alternatives, hydropower operations would slightly decrease. As a result, an alternative power source from either a coal or natural gas plant would be needed make up the deficit to keep up with high energy demands during peak production time. Those operations would release more greenhouse gasses into the atmosphere.

With regards to climate change, the USACE screening level climate change vulnerability assessment (VA) tool was used to assess the potential impacts and likelihood of climate change impacts to this region. The results indicated the Savannah River Basin is not in an area of vulnerability and did not show much change over time. It is anticipated therefore that the alternatives been evaluated will not have any significant impacts with regards to climate change. For more information on the climate change analysis completed for the study see Annex F of the Engineering Appendix.

4.8 Water Quality

Future Conditions with No Action Alternative:

There would be no anticipated change to water quality with the NAA.

Future Conditions with Project Alternative 1:

With implementation of Alternative 1, various water quality components such as temperature, DO, and salinity would be altered. Using annual data collected during the period of 1999-2013, water quality data was averaged to get the percent change from the NAA conditions. Appendix C contains more information on how data was used to determine percent changes from the NAA conditions for the various water quality metrics. Modeling results indicate that Alternative 1 would increase the average annual salinities in the harbor by 3.44 percent and would increase average annual salinities in the river near the Savannah River Wildlife Refuge by 33 percent. When compared to the No Action Alternative, modeling indicates that Alternative 1 would decrease DO levels in the river and harbor. DO levels in the river were calculated using both the 90 percent exceedance value and the minimum DO value. Alternative 1 would decrease the overall 90 percent exceedance DO levels by 0.024 percent and would decrease the overall minimum DO concentration levels by 0.58 percent. DO levels within the harbor would decrease by 0.11 percent. When GADNR looked at the data from a daily perspective during the critical months, the percent time the DO in the harbor would be less than a daily average of 5.0 mg/L would increase by 0.8%. In addition, Alternative 1 reduces the allowable deficit of 0.1 mg/L by 50% or greater over 36.8% of the time. Water temperature in the river and in the harbor showed minimal changes with Alternative 1, changing less than one percent from the NAA values. Alternative 1 has the least number of days where the DO levels would be below the 5 mg/l threshold in the river portion of the Savannah River Basin when compared to the NAA. Overall, water quality would decrease as result of Alterative 1.

Future Conditions with Project Alternative 2:

With implementation of Alternative 2, various water quality components such as temperature, DO, and salinity, would be altered. Using annual data collected during the period 1999-2013, water quality data was averaged to get the percent change from the NAA conditions. Appendix C contains more information on how data was used to determine percent changes from the NAA conditions for the various water quality metrics. Modeling results indicate that Alternative 2 would increase the average annual salinities in the harbor by 3.56 percent and would decrease the average annual salinities in the River near the Savannah River Wildlife Refuge by 33 percent. When compared to the NAA, Alternative 2 would not change DO levels in the river but would increase DO levels in the harbor by 1.27 percent. When looking at the data from a daily perspective during the critical months, the percent time the DO in the harbor would be less than a daily average of 5.0 mg/L would decrease 1.1%. However, the daily analysis shows the allowable deficit of 0.1 mg/L would be decreased by 50% or greater ~6.75% of the time. Water temperatures in the river and in the harbor show slight changes with Alternative 2, changing less than one percent from the NAA values. Overall, water quality would improve as a result Alterative 2.

Future Conditions with Project Alternative 3:

With implementation of Alternative 3, various water quality components such as temperature, DO, and salinity, would be altered. Using annual data collected during the period 1999-2013, water quality data was averaged to get the percent change from the NAA conditions. Appendix C contains more information on how data was used to determine percent changes from the NAA conditions for the various water quality metrics. Modeling results indicate that Alternative 3 would increase the average annual salinities in the harbor by 0.74 percent and would increase average annual salinities in the river near the Savannah River Wildlife Refuge by 33 percent. When compared to the NAA, Alternative 3 would decrease DO levels in the river and harbor. DO levels in the river were calculated using both the 90 percent exceedance value and the minimum DO value. Alternative 3 would decrease the overall 90 percent exceedance DO levels by 0.97 percent while remaining unchanged from the NAA with regards to the overall minimum DO concentration levels. DO levels within the harbor would increase by 0.99 percent. When looking at the data from a daily perspective during the critical months of the period of record, the percentage of time the DO in the harbor would be less than a daily average of 5.0 mg/L would decrease 0.4%. However, the daily analysis shows the allowable deficit of 0.1 mg/L would be decreased by 50% or greater ~29.3% of the time. Water temperatures in the river and in the harbor show slight changes with Alternative 3, changing less than one percent from the NAA values. Overall water quality would decrease as a result of Alterative 3.

Future Conditions with Project Alternative 4:

With implementation of Alternative 4, various water quality components such as temperature, DO, and salinity, would be altered. Using annual data collected during the period 1999-2013, water quality data was averaged to get the percent change from the NAA conditions. Appendix C contains more information on how data was used to determine percent changes from the NAA conditions for the various water quality metrics. Modeling results indicate that Alternative 4 would increase the average annual salinities in the harbor by 0.49 percent and would increase average annual salinities in the river near the Savannah River Wildlife Refuge by 33 percent. When compared to the NAA, modeling results indicated that Alternative 4 would both increase and decrease DO levels in the river and increase DO levels in harbor. DO levels in the river were calculated using both the 90 percent exceedance value and the minimum DO value. Alternative 4 would increase the overall 90 percent exceedance DO levels by 0.24 percent and would decrease the overall minimum DO concentration levels by 0.29 percent. DO levels within the harbor would increase by 1.05 percent. When looking at the data from a daily perspective during the critical months, the percentage of time the DO in the harbor would be less than a daily average of 5.0 mg/L would decrease 0.8%. However, the daily analysis shows the allowable deficit of 0.1 mg/L would be decreased by 50% or greater ~6.35% of the time. Water temperatures in the river and in the harbor show slight changes with Alternative 4, changing less than one percent from the NAA values. Overall, water quality would decrease as a result of Alterative 4.

Future Conditions with Project Alternative 5:

With implementation of this alternative, various water quality components such as temperature, DO, and salinity, would be altered. Using annual data collected during the period 1999-2013, water quality data was averaged to get the percent change from the NAA conditions. Appendix C contains more information on how data was used to determine percent changes from the NAA conditions for the various water quality metrics. Modeling results indicate that Alternative 5 would decrease the average annual salinities in the harbor by 1.70 percent, but would not change the average annual salinities in the river near the Savannah River Wildlife Refuge. When compared to the NAA, modeling results indicated that Alternative 5 would either stay consistent or increase DO levels in the river and increase DO levels in harbor. DO levels in the river were calculated using both the 90 percent exceedance value and the minimum DO value. Alternative 5 would stay consistent with the NAA when looking at the model results for the 90 percent exceedance DO levels, but would increase the overall minimum DO concentration levels by 1.46 percent. DO levels within the harbor would increase by 1.65 percent. When looking at the data from a daily perspective during the critical months, the percentage of time the DO in the harbor would be less than a daily average of 5.0 mg/L would decrease 1.8%. However, the daily analysis shows the allowable deficit of 0.1 mg/L would be decreased by 50% or greater ~10.8% of the time. Water temperatures in the river and in the harbor show slight changes with Alternative 5, changing less than one percent from the NAA values. Overall, water quality would slightly improve water quality as a result of Alterative 5.

Future Conditions with Project Alternative 6:

With implementation of Alternative 6, various water quality components such as temperature, DO, and salinity would be altered. Using annual data collected during the period 1999-2013, water quality data was averaged to get the percent change from the NAA conditions. Appendix C contains more information on how data was used to determine percent changes from the NAA conditions for the various water quality metrics. Modeling results indicate that Alternative 6 would decrease the average annual salinities in the harbor by 62.62 percent, but would not change the average annual salinities in the river near the Savannah River Wildlife Refuge. When compared to the NAA, modeling results indicated that Alternative 6 would increase DO levels in the river and increase DO levels in harbor. DO levels in the river were calculated using both the 90 percent exceedance value and the minimum DO value. Alternative 6 would increase the overall 90 percent exceedance DO levels by 0.49 percent and would increase the overall minimum DO concentration levels by 2.04 percent. DO levels within the harbor would increase by 2.30 percent. When looking at the data from a daily perspective during the critical months, the percentage of time the DO in the harbor would be less than a daily average of 5.0 mg/L would decrease 2.7%. However, the daily analysis shows the allowable deficit of 0.1 mg/L would be decreased by 50% or greater ~12.6% of the time. Water temperatures in the river and in the harbor show slight changes with Alternative 6, changing less than one percent from the NAA values. This alterative has the least number of days where the DO levels will be below the 5 mg/l threshold in the

estuary/harbor portion of the Savannah River Basin when compared to the NAA. Overall, water quality would slightly improve water quality as a result of Alterative 6.

4.9 Cultural Resources

Future Conditions with No Action Alternative:

Potential adverse effects to cultural resources caused by exposure when drought trigger levels are reached will continue under the NAA. Archaeological sites will continue to be subjected to drying episodes that can damage artifacts and features. Increased potential also exists for vandalism and looting because sites are more accessible to the public. There are multiple factors or unknowns, however that once known, may alter this statement. The effect these fluctuations have already had on cultural resources within the project area and if further fluctuations of the water will further impact resources are not known. No studies have been conducted to date that document the current site conditions, i.e., the degree of erosion, disturbance, and site integrity when initially recorded.

Resources on USACE-Managed Lands: Comprehensive archaeological surveys were not conducted within the flood pools of the lake projects prior to inundation. As stated in Section 2.11, surveys of the areas that would be inundated were conducted at JST Lake and Hartwell Lake, however fieldwork consisted primarily of visits to reported or previously recorded sites, rather than large-scale intensive surveys. Excavations were carried out at select sites within the flood pool. Surveys have been conducted of the upland areas at JST Lake and of the upland areas of Hartwell Lake, but no archaeological surveys have been conducted of the fluctuation zones since inundation. Extensive archaeological investigations were conducted at RBR project from the late 1970s to 1980s in areas that would be impacted by flooding, construction, and relocation of roads and pipelines. More recent investigations at all three multi-purpose projects have been confined to small surveys to comply with specific Section 106 site investigations. Two larger-scale Section 110 surveys have been conducted at RBR since 2010. All recent investigations were confined to the upland areas.

The current study focuses on water management operations at Hartwell and JST Lakes. RBR Lake does not have drought trigger levels like Hartwell and JST Lakes. Water levels at RBR Lake are controlled by releases from Hartwell Lake and Thurmond Lake. Because of hydropower operations at the RBR project, the conservation pool was designed to accommodate only a 5 foot fluctuation. Therefore, cultural resources at Richard B. Russell are not subjected to the same degree of fluctuations in water levels during drought conditions as experienced at Hartwell and JST Lakes. New Savannah Bluff Lock and Dam was authorized for navigation and recreation purposes and not flood control. The dam provides partial, but relatively insignificant, reregulation of daily average releases from J. Strom Thurmond multipurpose project. Although reregulation at the NSBLD smooths out some releases that pass downriver from the Thurmond Dam, it does not augment low river flows, does not serve water supply users downstream or store water for downstream flood risk management.

While intensive surveys have not been conducted of the submerged zones of JST Lake or Hartwell Lake, sites are known to exist within these areas. Elliott (1995) identifies 11 site locations at JST that, at the time of the 1940s River Basin Survey (RBS), were listed as partially submerged. Many of these sites were surface finds and considered to have limited, if any, intact buried deposits. Additionally, nearly 100 sites located during the RBS were considered to be flooded by the project. A two-mile shoreline and underwater survey conducted at JST Lake in the early 1990s identified 32 previously unrecorded shoreline sites and one known submerged site. To date, no attempts have been made to determine to what degree any of these sites are exposed during episodes of fluctuating water levels.

Recorded submerged sites at Hartwell Lake include two Native American villages, each with a mound, that were tested in the 1950s, as well as a previously unrecorded mill site. All three sites were exposed during the drought in 2007-2009 and were adversely affected by changes in pool elevation. These adverse effects include erosion and the destruction of artifacts resulting from the continually wetting and drying of the sites. Evidence of looting was also noted at one of the mound sites.

The number of other potentially significant prehistoric and historic resources that are located within the fluctuation zone and are adversely affected by changing pool elevations is unknown. The effect of fluctuations in water surface elevations upon these resources located at JST and Hartwell Lakes as the pools decline is not precisely known. A study conducted by the USACE Waterways Experiment Station of historic properties in drawdown zones of Corps of Engineers reservoirs discussed two types of impacts that may occur to sites within drawdown zones. Generally historic properties sustain impacts from the geomorphic processes of erosion or deposition and/or human impacts such as looting and vandalizing (Dunn et al. 1996). While management of JST Lake and Hartwell Lake is based on a guide curve and rain level, not a drawdown cycle, similar effects to historic properties at JST Lake and Hartwell Lake would still be expected to occur.

In 2012 when the DCP was last updated, Savannah District drafted a Programmatic Agreement (PA) as specified under 36 CFR 800.14b(1)(ii) to develop a survey strategy to understand the effects of hydrologic changes on cultural resources at JST Lake and Hartwell Lake. The PA allows Savannah District to complete needed studies and postpone its determination of effects while those studies are taking place. Although the PA was developed during the Section 106 of the NHPA compliance for the DCP update in 2012, it is written to address impacts associated with all water level fluctuations. The PA contains a strategy for identifying shoreline and submerged archaeological sites and assessing the impacts that may be caused by hydrologic changes. Studies outlined in the PA will continue to be implemented as funding becomes available. Once the surveys and assessments are complete, the impacts to archaeological sites can be more accurately determined. To date, no investigations have been conducted to comply with the PA due to funding constraints. Undertakings and assessments of effects on cultural resources are determined on a project by project basis to comply with Section 106.

Resources Located Downstream of JST Off USACE–Managed Lands: Archaeological sites that are located on lands not managed by the USACE could potentially be affected as water levels and discharge rates change from JST. It is anticipated that archaeological sites would be affected similarly to those sites located on USACE-managed property. As stated previously, studies have shown that historic properties sustain impacts from erosion or deposition and/or human impacts such as looting due to fluctuating water levels and flow.

Future Conditions with Project Alternatives 1 through 6:

Section 106 consultation conducted in 2012 for the update of the DCP determined that fluctuating water levels would or could have the potential to adversely affect significant archaeological or historical resources and a Programmatic Agreement was developed to assess the degree of impacts. No additional adverse impacts would result to significant archaeological or historical resources due to changes in water depths and durations. At this time, it is not precisely known what effect fluctuating water levels have already had on cultural resources that exist within the project area and if operations as proposed under these alternatives will further impact resources. If such impacts associated with changes to the hydrologic pattern have already impacted resources in the project area, then current proposed changes would have no additional adverse effect on historic properties. Savannah District is implementing the 2012 PA (Appendix D) to understand the effects of fluctuating water levels on archaeological sites within the project area. Once the surveys and assessments have been completed, a more accurate determination of effect can be made.

4.10 Demographics and Economic Conditions

Future Conditions with No Action Alternative:

The NAA would have no effects on demographics and economic conditions in the project area. The Georgia Governor's Office of Planning and Budget projects the state's residential population to increase by 1.9 M between 2015 and 2050, a growth of 15.8 percent. South Carolina's Office of Revenue and Fiscal Affairs projects a population growth of 13.0 percent, or 628,500 people, during the same period.

Future Conditions with Project Alternatives 1 through 6:

Implementation of any of the six alternatives is not anticipated to have any direct or indirect impact in the short term or long term on demographics and economic conditions in the project area.

4.11 Noise

Future Conditions with No Action Alternative:

The NAA would not increase noise within the project area.

Future Conditions with Project Alternatives 1 through 6:

Implementation of any of the six alternatives is not anticipated to have any direct impacts to noise within the project study area as the plans being evaluated involve the timing and flow rate of the water being released within the Savannah River Basin watershed.

4.12 Recreation

Impacts to recreation is based on the following performance metrics:

- Boat ramp use and availability at Hartwell, Russell, and Thurmond Reservoirs.
- Boat ramp use and availability downstream of Thurmond.
- Beach closures due to insufficient lake elevation at Hartwell and Thurmond.

Boat-Launching Ramps

Tables 21 and 22 detail an examination of the number of days water surface elevations are at and below the usable elevation of the existing boat ramps at Hartwell and Thurmond (1 January 1999 to 26 December 2013). "Lane days" are the product of total number of lanes in each respective project and the number of days in this period. Lake level variations at RBR are limited to a 5 foot range. Therefore, all of the boat ramps are always usable.

Table 21: Hartwell Boat Ramp Average Annual Impact

	NAA	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6
Number lane days ramps unusable	4,609	3,304	4,321	5,170	3,972	5,445	11,437
Percent time ramps unusable	11.4%	8.2%	10.7%	12.8%	9.8%	13.5%	28.3%
Delta from NAA percent time ramps unusable*		*-3.2%*	*-0.7%*	1.4%	*-1.6%*	2.1%	16.9%
Delta from NAA number lane days ramps unusable**		*-1,305*	*-288*	561	*-637*	835	6,828
Percent Difference from NAA***		*-28.3%*	*-6.3%*	12.2%	*-13.8%*	18.1%	148.1%
Delta negative numbers are positive impacts. Delta positive numbers are negative impact							

* Calculated by subtracting 'percent time ramps unusable' under that alternative from that under the NAA
** Calculated by subtracting 'number lane days ramps unusable' under that alternative from that under the NAA
*** Calculated by dividing 'delta NAA number lane days ramps unusable' under that alternative by 'number lane days ramps unusable' under the NAA

Table 22: Thurmond Boat Ramp Average Annual Impact							
	NAA	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6
Number lane days ramps unusable	1,912	879	1,700	2,097	1,385	2,547	7,399
Percent time ramps unusable	5.3%	2.4%	4.7%	5.8%	3.8%	7.1%	20.5%
Delta from NAA percent time ramps unusable*		*-2.9%*	*-0.6%*	0.5%	*-1.5%*	1.8%	15.2%
Delta from NAA number lane days ramps unusable**		*-1,033*	*-211*	186	*-527*	635	5,488
Percent Difference From NAA***		*-54.0%*	*-11.1%*	9.7%	*-27.6%*	33.2%	287.1%
Delta negative numbers are positive impacts. Delta positive numbers are negative impacts.							

Lane days for boat ramps downstream of JST are presented in Table 23.

Table 23: Lower River Average Annual Lane Days Ramp is Unusable (Days Less than 4,000 MSL)							
	NAA	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6
Augusta	72	122	87	99	119	46	36
Waynesboro	56	108	73	88	106	39	29
Millhaven	4	43	2	18	4	2	1
Clyo	1	37	1	2	1	0	0
Total	133	311	162	207	229	87	66
Delta from NAA		178	29	74	97	-46	-67
Percent Difference NAA		134%	22%	56%	73%	**-35%**	**-50%**
Delta negative numbers are positive impacts. Delta positive numbers are negative impacts.							

Boat Ramp Valuation

This analysis was not performed for RBR because there was no change in use or the level of use from any of the proposed alternatives. The economic effect downstream of JST was not calculated due to a lack of existing recreational data for those ramps.

Recreation benefits for the boat ramp usage at Hartwell and Thurmond were converted to average annual FY 2017 dollar values using the Unit Day Value methodology set forth in Economic Guidance Memorandum (EGM) 17-03. The result of the analysis is a unit day value of $9.01. Annual visitation averages (Table 24) at Hartwell and Thurmond over the period of analysis were then multiplied by the unit day value calculated for the projects. This product represented the recreation value in a scenario where all visitors used all usable boat ramps. There are boat ramps that become

unusable in the NAA during droughts. By multiplying the percent of the period boat ramps are usable for each alternative, a final recreation benefit value for each was determined (Table 25).

The PDT analyzed data collected at each project over a fifteen year period (1/01/1999 to 12/26/2013) and determined it to be an appropriate basis for projecting likely future conditions recreation conditions through 2050. This assumes that the recreational carrying capacity of each location has been reasonably maximized in the existing condition and that no substantial increases in capacity are likely. Data from this period was converted into annual averages, brought forward through a thirty-four year period of analysis, and discounted at the FY 2017 rate in conformance with EGM 17-01.

Table 24: Project Visitation and User Day Value

	Annual Visitation	Daily Visitation	Unit Day Value
Hartwell	2,318,568	6,352	$ 9.01
Thurmond	1,950,967	5,345	$ 9.01

Table 25: AAE Recreation Benefits
(FY17 Dollars)

	NAA	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6
Hartwell	$233,964,948	$242,490,302	$235,847,107	$230,301,041	$238,125,693	$228,508,861	$189,368,216
Delta NAA		$8,525,354	$1,882,159	($3,663,907)	$4,160,745	($5,456,087)	($44,596,732)
Percent Difference NAA		*3.64%*	*0.80%*	*-1.57%*	*1.78%*	*-2.33%*	*-19.06%*
Thurmond	$210,422,652	$216,786,122	$211,725,119	$209,277,662	$213,667,747	$206,507,869	$176,609,361
Delta NAA		$6,363,470	$1,302,467	($1,144,990)	$3,245,095	($3,914,783)	($33,813,291)
Percent Difference NAA		3.02%	0.62%	-0.54%	1.54%	-1.86%	-16.07%
Total	$444,387,600	$459,276,423	$447,572,226	$439,578,703	$451,793,439	$435,016,730	$365,977,577
Delta NAA		$14,888,824	$3,184,626	($4,808,897)	$7,405,840	($9,370,870)	($78,410,023)
Percent Difference NAA		*3.35%*	*0.72%*	*-1.08%*	*1.67%*	*-2.11%*	*-17.64%*

Delta positive numbers are positive impacts. Delta negative numbers are negative impacts.

*34 Year Period of Analysis
**2.875 Percent Discount Rate

Swimming

Although swimming can occur outside USACE park facilities, the USACE encourages limiting swimming activities to only the designated USACE facilities. Non-USACE swimming areas in the project area are not incorporated into this analysis due to limitations of available visitation data.

Hartwell Lake

At and below lake level 654 feet msl, all designated swimming areas are completely dry. Designated swimming areas are useable with greater than 3 feet of water. Hence, a change in the number of swimming days available from what would occur when the lake level is at 657 (in the NAA) would constitute an impact on swimming (Table 26).

Table 26: Hartwell Average Annual Beach Impacts

	NAA	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6
Days Closed due to Elevation	103	48	94	113	72	117	194
Delta NAA		*-54.44*	*-9.12*	9.85	*-31.01*	14.51	91.38
Number of Beach (23) *Days Closed	2,367	1,114	2,157	2,593	1,653	2,700	4,468
Delta NAA		*-1,252*	*-210*	227	*-713*	334	2,102
Percent Difference NAA		*-52.91%*	*-8.86%*	9.57%	*-30.14%*	14.10%	88.81%

Delta negative numbers are positive impacts. Delta positive numbers are negative impacts.

RBR Lake

There are no Corps-operated designated swimming areas at RBR.

JST Lake

At JST Lake, there are 64 swimming beaches located in 13 recreation areas. At and below lake level 324 feet msl, the designated swimming beaches become completely dry. Designated swimming areas are useable with greater than 3 feet of water. Hence, only a change in the number of swimming days available above lake level 327 from the NAA would constitute an impact on swimming (Table 27).

Table 27: Thurmond Beach Impacts							
	NAA	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6
Days Closed due to Elevation	100	43	88	109	70	112	192
Delta NAA		*-57.10*	*-11.98*	8.92	*-30.08*	11.65	92.38
Beach*Days Forgone	6,398	2,743	5,631	6,968	4,472	7,143	12,310
Delta NAA		*-3,655*	*-767*	571	*-1,925*	745	5,912
Percent Difference NAA		*-57.12%*	*-11.98%*	8.92%	*-30.09%*	11.65%	92.41%
Delta negative numbers are positive impacts. Delta positive numbers are negative impacts.							

Total USACE Beach Impacts

There are 89 Corps-operated swimming beaches located on the two lakes. The impacts to these facilities is shown in Table 28.

Table 28: Total Average Annual Beach Impacts							
	NAA	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6
Days Closed due to Elevation	203	91	182	222	142	229	387
Delta NAA		*-112*	*-21*	19	*-61*	26	184
Number of Beach (87)*Days Closed	8,764	3,857	7,788	9,562	6,126	9,843	16,778
Delta NAA		*-4,907*	*-976*	797	*-2,639*	1,079	8,014
Percent Difference NAA		*-55.99%*	*-11.14%*	9.10%	*-30.11%*	12.31%	91.44%
Delta negative numbers are (fewer than NAA) positive impacts. Delta positive numbers are negative impacts.							

Future Conditions with No Action Alternative:

The NAA would have no effects on recreational use of boat launches, private docks, and swimming areas within the project area.

Future Conditions with Project Alternative 1:

The effects that Alternative 1 would have on recreation depend on the type of recreation (boating or swimming) and the location (above JST or below JST).

Hartwell: Alternative 1 produces 3.23 percent positive impacts to boat ramp availability over the NAA. It also produces the largest positive impact to Beach Days, decreasing the average annual number of beach closures by 1,252 Beach Days.

Thurmond: Alternative 2 produces 2.86 percent positive impacts to boat ramp availability over the NAA. It also produces the positive impact of decreasing the average annual number of beach closures by 3,655 Beach Days.

Lane Days Downstream Ramps Unusable: Alternative 1 produces the largest negative impacts by increasing the number of boat ramp closures downstream of JST by 133.8 percent.

Overall

Alternative 1 produces the largest positive impact. It decreases the total number of beach closures by an annual average of 4,907 Beach Days out of a total of 32,418 possible beach days. Alternative 1 produces the largest amount of net recreation benefits (based on boat ramp availability in the lakes). The $459,276 of average annual recreational benefits in Alternative 1 represents an increase of $14,889 (3.35 percent) from the NAA. Private dock owners in the lakes would have the use of their docks for longer time periods with this alternative than the NAA.

Alternative 1 results in a tradeoff of positive boat ramp and swimming area availability in the USACE projects with the loss of downstream boat ramp availability.

Future Conditions with Alternative 2:

The effects that Alternative 2 would have on recreation are similar in nature to those of Alternative 1.

Hartwell: Alterative 2 produces 0.71 percent positive impacts to boat ramp availability over the NAA. It also produces a minor positive impact, decreasing the total number of beach closures by 210 Beach Days.

Thurmond: Alterative 2 produces 0.59 percent positive impacts to boat ramp availability over the NAA and produces a comparatively minor positive impact, decreasing the total number of beach closures by 767 Beach Days.

Lane Days Downstream Ramps Unusable: Alternative 2 produces a small negative impact by increasing the number of boat ramp closures downstream of JST by 22.03 percent.

Overall

Alternative 2 produces a comparatively minor positive impact, decreasing the average annual number of beach closures by 976. Alternative 2 produces a 0.72 percent average annual increase ($3,185,000) of net recreation benefits based on boat ramp availability in the lakes. Private dock owners in the lakes would have the use of their docks for longer time frame with Alternative 2, but not as long as Alternative 1.

Alternative 2 results in a tradeoff of positive ramp availability, swimming areas and private docks in the lakes, with the loss of boat ramps in the river downstream of the lakes.

Future Conditions with Alternative 3:

All of the project area would be negatively affected by Alternative 3.

Hartwell: Alternative 3 would produce 1.39 percent negative impacts to boat ramp availability compared with the NAA. This alternative increased the total number of beach closures by 227 Beach Days.

Thurmond: Alternative 3 would produce 0.52 percent negative impacts to boat ramp availability compared with the NAA and increases the total number of beach closures by 571 Beach Days.

Lane Days Downstream Ramps Unusable: Alternative 3 would create a negative impact by increasing average annual boat ramp closures downstream of JST by 55.8 percent.

Overall

Alternative 3 would increase the number of average annual beach closures by 797 at the USACE projects in comparison to the NAA, a negative impact. Alternative 3 would result in a 1.08 percent decrease (-$4,809,000) in average annual net recreation benefits based solely on boat ramp availability in the lakes. Private dock owners in the lakes would have less use of their docks with Alternative 3 than in the NAA. Alternative 3 would create a negative impact by increasing average annual boat ramp closures downstream of JST by 55.78 percent.

Future Conditions with Project Alternative 4:

The effects that Alternative 4 would have on recreation within the project area are similar to those of Alternative 1.

Hartwell: Alterative 4 would produce 1.58 percent positive impacts to average annual boat ramp availability over the NAA. It would also produce a minor positive impact, decreasing the total number of beach closures by 713 Beach Days over the 1999-2013 period.

Thurmond: Alterative 4 would produce 1.46 percent positive impacts to boat ramp availability over the NAA and produces a comparatively minor positive impact, decreasing the total number of beach closures by 1,925 Beach Days.

Lane Days Downstream Ramps Unusable: Alternative 4 would create a negative impact by increasing the average annual boat ramp closures downstream of JST by 72.61 percent.

Overall

Alternative 4 would produce a positive impact, decreasing the average annual number of beach closures by 2,639 Beach Days out of a total of 32,418 possible beach days.

Alternative 4 would produce a 1.67 percent increase ($7,406,000) in average annual net recreation benefits based on boat ramp availability in the lakes. Private dock owners in the lakes would have the use of their docks for longer time frame with Alternative 4 than in the NAA, but not as long as with Alternative 1.

Alternative 4 results in a tradeoff of positive ramp availability, swimming areas and private docks in the lakes, with the loss of boat ramp days in the river downstream of the lakes.

Future Conditions with Project Alternative 5:

Alternative 5 would have negative effects on recreation upstream of JST and positive downstream of JST.

Hartwell: Alternative 5 would produce a 2.07 percent negative impacts to boat ramp availability over the NAA. It would also have a negative impact on swimming, increasing the total number of beach closures by 334 Beach Days.

Thurmond: Alternative 5 would produce a 1.76 percent negative impacts to boat ramp availability over the NAA. It would also produce a positive impact on swimming, decreasing the total number of beach closures by 1,925 Beach Days.

Lane Days Downstream Ramps Unusable: Alternative 5 would produce a positive impact by decreasing the average annual number of boat ramp closures downstream by 34.9 percent.

Overall

Alternative 5 would produce a negative impact increasing the average annual number of beach closures by 1,079 Beach Days. Alternative 5 has a 2.11 percent loss ($9,371,000) in average annual recreation benefits based on boat ramp availability in the lakes compared to the NAA. Private dock owners in the lakes would have the use of their docks for a shorter time frame with this alternative compared to NAA.

This alternative results in a tradeoff of negative ramp availability, swimming areas and private docks in the lakes, with the gain of boat ramp days in the river downstream of the lakes.

Future Conditions with Project Alternative 6:

Alternative 6 would have negative effects on recreation upstream of JST and positive effects downstream of JST.

Hartwell: Alternative 6 would produce the largest negative impacts, more than tripling the average annual number of lane days that ramps are unusable in comparison to the NAA. It also has the largest negative impact on swimming, increasing the total number of beach closures by 2,102 Beach Days.

Thurmond: Alternative 6 would produce the largest negative impacts, more than tripling the number of lane days ramps are unusable in comparison to the NAA and produces the largest negative impact on beach closures by decreasing the total number of beach closures by 5,912 Beach Days.

Lane Days Downstream Ramps Unusable: Alternative 6 would produce a positive impact, decreasing the average annual number of boat ramp closures by 50.5 percent.

Overall

Alternative 6 would produce the largest negative impact increasing the total number of beach closures by 8,014 Beach Days. Alternative 5 would have a 17.64 percent loss ($78,410,000) in average annual recreation benefits based on boat ramp availability in the lakes compared to the NAA. Private dock owners in the lakes would have the use of their docks for a much shorter time frame with this alternative compared to NAA.

Alternative 6 would result in a tradeoff of negative boat ramp availability, swimming areas, and private docks in the lakes, with the positive gain of boat ramp days in the river downstream of the lakes.

4.13 Aesthetics

Future Conditions with No Action Alternative:

With the No Action Alterative, aesthetics will remain as they are presently.

Future Conditions with Project Alternatives 1, 2, or 4:

With implementation of Alternatives 1, 2, or 4, the pools would remain at higher levels longer in Hartwell and Thurmond compared to the NAA. The higher pool would maintain the non-drought viewshed for a longer time. Lower flows downriver would not be as noticeable until sand and gravel bars become exposed. These alternatives do not change the view shed downstream of the lakes.

Future Conditions with Project Alternatives 3, 5, or 6:

With implementation of Alternatives 3, 5, or 6, the lake shoreline would become exposed sooner in Hartwell and Thurmond, compared to the NAA. As the water level drops, the viewshed from the homes and recreational sites along the lakes has the potential to be impacted. Higher flows downriver would not be noticeable. These alternatives do not change the view shed downstream of the lakes.

4.14 Hydropower

Reservoir modeling with HEC-ResSim allows tracking of the system hydropower energy on a weekly basis relative to the hydropower contract. Weekly energy shortages were summed and a valuation for the current month per megawatt hour of on-peak energy

was used to calculate cumulative energy shortages during the drought simulations. Average monthly on-peak and off-peak energy values from FY 2006-2010 were used for the valuation (SEPA, per comm.). Cumulative hydropower energy shortages were computed for the NAA and each alternative during the period of analysis using weekly reservoir system energy output from ResSim. A monthly valuation of on-peak energy from the Southeastern Power Administration was applied to the energy shortages to compare cumulative energy shortage values in each alternative. Minimum cumulative system conservation storage was used to compare each alternative to the NAA in terms of its resiliency during the period of analysis.

The PDT evaluated data collected at each project over fourteen years (1/01/1999 to 12/26/2013), which was deemed an appropriate basis for projecting likely future conditions for hydropower through 2050. Data from this period was converted into annual averages, brought forward through a thirty-four year period of analysis, and discounted at the FY17 rate in conformance with EGM 17-01.

The evaluation of impacts to hydropower is based on the following metrics:

- Energy generation at Hartwell, Russell, and Thurmond.
- Pumping costs at Richard B. Russell.
- Cost of replacement power purchased by SEPA.
- Number of days Augusta would need to run diesel pumps to pull raw water due to implementation of FERC agreement.

The values shown in Table 29 are based on the average annual values of the energy produced at Lake Hartwell, Lake Russell, and Lake Thurmond. In addition, the table displays the percent change average annual equivalent (AAE) hydropower value that results from the difference between the future with project condition alternative and the NAA over a 34-year period of analysis.

Table 29: Percent Change in Hydropower Value ($1000s)

	Contract Energy Generated	Surplus Energy Generated	Capacity	Purchased Energy	Pumping Costs	AAE Hydro Value	Delta NAA	Percent Change
NAA	$303,447	$54,019	$1,275,602	($8,363)	($2,609)	$75,397		
ALT1	$302,448	$59,058	$1,269,698	($12,669)	($2,739)	$75,105	($293)	-0.39%
ALT2	$303,621	$56,886	$1,273,079	($8,042)	($2,697)	$75,432	$35	0.05%
ALT3	$300,510	$57,162	$1,271,165	($19,653)	($2,640)	$74,675	($723)	-0.96%
ALT4	$303,666	$56,155	$1,273,120	($8,898)	($2,673)	$75,364	($34)	-0.04%
ALT5	$302,752	$52,393	$1,278,925	($11,438)	($2,532)	$75,305	($93)	-0.12%
ALT6	$304,191	$40,986	$1,280,948	($6,760)	($2,286)	$75,164	($233)	-0.31%

*34 Year Period of Analysis
**2.875 Percent Discount Rate
***Costs Represent Net Present Value

System energy value is the value of the energy produced at Lake Hartwell, Lake Russell, and Lake Thurmond over a fourteen year period (1999 to 2013).

Augusta Canal Hydropower: Impacts to hydropower generation within the Augusta Canal are provided in Table 30.

Table 30: Average Annual Augusta Canal Hydropower Impacts (Dollars)			
	AAE	Delta NAA	Percent Change from NAA
NAA	$441,356		
ALT 1	$477,153	$35,797	8.11%
ALT 2	$471,328	$29,971	6.79%
ALT 3	$437,908	($3,448)	-0.78%
ALT 4	$490,343	$48,987	11.10%
ALT 5	$345,360	($95,996)	-21.75%
ALT 6	$238,782	($202,574)	-45.90%

*34 Year Period of Analysis
**2.875 Percent Discount Rate

Future Conditions with No Action Alternative:

The NAA would not have impacts on the amount or value of hydropower produced.

Future Conditions with Project Alternative 1

Alternative 1 would have a $293,000 negative average annual equivalent impact on hydropower. This results in a 0.39 percent change decrease from the NAA.

Future Conditions with Project Alternative 2

Alternative 2 would have a $35,000 positive average annual equivalent impact on hydropower. This results in a positive 0.05 percent change from the NAA.

Future Conditions with Project Alternative 3

Alternative 3 would have a $723,000 negative average annual equivalent impact on hydropower. This results in a decrease of 0.96 percent change from the NAA.

Future Conditions with Project Alternative 4

Alternative 4 would have a $34,000 negative average annual equivalent impact on hydropower. This results in a negative 0.04 percent change from the NAA.

Future Conditions with Project Alternative 5

Alternative 5 would have a $93,000 negative average annual equivalent impact on hydropower. This results in a negative 0.12 percent change from the NAA.

Future Conditions with Project Alternative 6

Alternative 6 would a $233,000 negative average annual equivalent impact on hydropower. This results in a negative 0.31 percent change from the NAA.

4.15 Water Supply

Periods of inaccessibility of water supply intakes to water due to low pool elevations were tabulated for each alternative and compared to the NAA. For exceedance tables and detailed impacts to lake levels, see Appendix B.

The tabulations of water supply needs resulted in the use of GADNR-EPD's projected 2050 water demand levels as a proxy for all years in the period of analysis. To verify the appropriateness for those years in the immediate future where water demand is projected to be less than in 2050, a comparative HEC-ResSim model run was performed using GADNR-EPD's current day (2008-2013) average net consumptive water use. These runs yielded nearly identical pool plots, demonstrating that only little differences in the pool elevations and discharges would be observed (See Appendix B). As such, the use of 2050 water demand levels is an acceptable methodology that accounts for expected future conditions in all years leading to 2050.

The PDT concluded that the hydrologic data covering a fifteen-year period 1/01/1999 to 12/26/2013 is appropriate for projecting likely future conditions for water supply through 2050. Data from this period was converted into annual averages and brought forward through a thirty-four year period of analysis. Not all of the municipal intakes are used for potable water only. Therefore, the PDT choose to evaluate all of the intakes regardless of their use.

The PDT used the following evaluation metrics:

- Number of days that lake levels are below the lowest possible elevation for water supply intakes to operate.
- Number of days that river flow and elevation levels are below that necessary for water supply intakes to function.

Impacts to individual water intakes can be found in Tables 31, 32, and 33. The modeling did not identify additional impacts to water intakes at RBR.

Table 31: Avg. Annual Days Below Critical Elevation at Hartwell Lake Intakes								
Hartwell Lake Intakes	Intake Inoperable (feet msl)	Average Annual Days below Critical Elevation Per Year						
		NAA	ALT1	ALT2	ALT3	ALT4	ALT5	ALT6
Clemson University Agriculture	653	71	20	63	77	49	93	183
Clemson University	623.5	0	0	0	0	0	0	0
City of Lavonia	634	0	0	0	0	0	0	11
Clemson Golf Course	633	0	0	0	0	0	0	8
City of Hartwell	620	0	0	0	0	0	0	0
Anderson County Joint Municipal Water Supply	615.3	0	0	0	0	0	0	0
Milliken Company	611	0	0	0	0	0	0	0
J.P. Stevens Company	600	0	0	0	0	0	0	0
Total		71	20	63	77	49	93	202
Delta NAA			-51	-8	6	-23	22	131
Percent Change			-71.3%	-11.8%	8.4%	-32.0%	30.2%	183.7%
Combined		9	3	8	10	6	12	25
Delta NAA			-6	-1	1	-3	3	16
Percent of Period		2.4%	0.7%	2.2%	2.7%	1.7%	3.2%	6.9%
Delta NAA			-1.7%	-0.3%	0.2%	-0.8%	0.7%	4.5%

Table 32: Avg. Annual Days Below Critical Elevation at JST Lake Intakes								
JST Lake Intakes	Intake Inoperable (feet msl)	Average Annual Days below Critical Elevation						
		NAA	ALT1	ALT2	ALT3	ALT4	ALT5	ALT6
Savannah Lakes (Monticello Golf Course)	324	100	43	88	109	70	112	192
Savannah Lakes (Tara Golf Course)	324	100	43	88	109	70	112	192
Hickory Knob State Park Golf Course	324	100	43	88	109	70	112	192
City of Lincolnton	321	0	0	0	0	0	0	0
City of Thompson/McDuffe e County	320	0	0	0	0	0	0	0
Columbia County	320	0	0	0	0	0	0	0
City of Washington	307	0	0	0	0	0	0	0
City of McCormick	300	0	0	0	0	0	0	0
Total		300	129	264	327	210	335	577
Delta NAA			-171	-36	27	-90	35	277
Percent Change			-57.1%	-12.0%	8.9%	-30.1%	11.7%	92.4%
Combined		37	16	33	41	26	42	72
Delta NAA			-21	-4	3	-11	4	35
Percent of Period		10.3%	4.4%	9.1%	11.2 %	7.2%	11.5%	19.8%
Delta NAA			-5.9%	-1.2%	0.9%	-3.1%	1.2%	9.5%

Table 33: Avg. Annual Days below Critical Flows at Downstream Intake Locations							
Downstream Intakes	Average Annual Days below Critical Flow						
	NAA	ALT1	ALT2	ALT3	ALT4	ALT5	ALT6
Augusta-Richmond County (Diesel Pumps)	0	0	0	0	0	0	0
City of North Augusta	0	38	0	0	0	0	0
Kimberly Clark Corporation Beech Island	0	38	0	0	0	0	0
SCE&G Urquhart Station	0	38	0	0	0	0	0
DSM Chemicals Augusta, Inc.	0	38	0	0	0	0	0
PCS Nitrogen Fertilizer, L.P.	0	38	0	0	0	0	0
General Chemical Corp., Augusta Plant	0	38	0	0	0	0	0
D/S of NSBL&D (Cretaceous Sand)	0	61	0	0	0	0	0
International Paper Corporation - Augusta Mill	0	61	0	0	0	0	0
DOE Savannah River Operation (Westinghouse SRS G Area Misc Ind)	0	57	0	0	0	0	0
Southern Nuclear Operating Co., Inc. (Vogtle)	0	2	0	0	0	0	0
Georgia Power Co - Plant McIntosh	1	37	1	2	1	0	0
GA Pacific (Fort James Operating Company)	1	37	1	2	1	0	0
Beaufort Jasper W&SA Main Plant	1	37	1	2	1	0	0
Savannah City Water Supply	1	37	1	2	1	0	0
Tronox Pigments (Savannah), Inc.	1	37	1	2	1	0	0
Weyerhaeuser Company	1	37	1	2	1	0	0
International Paper Corporation	1	37	1	2	1	0	0
Total	7	668	7	14	7	0	0
Delta NAA		661	0	7	0	-7	-7
Percent Change NAA		9442.9%	0.0%	100%	0.0%	-100.0%	-100.0%
Combined	0	37	0	1	0	0	0
Delta NAA		37	0	0	0	0	0
Percent of Period	0.1%	10.2%	0.1%	0.2%	0.1%	0.0%	0.0%
Delta NAA		10.1%	0.0%	0.1%	0.0%	-0.1%	-0.1%

Future Conditions with No Action Alternative:

The NAA would not adversely impact water supply.

Future Conditions with Project Alternative 1

Alternative 1 (at Hartwell Lake – critical elevations) would reduce the average annual number of inoperable days by the largest degree and would result in an estimated 71.3 percent decrease from the NAA. Alternative 1 would reduce the number of average annual inoperable days the largest degree and would result in an estimated 57.1 percent decrease from the NAA. Alternative 1 would produce a considerably larger increase than any of the other alternatives. The average annual number of days below critical elevation levels would increase by 9,442.9 percent. There would be minimal adverse impacts to water supply users in RBR Lake.

Future Conditions with Project Alternative 2

Alternative 2 would reduce the average annual number of inoperable days and constitutes an estimated 11.8 percent decrease from the NAA. Alternative 2 would reduce the average annual number of inoperable days and constitutes an estimated 12.4 percent decrease from the NAA. Alternative 2 would produce a 16.7 percent increase in average annual days below critical elevation levels during the period of analysis. There would be no adverse impacts to water supply users in RBR Lake.

Future Conditions with Project Alternative 3

Alternative 3 would increase average annual number of inoperable days by 8.4 percent over the NAA. Alternative 3 would increase the average annual number of inoperable days and constitutes an estimated 8.9 percent increase from the NAA. Alternative 3 would produce a 100 percent increase in average annual days below critical elevations during the period of analysis. There would be no adverse impacts to water supply users in RBR Lake.

Future Conditions with Project Alternative 4

Alternative 4 would reduce the average annual number of inoperable days by the second largest degree and constitutes an estimated 32.0 percent decrease from the NAA. Alternative 4 would reduce the average annual number of inoperable days by the second largest degree and constitutes an estimated 30.1 percent decrease from the NAA. Alternative 4 would produce no change in average annual number of days below critical elevations during the period of analysis. There would be no adverse impacts to water supply users in RBR Lake.

Future Conditions with Project Alternative 5

Alternative 5 would increase the average annual number of inoperable days by the second largest degree and constitutes an estimated 30.2 percent increase over the NAA. Alternative 5 would increase the average annual number of inoperable days by

the second largest degree and constitutes an estimated 11.7 percent increase from the NAA. Alternative 5 would reduce the average annual number of days below critical elevations by 100 percent during the period of analysis. There would be no adverse impacts to water supply users in RBR Lake.

Future Conditions with Project Alternative 6

Alternative 6 would increase the average annual number of inoperable days by the largest degree and constitutes an estimated 183.7 percent increase from the NAA. Alternative 6 would increase the average annual number of inoperable days by the largest degree and constitutes an estimated 92.4 percent increase over the NAA. Alternative 6 would produce the positive impact of a 100 percent reduction in the number of average annual days below critical elevations during the period of analysis. There would be no adverse impacts to water supply users in RBR Lake.

4.16 Environmental Justice

Future Conditions with No Action Alternative

The NAA (continuing with the 2012 SRBDCP) would have no effects on Environmental Justice.

Future Conditions with Alternatives 1 through 6

Alternatives 1-6 would affect the entire length of the Savannah River Basin. The adverse effects would be minimal in scope and relatively evenly distributed along the 238 miles of river downstream of JST. As a result, these alternatives would not result in disproportionately high and adverse human health or environmental impacts on minority or low-income populations. No adverse impacts to humans would occur on or adjacent to the Savannah District's three reservoirs. Therefore, these alternatives comply with Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations."

4.17 Hazardous Toxic and Radioactive Waste (HTRW)

The probability of encountering new HTRW contamination for the proposed action is low. No construction would occur as a result of these alternatives. If a new environmental condition is identified that is caused by a change to the DCP, USACE will take the necessary measures to avoid that recognized environmental condition so that the probability of encountering or disturbing HTRW would continue to be low.

4.18 Cumulative Impacts

Council on Environmental Quality regulations (40 CFR 150.7) require an analysis of the cumulative impacts resulting from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions, regardless of who undertakes these other actions. Cumulative impacts can result from individually minor, but collectively significant, actions. This section of the EA addresses the cumulative

effects arising from the Proposed Action when combined with other ongoing or proposed actions in the Savannah River Basin.

The Savannah River does not function as it did in the early-1900s. In many areas, the bends in the river were cut off to facilitate navigation in the mid-1950s. USACE, Savannah District, is studying the restoration of those bends along the Savannah River between Augusta and the mouth of the Savannah Harbor to improve fish and wildlife habitat. Several dams cross its flow, holding back high spring flows and raising low summer flows. Some meandering oxbows were cutoff in an effort to aid river navigation. Peaking operations at hydropower plants make the flows irregular in some areas during the course of the day and week, rather than being primarily in response to rainfall events and seepage from adjacent wetlands. Numerous withdrawals of water occur, some for municipal use, some for industrial purposes, and others to aid adjacent recreation. The number of users of the river has increased dramatically. The ponded lakes that occur upstream of the dams provide sources for several types of recreation, and those sites are used heavily for those purposes. Fishermen use the free-flowing portions of the river, and their numbers have continued to increase with the overall growth in regional population.

If it were not for the multiple users of the river and lakes as they now exist, there would be little concern about the amount of water flowing in the river during a drought. But the goals and activities of many individuals, organizations, corporations, and government agencies are now affected by the amount of discharge from J. Strom Thurmond Lake to the ocean. Those users are expected to continue to conduct their activities on the lake and in the river in the future.

The Savannah District expects growth in both the number of users and the amount of water that is desired to be withdrawn from the lakes and river. Georgia Power has obtained permission to withdraw additional water from the Savannah River for their expansion of Plant Vogtle, near Waynesboro, Georgia. Savannah District is presently evaluating reallocation of storage at Hartwell Lake for water supply for four requestors. The total request is for 24.55 MGD or 45 cfs.

The Savannah River is viewed by some located in other river basins as a ready source of clean water for their needs. If the regulating government agencies agree that additional inter-basin transfers can occur, stresses on existing uses along the entire length of the Savannah River basin would increase.

In summary, flows in the Savannah River have been substantially modified over time. However, the basin still provides a multitude of opportunities for the use and enjoyment of this valuable resource. The number of people desiring to use or benefit from this resource continues to increase. The uses vary seasonally, with lower demands placed on the aquatic ecosystem during the cooler fall/winter months. As a drought intensifies or continues in duration, the stress on both the natural ecosystem and human uses of the resources increases. Long term adverse cumulative impacts would result primarily from increases in water usage and an accompanying loss of water from the river basin.

4.19 P&G Screening Alternative for Plan Selection

USACE is required to consider the effects of proposed project alternatives using the following four criteria: completeness; effectiveness; efficiency; and acceptability.

4.19.1 Completeness

Completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. This may require relating the plan to other types of public or private plans if the other plans are crucial to obtaining the expected benefits to the objective.

A complete alternative is one that is well thought out. All the necessary implementation actions have been accounted for in the planning process. Once plan effects have been identified, it is important to scrutinize the plan to ensure that it includes all that is necessary to realize the plan effects. This means considering those things beyond the planners' control, as well as those things that may be beyond the scope of the USACE program or the sponsors' commitment.

Since this study accounted for all project purposes, necessary investments, implementation actions, and multiple levels of review, the NAA and each of the six detailed alternatives meets the above conditions of completeness.

4.19.2 Effectiveness

Effectiveness is the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities.

An effective plan is responsive to the wants and needs of people. An effective plan makes a significant contribution to the solution of some problems and achieves some opportunities. It contributes to the attainment of the planning objectives. In the screening process, it is often possible to identify alternatives that make little or no contribution to the planning objectives. When this happens, these alternatives can be rejected because they are relatively ineffective.

The alternatives were formulated to meet the project criteria by covering a wide range of discharges to address stakeholder concerns. The alternatives were evaluated based on effectiveness.

4.19.3 Efficiency

Efficiency is the extent to which an alternative plan cost effectively alleviates the specified problems and realizes the specified opportunities, consistent with protecting the Nation's environment.

Efficiency refers to the allocation of resources. Are the resources used efficiently in the construction of a project or the implementation of a plan? Are the outputs produced by the plan produced in an efficient manner? Are the resources that are going to be

significantly affected by the plan still going to be available for efficient use by society? A criterion of efficiency is cost effectiveness. Have we identified the lowest cost of implementation?

Efficiency must be considered in light of all opportunity costs, not just monetary costs. This makes the efficiency criterion considerably more difficult for planning for the Corps' environmental mission because planners may have to tradeoff increased implementation costs against less environmental losses.

In this study, the water resource is distributed to all users covering all project purposes. Once identified, the TSP would make no user worse off from a monetary or non-monetary unit of measure.

4.19.4 Acceptability

Acceptability is the workability and viability of the alternative plan with respect to acceptance by State and local entities and the public and compatibility with existing laws, regulations, and public policies. Acceptability does not equate with the non-Federal sponsor's willingness to sign a Project Cooperation Agreement. Also, if the plan has opposition, that doesn't make it unacceptable.

There are two primary dimensions to acceptability: implementability and satisfaction. Implementability means is it feasible in the technical, environmental, economic, and social senses.

To be acceptable to state and local entities as well as the public, a plan has to be implementable. There are many factors that can render a plan infeasible. These factors can generally be categorized as technical, economic, financial, environmental, social, political, legal and institutional. If a plan cannot be done for legitimate reasons, it is not feasible.

Acceptability can also be defined as the extent to which a plan is welcome or satisfactory.

The goal is to have high acceptability, which means that the alternatives are generally acceptable to all in both an implementable and satisfactory sense. These dimensions of acceptability have been considered in this study. The alternatives satisfy the requirements of all agencies and users and are implementable.

4.19.5 Risk and Uncertainty

The fundamental purpose of the study was to identify the best allocation of water resources to users both upstream and downstream of J. Strom Thurmond Dam and Reservoir and sustain environmental resources during drought conditions. The degree of hydropower and recreation are explicit planning objectives that deal with risk reduction. When we devise operating rules for reservoirs we are inherently dealing with situations of risk and considerable uncertainty as to the performance of our designed systems.

Since the Corps program explicitly deals with risk and uncertainty, the goal is to construct an approach that explains the risk and uncertainty in a uniform manner. Risk and uncertainty analysis is about improving information and, ultimately, the decisions based upon that information. The Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) of March 10, 1983, states:

"The planner's primary role in dealing with risk and uncertainty is to identify the areas of sensitivity and describe them clearly so that decisions can be made with knowledge of the degree of reliability of available information."

The PDT evaluated the consequences of all known risks and uncertainties and delineated them in the development of the risk register. After careful consideration, the PDT developed recommendations on how to manage the risks and uncertainties. The PDT selected the TSP that eliminates or minimizes as many adverse effects as possible.

5.0 Comparison of Alternatives (Quantitative and Qualitative Effects Matrix)

USACE

Savannah District evaluated the effects that each alternative would have on each project purpose: environmental stewardship, flood risk management, hydropower, navigation, recreation, and water supply. The team evaluated the effects of the alternative on each project purpose in terms of percent change from the NAA.

The effects of the alternatives on hydropower and recreation were measured using an economic factor, whereas the other project purposes used non-economic factors. Since the units of measurement for the effects on the project purposes are different, percent change was selected as a method of evaluation to give each project purpose a common unit of measurement (Table 34). Once the project purposes were measurable in the same unit, comparison rankings were conducted.

All seven alternatives, including the NAA, were ranked from 1 to 7 with respect to project purposes, with 1 being the highest positive impact and 7 being the highest negative impact. The team then tabulated these rankings and summed them by alternatives (Table 35). Ranking proved to be a transparent comparison process and allowed the selection of the Tentatively Selected Plan (TSP).

For hydropower, only Alternative 2 would produce positive benefits above the NAA.

For recreation, Alternatives 1, 2, and 4 would produce positive benefits above the NAA.

For environmental, only Alternative 2 would produce positive benefits above the NAA.

For water supply, Alternatives 2 and 4 would produce positive benefits above the NAA.

For navigation, Alternatives 1, 2, and 4 would produce positive benefits above the NAA.

For flood risk management, Alternatives 1, 2, 3, 5, and 6 would produce positive benefits above the NAA.

Alternative 2 achieves the planning objective of producing the most positive impacts and least negative impacts on the authorized project purposes compared to the NAA. Alternative 2 produces no negative impacts. Environmentally, Alternative 2 is the only alternative that would result in fewer DO violations than the NAA. Alternatives 3, 5, and 6 produce the most negative impacts and minimal positive impacts on the authorized project purposes. Those alternatives only benefit flood risk management. Alternative 1 benefits recreation, navigation, and flood risk management, but it produces one of the highest negative impacts to environmental, water supply, and hydropower. Alternative 4 positively impacts recreation, water supply, and navigation compared to the NAA. Alternative 4 negatively impacts hydropower, environmental, and flood risk management. Alternative 4 is the only alternative that would increase flood risks.

Only Alternatives 2 and 4 rank better than the NAA, but Alternative 2 ranks better than Alternative 4. Alternative 2 ranks as the best alternative because it is the only alternative that produces positive impacts for all authorized project purposes. In addition, it is the only alternative that produces more hydropower benefits and fewer DO violations than the NAA. Alternative 4 produces fewer hydropower benefits, increases flood risk, and produces more DO violations than the NAA.

Table 34: Evaluation of Alternatives							
	NAA	**Alt1**	**Alt2**	**Alt3**	**Alt4**	**Alt5**	**Alt6**
HYDROPOWER*		-0.39%	0.05%	-0.96%	-0.04%	-0.12%	-0.31%
AAE combined dollars		-$293,000	$35,000	- $723,000	-$34,000	-$93,000	-$233,000
Rank	**2**	6	**1**	7	3	4	5
RECREATION*		3.35%	0.72%	-1.08%	1.67%	-2.11%	-17.64%
AAE combined dollars		$14,889	$3,185	-$4,809	$7,406	-$9,371	-$78,410
Rank	**4**	**1**	**3**	**5**	**2**	6	7
ENVIRONMENTAL							
Rank Lake	3	5	2	7	1	4	6
Rank River	5	2	2	4	2	3	1
Rank Estuary/Harbor	6	7	3	5	4	2	1
Rank Overall**	**2**	6	**1**	7	3	5	4
WATER SUPPLY***		-117.74%	11.62%	-10.77%	29.93%	-13.93%	-107.60%
Rank	**3**	7	**2**	4	**1**	5	6
NAVIGATION		13.00%	7.00%	-2.00%	6.00%	-9.00%	-9.00%
Rank	**4**	**1**	**2**	5	**3**	6	7
FLOOD RISK MANAGEMENT***		0.85%	0.69%	100.00%	-23.77%	0.95%	100.00%
Rank	**6**	**4**	**5**	**2**	7	**3**	**1**
TOTAL RANK	**21**	**25**	**14**	**30**	**19**	**29**	**30**
FINAL RANKING	**3**	**4**	**1**	**7**	**2**	**5**	**6**

** Average annual benefits calculated at 2.875% over 34-yr. period of analysis.*
*** Percentages can be found in Appendix C. Ranks adjusted to address the DO issue in the harbor.*
****Signs switched to maintain consistency with regards to the rest of table. Original data located in Appendix B.*
Note: Negative signs equate to detrimental impacts. Positive equates to beneficial impacts.
Note: Percent signs represent percentage change from NAA.
Note: Shading represents a positive rank or improvement compared to the NAA.

Table 35: Ranking of Alternatives							
	NAA	**Alt1**	**Alt2**	**Alt3**	**Alt4**	**Alt5**	**Alt6**
HYDROPOWER	2	6	**1**	7	3	4	5
RECREATION	4	**1**	**3**	5	**2**	6	7
ENVIRONMENTAL	2	6	**1**	7	3	5	4
WATER SUPPLY	3	7	**2**	4	**1**	5	6
NAVIGATION	4	**1**	**2**	5	**3**	6	7
FLOOD RISK MANAGEMENT	6	**4**	**5**	**2**	7	**3**	**1**
Total Rank	21	25	**14**	30	**19**	29	30
Final Rank	3	4	**1**	7	**2**	5	6
Note: Shading represents an improvement compared to the NAA.							

South Carolina Department of Health & Environmental Control

SCDHEC used daily DO results to compute monthly average DO values. Those values then used to compute the monthly delta DO values (monthly DO for Alternatives 1-6 minus the monthly DO for the No Action Alternative). Monthly DO values were used for this analysis to smooth the delta DO values which vary on a daily basis due to changing model hydrodynamics between alternative release patterns.

Based on this analysis, Alternative 2 is best in terms of relative impact on harbor dissolved oxygen levels when compared to the No Action Alternative. The overall ranking for Alternatives 1-6 is as follows: 2 (best), 4, 5, 6, 3, 1 (worst).

South Carolina Department of Natural Resources

SCDNR compared the impacts of each of the six new alternatives and the NAA for numerous metrics associated with the lakes, river, and harbor along the Savannah River. The comparisons were made using data produced by the reservoir, river, and harbor models. SCDNR's evaluation considered how each alternative impacted the entire Savannah River basin, not just the lakes, river, or harbor.

The modeling indicated that some alternatives performed significantly worse than the NAA, while others performed almost as well or better in some respects. Although Alternative 1 was most beneficial for lake levels, it performed significantly worse than the NAA and other alternatives in terms of impacts to water intakes in the river. It also had significant negative impacts to water quality (dissolved oxygen) in the harbor. Alternative 3 also resulted in significant negative impacts to water quality in the harbor

when compared to the NAA. Alternatives 5 and 6 both had significant negative impacts to lake levels, making those options less desirable than the NAA. Alternative 4 performed slightly worse than Alternative 2 and the NAA in terms of lake levels and harbor water quality.

For harbor dissolved oxygen conditions, Alternative 2 is the best of the six alternatives tested, and appears to perform better than the NAA. Alternative 2 also appears to perform as well or better than the NAA in terms of the overall impacts to the river and to the lakes.

SCDNR supports the choice of Alternative 2 as the preferred alternative, with the following caveats:

- Alternative 2, as originally modeled, has no winter drawdown in the Drought Trigger Levels. As a result, Drought Trigger Level 1 has the same elevation as the Guide Curve for the last two weeks of December, which means, during that time, the system could only be in either Flood or Drought conditions. Because this situation would be problematic for lake operations, the lakes would probably be managed in a way that is slightly different from how Alternative 2 was actually modeled. SCDNR would be more supportive of Alternative 2 if it were modeled consistent with how it would actually be implemented.
- Although Alternative 2 appears to be an improved management strategy in terms of its overall effects on the lakes, river, and harbor along the Savannah River, the potential for reduced flows in the river may result in impacts to wastewater dischargers along the river that have not yet been identified. These potential impacts need to be assessed before SCDNR is fully supportive of this new drought management plan.

<u>Georgia Department of Natural Resources</u>

Georgia EPD compared the impacts of each of the six alternatives to the No Action Alternative (NAA) by looking at the effect the each alternative had on the daily DOs levels in the Harbor (Table 36). The Savannah Harbor Model predicted Alternative 1 would increase the extent DO levels in the Harbor were less than a daily average of 5 mg/L, both temporally and spatially by 0.08% of the time. Whereas, Alternatives 2, 3, 4, 5, and 6 all showed a slight improvement in the Harbor DO. The percent time the daily DO was less 5.0 mg/L was predicted to decrease for each of these alternatives: 1.2%, 0.5%, 0.9% 1.9% and 2.8%, respectively. GA EPD further compared the change in the percent time the Harbor DO levels were predicted to be above 4.0 mg/L, above 3.0 mg/L and below 2 mg/L for the six alternatives compared to the NAA. These results are given in Table 33. Positive results indicate a detrimental impact to the Harbor DO; whereas negative results indicate an improvement in the Harbor DO. Based on this analysis, Alternative 6 had the least impact, followed by Alternatives 5, 2, 4, 3, and 1, in that order.

GA EPD also compared the difference in the daily DO for the NAA and each of the six alternatives during the critical period, when the daily average Harbor DO is predicted to be less than 5 mg/L, to see the impact on the allowable deficit, which is only 0.1 mg/L. Based on a daily analysis, GA EPD examined the percent time when the allowable deficit of 0.1 mg/L was reduced by 50% or greater over 36.8% of the time for Alternative 1, 6.75% for Alternative 2, 29.3% for Alternative 3, 6.35% for Alternative 4, 10.8% for Alternative 5, and 12.6% of the time for Alternative 6. The percent of the time the various alternatives reduced the allowable deficit more than 1% was also examined. Table 29 presents the results which are 59.73% for Alternative 1, 14.82% for Alternative 2, 43.68% for Alternative 3, 14.60% for Alternative 4, 14.89% for Alternative 5, and 16.64% of the time for Alternative 6. Based on this analysis, Alternative 4 reduces the allowable DO deficit the least amount of time, followed closely by Alternative 2, then Alternatives 5, 6, 3, and 1, in that order.

The evaluation of the alternatives was determined by summing the percent time each alternative impacted the DO levels and the DO deficit as compared to the NAA. The total percent times was then ranked and overall ranking is as follows: Alternative 2 (best), 4, 5, 6, 3, 1 (worst).

Table 36: GADNR Ranking of the Alternatives Based on the Percent Time DO Affected as compared to the NAA

DO Evaluation		Alternatives					
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6
Daily DO (mg/L)							
> 5.0 mg/L		0.70%	-1.20%	-0.50%	-0.90%	-1.90%	-1.20%
> 4.0 mg/L		0.70%	-1.30%	-0.30%	-1.10%	-2.10%	-1.30%
> 3.0 mg/L		0.60%	-0.80%	0.20%	-0.60%	-1.20%	-0.80%
> 2.0 mg/L		0.10%	-0.20%	0.10%	-0.10%	-0.30%	-0.20%
< 2.0 mg/L		0.20%	-0.10%	0.20%	0.00%	-0.20%	-0.10%
Delta DO (mg/L)	Allow Deficit						
>0.05->1	>50-100%	36.86%	6.76%	29.34%	6.35%	10.80%	12.60%
>0.001	>1%	59.73%	14.82%	43.68%	14.60%	14.89%	16.64%
	Sum	98.89%	17.98%	72.72%	18.25%	19.99%	17.98%
	Rank	6	1	5	2	3	4

GADNR ranks Alternative 2 as the best alternative.

The Nature Conservancy (TNC)

To select a preferred alternative, The Nature Conservancy evaluated the NAA Alternative (NAA) and the six action alternatives on three basis points. TNC's primary basis as an environmental conservation organization was alternative performance as evaluated by the USACE *Ecosystem Functions Model* (EFM) for the period of record from 1999-2013. This period was chosen as it contains a number of years of significant drought, which best reflects the primary purpose of this study. Strong secondary factors

included 1) performance across a variety of human use measures including hydropower output, recreational impacts to the reservoirs, and water supply impacts and 2) performance in meeting dissolved oxygen standards in the Savannah River harbor.

Through a combination of direct environmental performance benefits, good balance with reservoir and harbor conditions, and a process of elimination from unacceptable alternatives, The Nature Conservancy supports Alternative 2 as the Preferred Alternative.

6.0 Selection of Tentatively Selected Plan (TSP)

The PDT selected Alternative 2 as the TSP because it would produce the most beneficial impacts and least negative impacts on the project purposes and users.

With implementation of the TSP, hydropower, recreation, environmental, water supply, and navigation would improve compared to the NAA. The TSP would decrease the total number of beach closures and increase boat ramp availability within the lakes. Private dock owners in the lakes will also have the use of their docks for longer periods with implementation of the TSP when compared to the NAA. In addition to the recreational benefits of the TSP, there are several environmental benefits that will be realized. These benefits include improved DO levels within the river and harbor, the ability to maintain stable lake levels during spawning periods, providing adequate flows in the shoals for spawning habitat, and having an increased effect on downstream fish spawning and fish populations in the harbor. With these slight ecosystem benefits, over time, both the water quality and fish and wildlife habitat within the project area show an improvement when compared to existing conditions. These improvements could be lost if additional water withdrawals occur in the future. No measurable negative impacts on the FRM are expected.

When in drought trigger level 1, Thurmond would target a daily average release of 4,000 cfs. When in drought trigger level 2, Thurmond would target a daily average release of 3,800 cfs, and 3,600 cfs from November through January. When in drought trigger level 3, Thurmond would target a daily average release of 3,600 cfs, and 3,100 cfs from November through January.

Alternative 2 addresses increased conservation opportunities by raising trigger level 3, and slightly decreasing the required flows for each trigger level. The drought triggers do not vary seasonally in this alternative. Drought trigger level 1 is located at the same elevation as the winter guide curve (4 feet down from summer guide curve). Drought trigger level 2 is located 2 feet below drought trigger level 1. Drought trigger level 3 is located 2 feet below drought trigger level 2.

7.0 Public Involvement*

As part of Interim I Comprehensive Basin Study, the District and TNC worked together to develop an Ecosystem Flow Prescription. Completed in 2003 through a workshop process, the Prescription was one of the first-ever comprehensive set of river flow recommendations developed for a public water management facility. The Prescription was constructed by a science and engineering stakeholder group with 55 participants representing state and federal agencies, academic institutions and nonprofit conservation organizations. The Prescription described base flows, ranges of variability, and pulse and flood flows to benefit the full range of ecosystem resources and processes in the Savannah River.

The Prescription 2.0 was developed collaboratively with university scientists, agencies and stakeholders over the year 2014. Fifty-one individuals representing 21 organizations participated in its development. The process included six months of preparatory work from January-June 2014 through a 20-person technical committee. Important aspects of this preparation included acquisition and mining of new flow-ecology data and studies generated since 2003, and detailed review of the original 2003 prescription for elements whose context may have changed or for which new data may have been acquired since 2003. The preparatory work culminated in a Savannah River flow strawman; essentially a very rough draft of a new prescription intended for further development.

The strawman was then used as a launching point for a two-day participatory workshop held in Augusta, GA on July 23-24, 2014. Workshop participants were also provided with several supporting documents ahead of the dates, including the original 2003 prescription (Meyer et al., 2003), a post-2003 literature review through 2012 of direct Savannah River research and other highly relevant findings (Long and Jackson, 2012), and a compendium of drought-focused instream research conducted in 2012-13 by the US Fish and Wildlife Service (Duncan et al., 2014). The participants also received analyses of pre- and post-dam flows in the Ecosystem Functions Model (http://tinyurl.com/q8hf9vn), using flow benchmarks developed in the pre-workshop strawman to provide context of which benchmarks are already met in normal operations versus those needing targeted management action. Participants were briefed on significant unpublished research regarding movements of endangered sturgeons (B. Post, unpublished data), and relationships of floodplain forest elevations to flow magnitude (B. Sharitz, M. Davis, and L. Lee, unpublished data).

Savannah District has posted the following study documents to its public website

- Review Plan
- Project Management Plan
- Study Schedule

Those documents explain what the study will examine, the types of analyses that will be performed, and a timetable for when they will be performed.

The District maintains a Balancing-The-Basin blog where it regularly posts articles about the Savannah River Basin. This study has been discussed on that blog numerous times.

District staff have discussed the study with non-federal groups, including the following:

- South Carolina Savannah River Basin Advisory Board
- Lake Hartwell Homeowners Association

Public access to the draft report and environmental assessment is scheduled for a 30-day review period beginning in June 2017.

8.0 Coordination and Regulatory Compliance

Coordination with state and federal agencies on the project has been ongoing throughout the study process. South Carolina and Georgia Department of Natural Resources are not only part of the project team but they are also two of the three non-federal sponsors. U.S. Fish and Wildlife Service is also part of the project team and have been consulted with regards to Section 7 of the Endangered Species Act The Nature Conservancy is a third non-federal sponsor and an active member of the team, hosting several interagency meetings for the project.

Preparation of this EA and draft Finding of No Significant Impact (FONSI) is being coordinated with appropriate Congressional, Federal, state, and local interests, as well as environmental groups and other interested parties. The following is a list of federal and state agencies and NGO's that will receive a copy of the EA for review:

U.S. Department of Interior, Fish, and Wildlife Service
U.S. Environmental Protection Agency
U.S. Department of Commerce, National Marine Fisheries Service
Natural Resources Conservation Service, State Conservationist
Advisory Council on Historic Preservation
S.C. Department of Health and Environmental Control
S.C. Department of Natural Resources
S.C. Historic Preservation Officer
Georgia Department of Natural Resource
Georgia Historic Preservation Officer

Recommendations of the U.S. Fish and Wildlife Service in accordance with the Fish and Wildlife Coordination Act will be added when received.

Coordination of the 2012 PA is ongoing with both SHPO and the Tribes. The signing of this agreement will occur before the signing of the FONSI for this EA.

9.0 Mitigation

The appropriate application of mitigation is to formulate an alternative that first avoids adverse impacts, then minimizes adverse impacts, and lastly, compensates for unavoidable impacts.

The proposed action avoids adverse impacts by:

1. Requiring the minimum flows through the Augusta shoals needed for endangered species.
2. Decreasing the amount of greenhouse gas emissions by maintaining hydropower efficiencies during peak performance times.
3. Increasing the DO levels within the harbor and the river and reducing the amount of days DO standards are not met in the harbor.

The proposed action minimizes adverse impacts by:

1. Maintaining stable lake levels during spawning season for largemouth bass.
2. Improves fish spawning downstream of the New Savannah Lock and Dam.
3. Improves fish spawning in Savannah Harbor.

Compensatory mitigation is not warranted for the tentative selected plan.

10.0 Compliance with Law and Regulations*

Table 37 summarizes compliance of the proposed action with applicable Federal/State laws.

Table 37: Relationship of Project to Environmental Requirements

Federal Statutes	Level of Compliance*
Clean Air Act	Full
Clean Water Act	Partial
Coastal Barrier Resources Act	N/A
Coastal Zone Management Act	Partial
Comprehensive Environmental Response, Compensation and Liability Act	Full
Endangered Species Act	Partial
Estuary Protection Act	Full
Farmland Protection Policy Act	Partial

Federal Water Project Recreation Act	N/A
Fish and Wildlife Coordination Act	Partial
Flood Control Act of 1944	Partial
Land and Water Conservation Fund Act	N/a
Magnuson Fishery Conservation and Management Act	Partial
Marine Mammal Protection Act	Full
National Environmental Policy Act	Partial
National Historic Preservation Act	Partial
North American Wetlands Conservation Act	Full
Resource Conservation and Recovery Act	N/A
Rivers and Harbors Act	Full
Water Resources Development Acts of 1976, 1986, 1990, and 1992	Full
Water Resources Planning Act	Full
Watershed Protection and Flood Prevention Act	Full
Wild and Scenic Rivers Act	Full
Executive Orders (EO), Memoranda, etc.	
Migratory Bird (E.O. 13186)	Partial
Protection and Enhancement of Environmental Quality (E.O. 11514)	Partial
Federal Statutes	Level of Compliance*
Protection and Enhancement of Cultural Environment (E.O. 11593)	partial
Exotic Organisms (E.O. 11987)	Full
Floodplain Management (E.O. 11988)	Full
Protection of Wetlands (E.O. 11990)	Full
Relating to Protection and Enhancement of Environmental Quality (E.O. 11991)	Partial
Environmental Justice in Minority and Low-Income Populations (E.O. 12898)	Full
Invasive Species (E.O. 13112)	Full
Protection of Children from Health Risks and Safety Risks (E.O. 13045)	N/A

Prime and Unique Farmlands (CEQ Memorandum, 11 August 1980)	N/A

*Level of Compliance:
Full Compliance (Full): Having met all requirements of the statute, E.O., or other environmental requirements.
Partial Compliance (Partial): Not having met some of the requirements at current stage of planning. Compliance with these requirements is ongoing.
Non-Compliance (NC): Violation of a requirement of the statute, E.O., or other environmental requirement.
Not Applicable (NA): No requirements for the statute, E.O, or other environmental requirement for the

No sediment disposal in waters of the US activities are included in the proposed plan. Therefore, a Section 404(b)(1) evaluation is not required.

Section 401 Water Quality Certifications from the States of Georgia and South Carolina are not needed for the proposed action because no discharge effluent or materials would be deposed of into waters of the U.S.

Environmental compliance for the proposed action would be achieved upon completion of the following:

- Coordination of this EA and draft Finding of No Significant Impact (FONSI) with appropriate agencies, organizations, and individuals for their review and comments.
- U.S. Fish and Wildlife Service (USFWS) confirmation that the proposed action would not likely adversely affect any endangered or threatened species or their critical habitat.
- Concurrence by the Georgia and South Carolina State Historic Preservation Officers in the USACE's determination of No Effect on cultural resources.
- Receipt and acceptance or resolution of all USFWS Fish and Wildlife Coordination Act recommendations.
- Receipt and acceptance or resolution of all EPA's comments on the air quality impact analysis documented in the EA.
- Coordination of the 2012 Programmatic Agreement is ongoing with both SHPO and the Tribes. The signing of this agreement will occur before the signing of the FONSI for this EA.

The draft FONSI will not be finalized and signed until the proposed action achieves environmental compliance with applicable laws and regulations, as described above.

11.0 Recommendations

The PDT, which includes members of the Georgia Department of Natural Resources, the South Carolina Department of Natural Resources, The Nature Conservancy, and USACE, recommends Alternative 2 as the Tentatively Selected Plan.

Alternative 2 addresses increased conservation opportunities by raising trigger level 3, and slightly decreasing the required flows for each trigger level. The drought triggers do not vary seasonally in this alternative. Drought trigger level 1 is located at the same elevation as the winter guide curve (4 feet down from summer guide curve). Drought trigger level 2 is located 2 feet below drought trigger level 1. Drought trigger level 3 is located 2 feet below drought trigger level 2.

When in drought trigger level 1, Thurmond targets a daily average release of 4,000 cfs. When in drought trigger level 2, Thurmond generates a daily average release of 3,800 cfs from February through April, and, then, 3,600 cfs from May through January. When in drought trigger level 3, Thurmond targets a daily average release of 3,600 cfs from February through April, and, then, 3,100 cfs from May through January.

Date: _____

Draft

_____

Marvin L. Griffin, P.E.
Colonel, U.S. Army
Commanding

12.0 References

Anderson, David G., Christopher Amer, and Rita F. Elliott
1994 Archeological Survey Along the Upper Savannah River, Including Underwater Investigations at the Rembert Mound Group. Technical Reports No. I, Interagency Archeological Services Division, National Park Service, Atlanta.

Caldwell, Joseph R.
1953 *Appraisal of the Archaeological Resources of Hartwell Reservoir, South Carolina and Georgia.* Report prepared by the National Park Service.

Elliott, Daniel T.
1995 *The Clark Hill River Basin Survey*. LAMAR Institute, Watkinsville, Georgia and the Savannah River Archaeological Research Project, University of South Carolina. New Ellenton, South Carolina. LAMAR Institute Publication 26.

Georgia Department of Natural Resources, Environmental Protection Division. Savannah River Basin Management Plan. 2011.

Hutto, Brooks
1970 *Archaeological Survey of the Elbert County, Georgia, Portion of the Proposed Trotters Shoals Reservoir, Savannah River.* University of Georgia Laboratory of Archaeology Series Report No. 7. University of Georgia, Athens.

Pope, Natalie Adams, William Matthew Tankersley and Tracy Martin
2016 *Phase I Archaeological Survey of 2,561 Acres, Richard Bu. Russell Dam and Lake, Elbert and Hart Counties, Georgia and Abbeville County, South Carolina (Revised Draft).* Contract Number W912HN-12-D-0016, Task Order 0031. Prepared by New South Associates, Stone Mountain, Georgia for U.S. Army Corps of Engineers, Savannah District.

Taylor, Richard L., and Marion F. Smith
1978 *The Report of the Intensive Survey of the Richard B. Russell Dam and Lake Project, Savannah River, Georgia and South Carolina*. South Carolina Institute of Archaeology and Anthropology Research Manuscript Series 143. Columbia.

Sweeney, Alex and Thomas G. Whitley
2011 *American Recovery and Reinvestment Act 2009 Section 110 Compliance Report for the U.S. Army Corps of Engineers, Savannah District NHPA, Cultural Resources Investigations Technical Report No. 22 Section 110 Survey of 3,727 acres at Lake Hartwell, Hart County, Georgia, and Oconee and Anderson Counties, South Carolina, and 2,465 acres at Richard B. Russell Reservoir, Elbert County, Georgia, and Abbeville County, South Carolina.* Prepared by Brockington and Associates, Stone Mountain, Georgia. Submitted to U.S. Army USACE of Engineers, St. Louis District.

DRAFT FINDING OF NO SIGNIFICANT IMPACT
(FONSI)

Savannah River Basin Comprehensive Study
Drought Contingency Plan Update, Georgia and South Carolina
Water Management and Ecosystem
INTERIM 2

1. Description of Proposed Action: The U.S. Army Corps of Engineers (USACE), Savannah District, proposes to refine the 2012 Savannah River Basin Drought Contingency Plan (SRBDCP) for drought operations. The proposed action will increase conservation opportunities by raising drought trigger level 3 and slightly decreasing the required flows for each drought level. The drought triggers do not vary seasonally in this alternative. Drought trigger level 1 is located at the same elevation as the winter guide curve or 4 feet down from summer guide curve. Drought trigger level 2 is located 2 feet below drought trigger level 1. Drought trigger level 3 is located 2 feet below drought trigger level 2.

When in drought trigger level 1, Thurmond would target a daily average release of, 4,000 cfs. When in drought trigger level 2, Thurmond would target a daily average release of, 3,800 cfs (February through April), and then 3,600 cfs (May through January). When in drought trigger level 3, Thurmond would target a daily average release of, 3,600 cfs (February through April,) and then 3,100 cfs (May through January).

2. Factors Considered in Determination: USACE Savannah District has assessed the impacts of the proposed action on important resources, including wetlands and aquatic resources/fisheries, terrestrial resources, wildlife, threatened, endangered and protected species, cultural, air quality, and water quality. No significant adverse impacts were identified for any of the important resources. The risk of encountering HTRW is low. No impacts were identified that would require compensatory mitigation. The proposed action does not change the impact on the Coastal Zone, but has the potential to improve Air Quality within the project area by reducing the amount of greenhouse emissions that would be released from power generating plants. There are only minor changes in water quality when compared to the no action alternative. No additional fill would be placed in the waters of the U.S., therefore, a Section 404(b)(1) evaluation or Section 401 water quality certification is not required. In addition, USACE Savannah District will concur with, and/or resolve, all Fish and Wildlife Coordination Act recommendations. Savannah District will concur with and/or resolve, all comments provided by Federal and state agencies and the public. The flow reductions from the proposed action has the potential to alter essential fish habitat in the estuary in the lower Savannah River. Although the reduced flow volume would change velocities, the extent of those changes would be too small to be measurable.

3. Environmental Design Commitments. The following commitments are an integral part of the proposed action:

1. If the proposed action is changed significantly or is not implemented within one year, Savanah District will coordinate with the U.S. Fish and Wildlife Service to ensure that the proposed action would not adversely affect any Federally-listed threatened or endangered species, or their habitat.
2. If any unrecorded cultural resources are determined to exist within the proposed project boundaries and ground disturbance is required, then no work will proceed in the area containing these cultural resources until a Savanah District staff archeologist has been notified and final coordination with the State Historic Preservation Officer and Tribal Historic Preservation Officer has been completed.
3. Adequate flow in the Augusta shoals, as documented in the draft FERC Agreement for the Augusta Diversion Dam, will be maintained to ensure that there are no impacts to fish spawning activities.

4. Public Involvement. An interagency meeting was held on 1 November 2016 with the non-federal sponsors and various stakeholders to compare and evaluate the final array of alternatives for the Savannah River Basin Comprehensive Study, and to select the tentatively selected plan. The proposed action will be coordinated with appropriate federal, state, and local agencies and businesses, organizations, and individuals through distribution of a draft environmental assessment for their review and comment.

5. Conclusion. USACE Savannah District has assessed the potential environmental impacts of the proposed action. Based on this assessment, a review of the any comments made on the environmental assessment, and the implementation of the environmental design commitments listed above, USACE Savannah District could conclude that the proposed action will not result in a significant impact on the human environment. Therefore, an Environmental Impact Statement will not be prepared.

Draft

Date

C. David Turner
Brigadier General, U.S. Army
Commanding